Computers & Electronics

NOVEMBER 1982

formerly Popular Electronics

$1.25

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This Issue:
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egrated Stereo Amplifier
Teknika 19" Color TV Monitor

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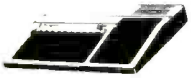
TI-99/4A Home Computer System



TI-99/4A Keyboard	**$300.00**
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Final Price	**200.00**

TEXAS INSTRUMENTS
INCORPORATED

Model	Name	Mfr. Sugg. Ret.	Elek-Tek Price
CONSOLE			
PHC 004A	TI-99/4A Home Computer (incl. RF Modulator)	450.00	300.00
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)	69 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, Foresman)			
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 3083	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)	29 95	24.00
PHD 5079	Elementary Economics	29 95	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

* Available in Fourth Quarter 1982
† 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	14 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)			
PHM 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	9.00
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	60.00
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) a (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 En[illegible]eering Library	24 95	20.00
PHT 6013	Graphing Package	14 95	12 00
PHT 6016	Structural Engineering Library	24 95	[illegible]
PHT 6044	AC [illegible]alysis	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

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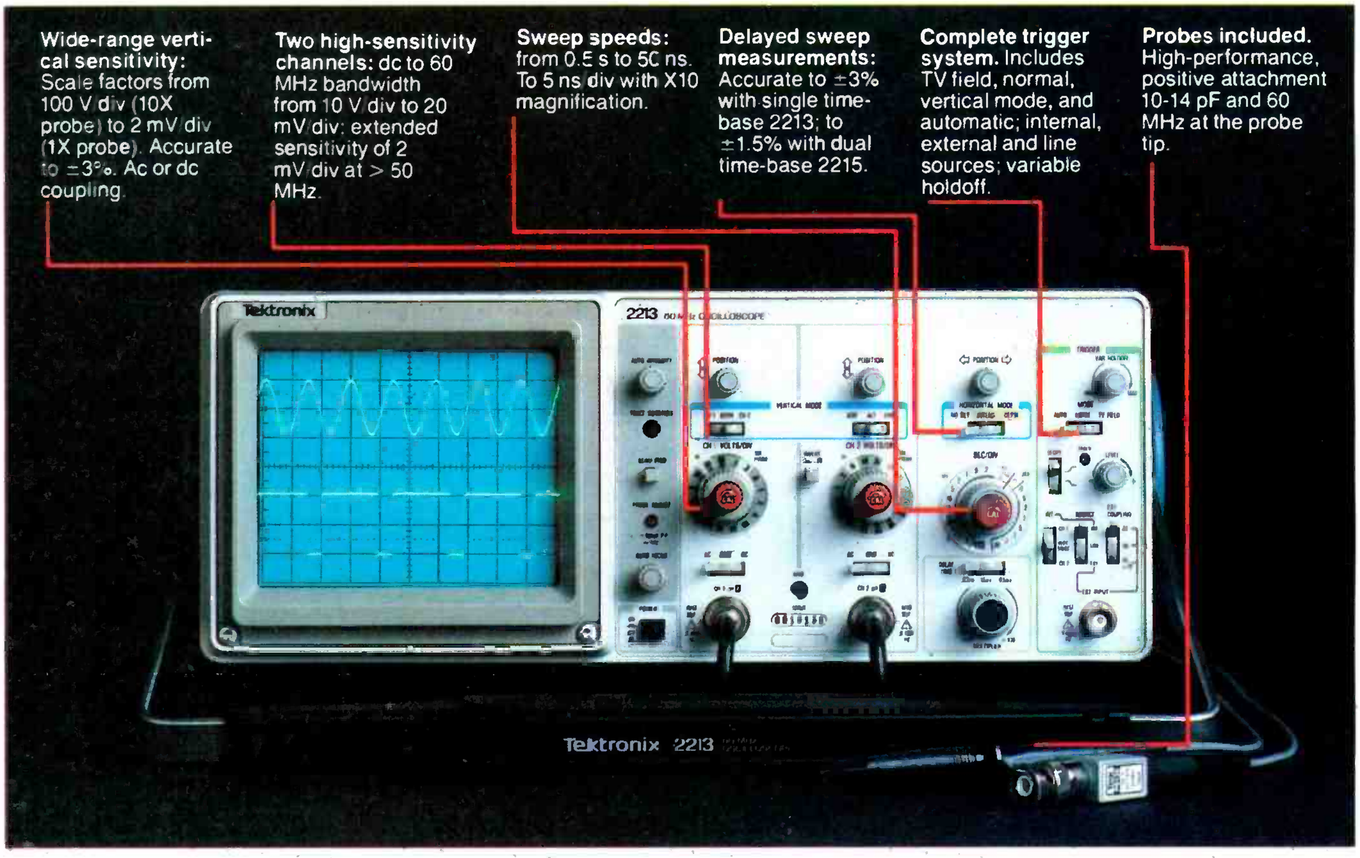

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Computers & Electronics

NOVEMBER 1982
VOLUME 20, NUMBER 11

FEATURE ARTICLES

CONSTRUCTION ARTICLES

EQUIPMENT REVIEWS

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DEPARTMENTS

COVER ART BY JAMES HEGEDUS

Computers & Electronics (ISSN 0032-4485) November 1982, Volume 20, Number 11. 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. 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.

EDITORIAL

Number One!

Though this issue marks number 11 of the year, it's really number 1 under our new banner, COMPUTERS & ELECTRONICS. As you will observe as you read through the issue, we've touched many more computer-related bases than ever before as a result of committing extra pages to this purpose. But you will doubtlessly also notice that the editorial tradition of covering the broad field of electronics technology is being carried forward as ever.

The typical reader of COMPUTERS & ELECTRONICS has a host of electronics interests, with microcomputers fast becoming a staple for avocational, business, and professional purposes. A survey of subscribers conducted last year confirmed again that the great majority of our readers are male (97%); well-educated (7 of 10 attended college and 17% have had post-graduate study); and involved with more than one electronics activity (usually it amounts to three or four).

The study revealed that more readers plan to become active in the microcomputer area within the year than in any other electronics activity. Considering this fact, it is not surprising then to learn from the survey that, from among subscribers who plan to purchase a consumer electronic product in the next 12 months, microcomputers rank first with 20% (followed by video cassette recorders with 17%). In giving purchasing advice to others, advice on microcomputers ranked second (with 20%) only to audio equipment (21% gave advice).

Experimenting with electronics is, naturally, at the forefront of our readers' interests, whether it be microcomputers, audio, video, or a home electronics gadget. In this respect, I'm eagerly following Forrest Mims's three-part column on experimenting with Kodak's new disc camera, which starts in this issue. Forrest tells me that the applications resulting from his electronic modification work on the camera are among the most exciting work he's ever done. The final result of his efforts is expected to appear in our January 1983 issue.

One issue before that, in December, we'll present a modestly priced universal speech synthesizer project. It will let any computer talk back to you—or anyone else. Meanwhile, talk to you next month.

Art Salsberg

Computers & Electronics
formerly Popular Electronics

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LETTERS

EXMON AND MONDAPT FOR OSBORNE

In the review of the Osborne 1 computer in your September issue, it was noted that we make the EXMON adapter. This is not true. We originated the MONDAPT, which was the first monitor adapter for the Osborne 1. The original MONDAPT does not fit the new Osborne 1, however, so we are currently developing a new one which will be announced soon.—*Charles B. Hornbrook, President, Esoteric Engineering Inc., San Diego, CA.*

TELEPHONE TERMINAL DEVICES

Under telephone company tariffs and Part 68 of the FCC rules, in order to protect the telephone network, it is required that all terminal devices connected to the network either be registered or connected through registered protective couplers. Your article "Build a Telephone Status Monitor" (June 1982) is an example of the type of equipment that should have such a registration.—*James R. Keegan, Federal Communications Commission, Washington, DC.*

PAY TV DECODER

Is it possible to build a "decoder" that will unscramble the signals on pay TV? Have you ever published such a circuit or do you plan to?—*F. J. Caraballo, Trenton, NJ.*

Its legality in the hands of the user is being challenged, so we can't publish the information.—Ed

OUT OF TUNE

In "Digital Auto Tune-Up Meter" (May 1982), *R3* should be 56 ohms and should be connected to *DIS2* instead of *DIS1*. *R13* should be 300 kilohms, *R16* should be 1.33 megohms and *R17* should be 665 kilohms.

In "Triac Motor Control for Warm-Air Systems" (August 1982), the diacs should be listed as type 1N5759 in Parts List.

In "Simple Audio Gate Expands Dynamic Range" (July 1982), potentiometer *R16* should be omitted from Parts List.

The Software: PROGRAMS

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8" CP/M

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NEW PRODUCTS

VIDEO CAMERA WITH TIME-LAPSE SETTING

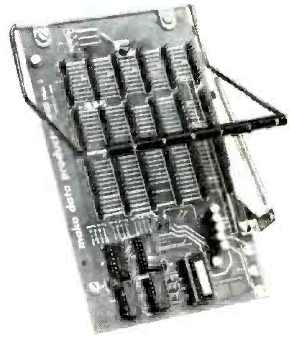
The VC-X2 from Akai has an "intervalometer" that serves as a time-lapse device capable of recording periods from 8 hours to 11 days. The camera uses the new Saticon tube, said to be superior to a vidicon tube in resistance to burning (after-images when a camera is moved from a bright scene to a dim one) and effectiveness in low light situations. A 1.5" black-and-white monitor is built into the unit for in-field viewing and playback. Automatic features of the VC-X2 include auto focusing, motorized two-speed telephoto with 6:1 zoom, macro setting, audo fade-in/fade-out for both audio (via a standard boom microphone) and video. A second mike jack permits recording in stereo. Resolution is given at 300 lines. Weight is 5.3 lb. $1195.

Circle No. 100 on Free Information Card

I/O EXPANSION

The MH89 plus 3 accessory to the Heath/Zenith H89 and H90 computers is reported to double I/O expansion capability. It replaces the right-hand accessory board area with a 6-slot mother board, creating three additional slots. The latter have four device-select lines each, separately port-addressed on 8-byte boundaries. Current draw is 50 mA. $150.

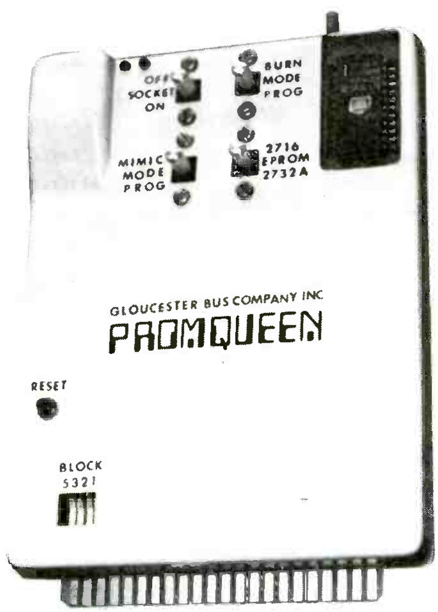
Circle No. 98 on Free Information Card



MINI DRILL/STAND

The PD-3 portable hand drill from OK Machine and Tool Corp. is especially useful for pc-board drilling. It runs at 2500 rpm on four "AA" batteries and weighs 10.5 oz with batteries. The collet accepts drills from 0.019" to 0.58" diam. Together with OK's STD-50 stand, designed especially for the PD-3, it can be used like a drill press to increase precision.

Circle No. 99 on Free Information Card



VIC-20 DEVELOPMENT SYSTEM

The Gloucester Computer Bus Co. has introduced the Promqueen Cartridge, designed to provide EPROM programming capability for the Commodore VIC-20 computer. All necessary connections are made when it is plugged into the VIC's extension port. The Promqueen uses 4K bytes of RAM for program testing before burning them in on the EPROM. A Mimic switch permits an external computer to access programs from a Promqueen RAM or to transmit its own programs to the Promqueen, so the VIC keyboard can be used as part of a development system. A switch determines which of the four VIC expansion blocks is occupied by the Promqueen, so the Promqueen RAM can be used either for direct memory expansion or in conjunction with other cartridges. A switch sets the unit for either 2716 or 1732 EPROMs. Software for storing BASIC programs is included. $170.

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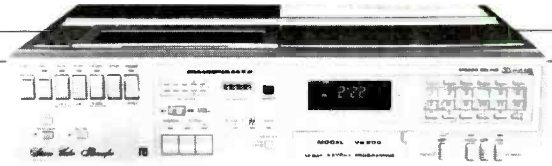
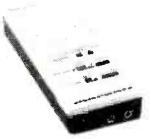
Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.





STEREO-SOUND VCR

The new Marantz Model VR 200 Beta VCR combines stereo audio capability with Dolby C and Beta Noise Reduction. In addition, the unit has a separate audio input that permits taping of FM simulcast while the video section records the picture on the same tape. Other features include gold-plated connectors for corrosion resistance and improved signal quality, light-touch solenoid controls, LED signal-level indicators, full-function remote control (wired), automatic or manual record levels, 5-event/14-day programmable timer, audio dubbing, freeze frame, 9X Betascan in forward or reverse, quartz-lock speed control, automatic tape rewind, slow-motion playback, and stereo headphone jack. $1295.

Circle No. 96 on Free Information Card

TWO-CHANNEL DIGITAL MULTIMETER

The ac-powered WD-753 is a dual-input, auto-ranging, auto-zero DMM with a 3½-digit LED display. The display shows numeric value plus limit of measurements selected. The dual input provides "A" and "B" channels pre-programmed by the user for either ac or dc volts or amps, or low- or high-power ohms. Each channel can be monitored independently, even while a different measurement is being made by the other channel. Ranges are volts from 200 mV to 1000 V dc or 750 V ac; ac and dc current from 200 mA to 2 A; and resistance from 200 ohms to 20 megohms. Basic dc accuracy is rated at 0.1%. Dimensions are 3½" H × 8½" W × 10" D. Weight is 4 lb. $385. VIZ Mfg. Co.

Circle No. 94 on Free Information Card

LOW-COST CASSETTE DECK

The front-loading V-33 from Teac is metal-compatible and has Dolby-B noise reduction with an additional Brilliance switch to boost higher frequencies. It features a 12-segment LED-bar level indicator, 3-digit tape counter, and record muting to eliminate commercials. Frequency response is rated at 30 to 16,000 Hz with either metal or CrO^2 and from 30 to 15,000 Hz with ferric tape. S/N is rated as 57 dB before applying noise reduction and increases by 10 dB above 5000 Hz with Dolby B. Wow and flutter is given as 0.05%. $210.

Circle No. 95 on Free Information Card

PORTABLE PRINTING DATA TERMINAL

Radio Shack's TRS-80 PT-210 portable printing data terminal has a full typewriter keyboard, thermal printer, and 110-300-baud acoustic telephone coupler. It can generate 99 ASCII codes, including 67 printable characters, 32 terminal control characters, and digits via a switch-selectable keypad. Operation can be half or full duplex, with odd, even, or no-parity modes. The thermal printer uses a 35-element matrix and offers variable contrast control. Each 8" line can include up to 80 characters and carriage return is automatic at the 81st column. Printing speed is 50 cps, with 6 lines per vertical inch. Indicators include a ¼-s tone, a power-on lamp, and carrier-detect and character-error lamps. It is housed in a silver-grey case 15½" × 14½" × 5"; weight is 15 lb with paper. Price is $995; optional RS232C interface plug-in module is $70.

Circle No. 93 on Free Information Card

SUPERHET RADAR DETECTOR

Electrolert's Fuzzbuster uses phase-lock circuitry that reportedly picks up all bands and types of radar, including low-power and pulse. It has a highway/city selector, a light to signal that contact with radar has been made, and an alarm panel to indicate distance from the radar source by sequentially lighting a row of LEDs as the vehicle nears the radar. Audio warning trigger is set by adjusting an on-off control. $300.

Circle No. 92 on Free Information Card

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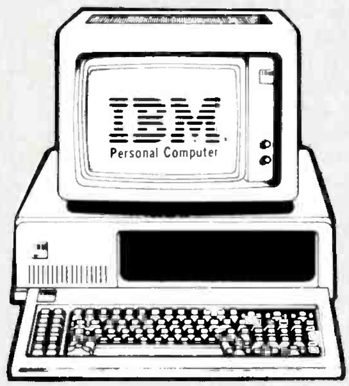

HARDWARE for the IBM-PC

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AST RESEARCH, Combo Plus, 64K with one option	NEW!	$ 495	$379
Combo Plus, 256K with one option	NEW!	$1095	$729
Options Async Comm Port, Para Printer Port, Clock/Calender. Add $80 for second option and $55 for third			
Parity Memory Card, 64K		$ 395	$279
256K		$ 995	$659
Note: All of above cards are memory upgradeable			
BYAD INC., DS1, Z80B for CP/M-80		$ 660	$570
DS2, above with serial port, (Sept)		$ 760	$660
CORVUS, Hard Disk System, See Corvus Section This Page.			
CURTIS, PC Pedestal, TM for Display on PC		$ 80	$ 65
3 Foot Cable for IBM Mono Display		$ 50	$ 39
DAVONG, DS1-501 Hard Disk, 5 Meg		$1995	Call
64K RAM Card		$ 299	Call
256K RAM Card		$ 799	Call
★ MICROSOFT, 64K RAM Card w/Parity, RAM Drive & Utility		$ 350	$259
128K RAM Card w/Parity, RAM Drive & Utility		$ 525	$395
256K RAM Card w/Parity, RAM Drive & Utility		$ 875	$659
64K RAM Chips TM		$ 175	$129
★ QUADRAM CORPORATION			
Quadboard, 64K expandable to 256K, 4 function board		$ 595	$449
256K, four function board		$ 995	$689
Microfazer or Interfazer			Call
TG PRODUCTS, Joystick		$ 65	$ 49
TANDON, Disk Drives			
TM100-1 Single Sided 160K		$ 280	$229
TM100-2 Double Sided 320K		$ 350	$295
VISTA COMPUTER, 576K Maxicard		$1395	$1195
XEDEX, Baby Blue, 64K plus CP/M operation		$ 600	$495

SOFTWARE for the IBM-PC

BUSINESS

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COMSHARE TARGET, Target Planner Calc		$ 50	$ 39
DENVER SOFTWARE, Easy (Executive Accounting System)		$ 725	$545
INFORMATION UNLIMITED, Easywriter II (a WPS)		$ 350	$259
Easyspeller (88K Words)		$ 175	$129
Easyfiler (a DBMS)		$ 400	$299
INNOVATIVE SOFTWARE, T.I.M. III (a DBMS)		$ 495	$369
★ INSOFT, Data Design (a DBMS)	NEW!	$ 225	$169
INNOVATIVE, Spell Guard		$ 295	$220
ISM, MatheMagic		$ 90	$ 69
MICRO LAB, The Tax Manager		$ 250	$189
★ MICROPRO, WordStar® plus free WordStar Training Manual		$ 495	$249
MailMerge TM		$ 150	$ 79
SpellStar TM		$ 250	$149
Special! All Three Above, WordPac		$ 895	$459
WordStar Training Manual		—	$ 25
MICROSOFT, Multiplan (uses MSDOS)		$ 275	$199
PERFECT SOFTWARE, Perfect Writer TM		$ 389	$239
Perfect Speller TM		$ 189	$119
Perfect Filer TM		$ 289	$179
SELECT INFO., Select (a WPS)		$ 595	$375
SORCIM, SuperCalc		$ 295	$219
SuperWriter, call on availability		$ 395	$295
Spell Guard, call on availability			Call
VISICORP, VisiCalc®/256K		$ 250	$189
VisiDex		$ 250	$199
VisiTrend/Plot		$ 300	$239
VisiFile		$ 300	$199
Desktop Plan		$ 300	$239

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8" CP/M BUSINESS & DEVELOPMENT SOFTWARE

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COMSHARE TARGET, Target PlannerCalc	$ 50	$ 39
INFOCOM, Deadline, 8"	$ 60	$ 45
Zork I, 8"	$ 50	$ 39
Zork II, 8"	$ 50	$ 39
INNOVATIVE, Spellguard, 8"	$ 295	$220
ISM, MatheMagic	$ 100	$ 75
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Prof. Billing & Time Keeping	$ 750	$395
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CalcStar TM	$ 350	$180
Special! All Three Above, DataPac	$ 695	$359
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OASIS, The Word Plus (a WPS)	$ 150	Call
MICROSOFT, Fortran-80, 8"	$ 500	$325
BASIC Compiler, 8"	$ 395	$295
COBOL-80, 8"	$ 750	$545
BASIC-80, 8"	$ 350	$275
PEACHTREE, Magic Wand, 8"	$ 500	$350
GL, A/R, A/P or Inventory, 8"	$ 750	$495
PERFECT SOFTWARE, Perfect Writer TM	$ 389	$239
Perfect Speller TM	$ 189	$119
Perfect Speller TM	$ 289	$179
QUALITY, GBS with 3 generators, (a DBMS)	$ 700	$525
SELECT INFO., Select (a WPS)	$ 595	$375
SORCIM, SuperCalc	$ 295	$219
Super Writer, call on availability	$ 395	$295
Spell Guard, call on availability	$ 295	Call

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EPSON, See Epson section below			
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SANYO, 9" B&W	$ 190	$149
★ 9" Green	$ 200	$119
12" B&W	$ 250	$199
12" Green	$ 260	$199
13" Color, Composite	$ 470	$349
13" Color RGB	$ 995	$795
Monitor Stand	$ 50	$ 39
ZENITH, 12" Green	$ 150	$119
AMDEK, 12" Green #300	$ 200	$159
13" Color I, Composite	$ 449	$359
13" Color IIA, RGB, Hi Res (Ap II, III & IBM-PC)	$ 999	$799
13" Color III, RGB, Commercial (Ap II, III)	$ 569	$469
DVM, Color II or III to Apple II Interface	$ 199	$175
Note: Color II and III come with cable for IBM PC		

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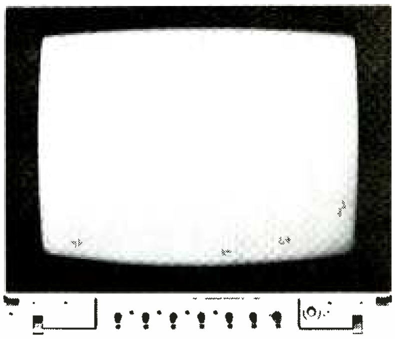
Teknika ATV-M19 19" Color TV Monitor



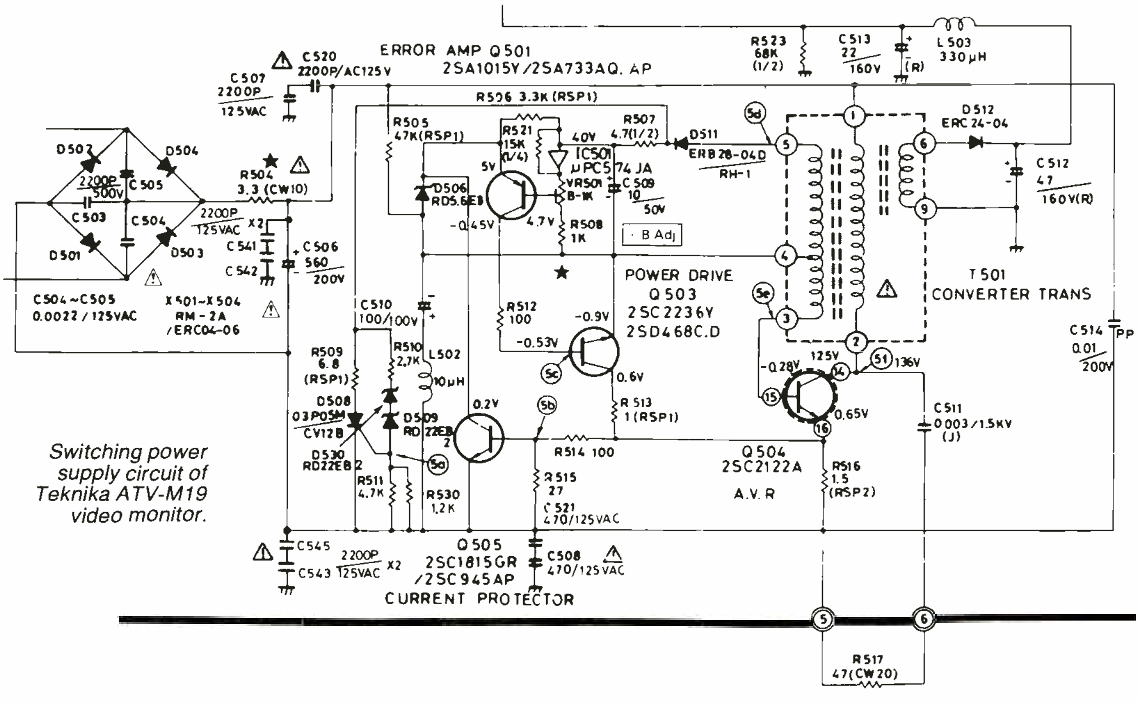
TEKNIKA Electronics Corp. has been distributing electronic products produced by the Japanese manufacturing giant, the General Corporation, for about five years. The company was a leader in this country with a component TV system, which features an optional TV/FM tuner stereo amplifier as well as the separately available 19" video monitor reviewed here. Like other "component" TV systems, one must use a TV tuner to get TV stations; a video cassette recorder can be used for this purpose, as well as an optional tuner such as offered by Teknika and others.

Whereas the Sony "Profeel" video monitor examined in our September 1982 issue has a built-in stereo amplifier, the Teknika Model ATV-M19 that's the subject of this review does not incorporate audio amplifiers. There is a significant difference in the price of this 19" model and the highly rated Sony 19" model, though. While the Teknika monitor has a suggested retail price of $599, the Sony has a suggested price tag of $850. To provide a good buying perspective, we will be comparing the two monitors while detailing our findings on the Teknika.

General Description. This unit uses a familiar type of color picture tube. It's a 90°-deflection, three-gun, in-line, slotted-mask, quick-start tube that requires no dynamic convergence adjustments. Housed in an attractive 20½" × 18⅛" × 18" cabinet that has a brushed silver metallic front and weighing 55 lb, the Teknika monitor is slightly smaller and 17 lb lighter than its Sony counterpart. The Teknika monitor has a solid-state design of course, using two ICs, 23 transistors, 29 diodes, 2 thermistors, and a crystal. Most of these components are mounted on a single, horizontal board located just below the picture tube. A separate board contains video output transistors in the usual arrangement at the socket of the color CRT. All of the adjustment controls are located behind a hinged front panel just below the screen, similar to the arrangement used by Sony.

When we review the schematic diagram, however, the difference between the two units becomes apparent. Teknika uses a transformerless power supply with a switching regulator circuit that carefully regulates the 115-V bus, which then goes to the horizontal flyback transformer. All other voltages (+12V +180V, and +750V) are derived from the horizontal flyback. In the Sony KX1901, separate power transformers, providing complete power-line isolation, are used for all major B+ voltages.

The Teknika converter transformer uses a ferrite core and three windings. Output of the 60 Hz bridge rectifier goes through the



Switching power supply circuit of Teknika ATV-M19 video monitor.

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EPSON MX-100 W/GRAFTRAX+	$CALL
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center winding to the collector of transistor *Q504*. With its base connected to the primary winding, *Q504* generates the necessary oscillations, which are then amplified by power driver *Q503*. Regulation is provided by the combination of *Q501* and the op amp on *IC501*, developed by the output of *D511* in combination with the reference voltage. This reference is based on the two series zener diodes, *D503* and *D509*.

The third winding generates the high-frequency signal to rectifier *D512* and the pi-filter consisting of *C512*, *L503*, and *C513*. Note that only small values of L and C are required owing to the high frequency involved.

It is interesting to observe that the Teknika service manual urges the technician to measure power-line leakage from the unit as well as to perform a special resistance test. The leakage test measures ac from any exposed metal surface to the ground of the power line, and specifies less than 0.5 mA. In addition, a resistance test is recommended in which the resistance between the jumpered ac plug's prongs and any metal part (such as the screws of the antenna terminal) should be no less than 1.0 megohms and no more than 5.2 megohms, with the ac switch on or off. In this respect, the Teknika video monitor may be slightly better than most color TV receivers, but, unlike the Sony KX1901, it is not completely isolated from ground.

A single 75-ohm phone jack is available for the 1-V p-p composite video input to the Teknika video monitor. This presents quite a contrast to the elaborate "jack-pack" we found at the rear of the Sony monitor. The Sony has different connectors, among them a 34-pin connector for RGB (red, green, blue) and control signals from a computer. No such provision is available on the Teknika monitor.

On the basis of the video circuitry in Teknika's schematic we would predict its performace to be that of a typical, good-quality color TV receiver; automatic frequency, and phase and color-correction circuits are of the standard type. The Sony monitor, on the other hand, contained a number of special circuits, including flesh-tone correction, which assure particularly life-like color reproduction. The Teknika monitor contains an on-off for color and phase correction, but its only function is to activate the present potentiometers via a screwdriver access or, in the manual mode, to permit the user to make corrections with the knobs on the control panel. Although called "automatic", this switch does not control automatic circuitry.

From a technical point of view, the most significant performance difference between the Teknika ATV-M19 and its Sony counterpart is the video bandwidth of "not less than 3.0 MHz at 50% of amplitude." The Sony monitor's bandwidth is specified at 4.0 MHz. This difference in bandwidth may not be apparent on a weak, somewhat ghosty, TV broadcast picture. But it can certainly be seen when a high-quality video signal is available. The crisp, clear appearance of letter and numerals on the Sony monitor presents a sharp contrast to the merely good resolution we saw on the Teknika. Both monitors have a sharpness control, and in both cases it has a very limited effect.

Laboratory Measurements. as indicated in the accompanying table, the Teknika's bandwidth ranged to 3.1 MHz. Dc restoration was an excellent 95% (producing bright, pure colors) and was obviously due to the restoration transistor circuit and the individual clamping levels at each subsequent video stage. Horizontal linearity and vertical linearity were quite good but not, as in the Sony unit, essentially perfect.

We determine horizontal and vertical linearity by displaying a grid pattern and actually measuring the difference, in centimeters, between the left and right portions of the screen, and the top and bottom portions, respectively. If the distance between grid lines at all points are of exactly equal length, the linearity is 100%. A 90% difference, as indicated in the table, means that the difference between the center, or reference line, and the other lines is 10%. The linearity measurements obtained for the Teknika 19-inch monitor are typical of those found in good quality 19-inch color TV receivers.

Similarly, convergence is measured by millimeters of overlap at individual grid lines at the screens top, center, bottom, and sides. Again the Teknika unit matched most color TV receivers, but fell short of in the Profeel.

The table also illustrates performance of the various voltage regulators—a good indicator of the entire system's stability. Some of the regulation measurements are not as good as those of the Sony, but they are all adequate and will not affect picture quality.

We looked at color pictures provided by a studio camera, off-the-air color broadcasts, and via a high-quality VCR. The colors were, in general, very good but we noticed some imperfections in naturally occuring red and greens, e.g., trees and sunsets. When pure reds and greens appeared in a picture, they were faithfully reproduced but seemed particularly bright. This was not the case with blue and in-

TEKNIKA MODEL ATV-M19 19" COLOR TV MONITOR

Parameter	Measurement
Video bandwidth to CRT (-6 dB):	3.1 MHz
Dc restoration	95%
Horizontal linearity	95% left, 90% right
Vertical linearity	90% top, 90% bottom
Convergence	90% horiz., 85% vert.
Dc voltage regulation (115 V dc) (105 to 130 V ac)	96%
High-voltage regulation (105 to 130 V ac)	92%
12-volt dc regulation (Max. brightness variation)	90%

termediate colors. A concensus of five individuals provided a general satisfaction with the quality of Teknika's color reproduction. Three of the five had also seen the same test on the Sony video monitor, and they felt Sony's colors were more natural.

Conclusion. the Teknika ATV-M19 color video certainly provides good color pictures, probably better than the majority of commercial color TV receivers. As part of an integrated TV/FM/stereo component system, this monitor has the simplicity of interconnection and a high-quality picture to recommend it. While its suggested selling price of $599 is considerably higher than that of an ordinary 19" color TV model, the overall appeal of a modular component system is obviously attractive to a certain segment of the buying public. The manufacturer's suggested price for a complete system—the 19" monitor, TV/FM stereo tuner with speakers, and an IR remote control—is $1200. The comparable Sony system is $1530, without the FM receiving capability. There may also be a variation in the quality of the speakers and stereo, but we cannot comment on this since no audio tests were performed.

For the consumer who is interested primarily in the quality of the TV picture, the additional cost of the Sony system may not be an objection. This is especially true if the monitor is to be used with a personal computer. Moreover, the Sony has a built-in stereo amplifer, allowing one to use it with a video cassette recorder as the TV tuner without adding an audio amplifier. And it has a "name". For the average TV viewer who buys the optional tuner, there's the gain of FM stereo, while providing good video performance at a lower price. If you are buying the video monitor alone, though and planning to use it with a VCR, the Sony and some others not mentioned would seem to be better choices. This view might change if Teknika's next model corrects some of its shortcomings without raising the price appreciably.

—*Walter Buchsbaum*

CIRCLE NO. 103 ON FREE INFORMATION CARD

The new QX-10 computer promises much for the future

AT THE National Computer Conference in Houston last June, I was shown a working prototype of a new computer that went under the code name of "Rising Star." The system was scheduled to be on its way to dealers by now so here are some of the details concerning it. Some of them are particularly noteworthy.

The computer is now called the QX-10 and it is manufactured by Epson. It consists of three major elements: the main system in an enclosure 20″W × 13½″D × 4″H, a keyboard unit approximately 20″W × 9″D × 2″H, and a video monitor 12½″H × 13½″D × 11″H. The main system contains the mother board, a sub-board, a power supply, a pair of integral low-profile 5¼″ Epson floppy disk drives, and five 60-pin expansion slots accessible through a lift-off door.

The keyboard uses an 8049 CPU and connects to the main board via a cable similar to a telephone cord for bidirectional operation at 1200 baud. The ASCII keyboard (there are several versions for different approaches) has 103 keys of which 58 are conventional, 19 are for numerics, 8 for cursor control, and 18 for special functions. The keyboard is provided with a choice of English, German, Italian, Danish, French, Spanish, or Swedish.

The video monitor has a 12″ green-phosphor, black-face, nonglare CRT with a display format of 80 characters on 25 lines. Using an NEC μPD 7220, the graphics are capable of 640 × 400 pixels. There is a character grid of 16 × 20 that can be employed for user-defined characters. The sync is nonstandard at 20.8 kHz horizontal and 49.5 vertical.

The CPU is a Z80 operating at 4 MHz, while the memory consists of 64K of RAM, with a total of 256K bytes maximum on the main board. There are also 2K bytes of battery-backed CMOS RAM and a choice of 2K, 4K, or 8K bytes of EPROM. Other features include a battery-backed CMOS real-time clock, a small loudspeaker, a Centronics-compatible printer interface, RS-232C port, and a light-pen interface. Seven channels of DMA are provided along with 15 levels of interrupt and six counter/timers.

The twin floppy disk drives can store 320K bytes using 48 tracks/inch, double-sided. Data-transfer rate is 250K bytes/s; track-to-track access time is 35 ms; motor rising time is 500 ms; and power consumption is 15 W/drive. A hard disk is in the offing.

Across the top of the keyboard are four groups of pushbuttons. Under SYSTEM CONTROLS are STOP, HELP, COPY DISK, and UNDO. There are five under FILE CONTROLS: STORE, RETRIEVE, PRINT, INDEX, and MAIL. The four under APPLICATIONS are MENU, CALC, SCHED, and DRAW. Under TYPE STYLES are BOLD, ITALIC, SIZE, and STYLE. Almost all of these are self-explanatory, the last group being used for the printer. For the typist, the left side of the keyboard contains the MAR (margin) REL (release), TAB SET, and TAB REL (release) pushbuttons, all similar to those on a conventional typewriter.

Since we were only allowed to operate the machine for a half hour or so, we were not able to tell too much about its operation. However, in this brief time, I found it to be exceedingly user-friendly—far more so than most other machines we have ever used. This was due mostly to the superb operating software resident in the machine.

When turned on, it came up as a word processor. However, at any time, you could exit the word processor for another function and, after completion of that operation, the machine would pop right back to where you left off in the word processor. You can also jump from utility to utility, including using the modem, and the machine never faulted.

IBM Winchester. This add-on hard disk can be installed directly in the floppy disk area of the IBM

The "Rising Star" system, manufactured by Epson.

Personal Computer. It comes with 6, 12, or 18 megabytes/ drive and the system controller can support up to four drives. The 6-megabyte version with controller, drive, and documentation is $2995; the 12-megabyte version is $3495; and the 18-megabyte is $4195. The disk controller, available separately, is $1950. **Address:** Datamac Computer Systems, 680 Almanor Ave., Sunnyvale, CA 94086 (Tel: 408-735-0323).

TRS-80 Cassette Loader. The LemonAid Loader fits between the cassette earphone jack and the TRS-80 and shapes the cassette output signal while removing noise, overshoot, and eliminating cassette loading problems. There are no volume control settings, no rewiring, adjustments, or software. The circuit is signal powered. $12.99. **Address:** Lemons Tech Services, 325 N. Highway 65, PO Drawer 429, Buffalo, MO 65622-0429 (Tel: 417-345-7643).

Microcomputer Trainer. The Micro-Professor is a Z80-based system featuring a six digit LED display, 2K-bytes of ROM (expandable to 8K), 2K-bytes of RAM, 24 I/O lines, 2K monitor, cassette interface, countertimer circuits, a user wire-wrap area, 36-key keyboard, 9-volt power adapter, and an extension connector. The system is expandable. $129.95. **Address:** Etronix, 14803 N.E. 40th, Redmond, WA 98052 (Tel: 1-800-426-1044).

CBM 16-Bitter. The BX256 is a multiprocessor system using a 6509 and 8088 with an optional Z80, 256K of internal RAM expandable to 640K externally, 40K of ROM, and interfaces for IEEE-488, RS232, CBM cassette, 8-bit user port, and a cartridge slot. The green phosphor video monitor has 80 columns of 25 lines and has tilt/swivel controls. The detachable 94-key keyboard includes a separate numeric keypad featuring a double-zero key, clear entry key, and a double-size enter key for ease of use. The keyboard also has 10 user-definable keys. A built-in 6581 CPU allows a full 3-voice, 9-octave music synthesizer having an output for an external audio system. A dual disk drive is built in as is a real-time clock. Software includes BASIC 4.0, with options of CP/M, CP/M-86, and UCSD Pascal. The BX256 micro processor system supports all CBM peripherals. Planned price is $2995. **Address:** Commodore Business Machines Inc., The Meadows, 487 Devon Park Drive, Wayne, PA 19087 (Tel: 215-687-9750). ◇

STAN VEIT ON COMPUTER SOFTWARE

VALDOCS and the Mind Amp

WELCOME to your new software column. Here's where I will keep you up-to-date on the world of operating systems, languages, applications, games, and graphics software. For starters, I consider the most important software development of the year to date to be VALDOCS, the operating software for an upcoming computer, the Epson QX-10 Mind Amp Computer.

The QX-10 is the result of a collaboration between U.S. software designers and Japanese engineers. It comes from the same source as the Epson printer and the Seiko watch. The American designers are with Rising Star Industries, a group that includes Chris Rutkowski and Roger Amidon, computer pioneers from the former Technical Design Labs (TDL) of Princeton, NJ. Rutkowski has been researching the interface betweeen humans and computers for six years. The VALDOCS system and the QX-10 computer designs represent his efforts to implement the results of his studies. Before I go into a description of what VALDOCS and the QX-10 can do, let me give you a synopsis of the ideas that Chris has incorporated in his paper "An Introduction to the Human Applications Standard Computer Interface (HASCI)."

First he describes the computer environment of the years before 1975, when microcomputers were just beginning. Then he discusses the formative years from 1975 to 1981, when personal computers were in an embryonic state, just developing from an engineer's tool into a small business and scientific utility. He describes each of the development stages of the computer and compares them to the development cycle of the automobile before and after 1925. He states that, after 1925, the automobile had achieved architectural stabilization (a state where the design of the major components had become stable).

In computers, he explains that architectural stabilization will occur when both the human and the computer do what they are best fitted to do without getting in each other's way. The computer is best at manipulating symbols such as mathematical operators and functions, while the human is best at pattern recognition (the broad view of things). When the design is stable, the equipment is reliable, and it can be mass-produced to sell at a reasonable price, then the requirements for a "consumer" computer will have been met.

The hardware is fast approaching that point, but there has not been a comparable improvement in the software. Rutkowski describes the specifications for both a computer and a software operating system that will best interface with a human operator. It turns out that these are the specifications that went into the design of the QX-10 Mind Amp Computer. Since it is my purpose to talk about software in this column, I will stick as close to the subject as possible, though some hardware notes are difficult to ignore entirely.

The QX-10 VALDOCS Computer System consists of a Z80-based CPU with 128K of RAM, a video display, two built-in disk drives with 320 bytes per drive, full parallel and serial I/O, and of course an Epson printer. This is not an unusual group of components; but, when the VALDOCS operating system is added, there is a synergistic result (the whole is greater than the sum of its parts).

When you power up the QX-10 computer, VALDOCS is there ready to work for you. It comes up running the word processor. Thus, there is no requirement for the user to first access the system via the operating system. The word processor is very simple to learn. It is self-prompting and tutorial with HELP messages available when needed.

The detached keyboard design complements the software. There are seven main groups of keys on the keyboard. The first three are similar to almost all computer keyboards:

1. Alphanumeric typing keys
2. Editing/cursor movement keys
3. Numeric keypad

The last four groups are concerned with the essential system functions:

4. System controls
5. File controls
6. Applications
7. Type styles

The titles of these four groups are labeled on the keyboard.

Once learned, the word processor is very easy to use, operating on a "what you see is what you get" principle. It has both an editor and a formatter. If you decide you want to use boldface type or italics, just press the BOLD or ITALIC key and the text on the screen appears in the type face you selected! Not only that, when you give the print command, the printer will print exactly what you see on the screen.

Of course you can also use the capability of the printer to produce condensed or expanded type. Whatever selection you make remains in force until you again hit the key to toggle it back to standard type. There are four type style keys: BOLD, ITALIC, SIZE, and STYLE. If you make a mistake or change your mind, you can use the UNDO key to return to the style you were using before you started changing things.

During your word-processing session, someone may ask you for a telephone number. You can put yourself on "hold," by hitting the STORE key, then the RETRIEVE key, and proceed to ask the system for the address book. The information for the person being sought appears on a subdivision of the screen. You find the phone number and mark it down or direct the system to send electronic mail. Press another key and you are back doing word processing again, just where you left off.

If you don't know where to look for something, there is an INDEX key that selects an index of all the files on the system. When you press it, you can selet one of three choices. You can view the index: (1) sequentially by date and time of creation, (2) alphabetically by index reference, or (3) alphabetically cross-indexed, with each word crossing to each other word.

The video screen layout is essentially the same for all menus; the display is subdivided into "windows," each of which contains specific kinds of information. There is a document window that holds the full document you are working on. There's also a smaller "interaction window" that appears when the system requires some specific information like "What is your name?" This always appears below the document window and can be 8 lines deep. Menus always appear in the interaction window. The third type of window is the prompt window, containing brief prompts or flags to get the user's attention.

In addition to the word processor, the VALDOCS system contains a data base, an electronic mail system and communication program, an address book, a calculator, an appointment book, a note pad, a "things to do" file, a graphics package, and TP/M (a CP/M-type operating system that runs all CP/M applications software).

All these things are completely accessible to the user by means of simple key strokes.

Furthermore, I was told that a VALDOCS FPL (Forms Processing Language) is in the works to add electronic spreadsheet capability, forms generation, and report writing. With this, one will be able to write complex business applications without reference to any other language or system.

At this point, you might think that this must be an expensive system. It isn't, since Epson is talking about a desktop computer that includes VALDOCS for about $3000. You may also think that I am describing something that will happen in the future. But according to Epson, units should be en route to dealers by the time you read this. Licensing of VALDOCS must undoubtedly be on Epson's mind too.

Format II. For all those who own Apple II computers and long for a really good word processor without the expense of buying a Z80 board and WordStar, there is now a way to do it and also get a bonus in the form of a built-in mailing list system!

Kensington Software (300 E. 57th St., New York, NY 10022) has imported the Format II system from Great Britain, made some improvements, translated the already good manual into American English, and is selling the system disk for $275. You do need an 80-column board to use the system, but Kensington will provide the keyboard modification for upper/lower case and for redefining the zero-to-nine keys to word-processing functions. There is a version of the system that will work with all the popular 80-column boards for the Apple. I find this system to be as powerful as WordStar, but much easier to use. The mailing list section of the Kensington system is very useful and it will hold enough data about each entry to be considered a mini-data base.

File Converter. LoadCalc is a disk based program that converts any text file to a Visicalc (DIF) file. Data can now be received from Dow Jones or Compuserve and converted into VisiCalc format without retyping. Fractions are interpreted and converted to decimals. Data can be edited for conversion by row and column. Each field is analyzed and saved either as a Label or a Value in a DIF file. Program can be used with Visi-Trend/Plot and other Visi series software. $95. **Address:** Cypher, 121 Second St., San Francisco, CA 94105. (Tel: 415.974-5297).

Word Processor. The Electric Pencil has been configured for the NEC PC-8001 computer. It is the oldest and most popular word processor for microcomputers. It features full screen editing and a simple format menu that makes this system easy to learn and easy to use. The NEC disk version will sell for $99.95 and will be available from NEC dealers.

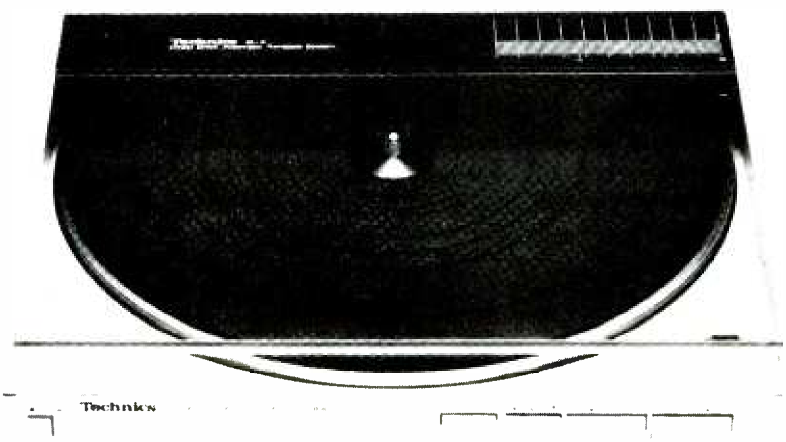
Invaders for Osborne 1. A disk version of the popular Invaders game has been released for the Osborne 1 Computer. Features a variable parameter file that can be changed by the user to increase the challenge of the game. $19.95. **Address:** Toolworks, 14478 Sherman Oaks, CA 91423. (Tel: 213-986-4885).

Atari Adventure. Probe One, a space adventure game for the Atari 400/800 features a hi-res color graphics disk with sound effects and arcade action. Requires BASIC cartridge and paddles or joystick. $34.95. **Address:** Synergistic Software, 830 North Riverside Drive, Suite 201, Renton, WA 98055. (Tel: 206-226-3216.

IBM Reference Card. This 14-panel reference for the IBM Personal Computer covers the BASIC with all options, commands associated with controlling BASIC for development and program execution, functions related to mathematics/string manipulation and I/O, an alphabetized description of over 80 BASIC statements including disk and advanced versions, and color programming, etc. $2.50. **Address:** Minimagic Co., 104 Park Rd #34, West Hartford, CT 06119 (Tel: 203-233-6261).

Screen Editor. Designed for the IBM Personal Computer, this editor features full cursor movement, overlay or insertion modes, tab control, replacement of strings, adjust and margin control, searches in both directions, partition of buffer by set marks, file merging, and repeat count for most commands. $75. **Address:** Don-El Enterprises, 3261 Michigan Ave., Costa Mesa, CA 92626 (Tel: 714-546-7481). ◊

Technics Model SL-5 Linear-Tracking Turntable



PLAYING a record in the same straight-line path taken by the recording lathe while it was cutting the master has been acclaimed by serious audiophiles for about two decades. Until recently, however, the few linear-tracking models available were not big sellers. Now a combination of factors has thrust them into the "popular" area in the eyes and minds of hi-fi stereo enthusiasts. The impetus has come from technological improvements and the near-total acceptance of single-play turntables, of course. Most important have been the introduction of a broad line of such turntables by a leading manufacturer, Technics; that company's development of plug-in connector ("P-type") phono cartridges; and the agreement of many cartridge makers to package their products to physical (not internal) standards set by Technics (not known as a major cartridge manufacturer).

The foregoing developments permit a user to buy one of a host of P cartridges on the market, plug in the cartridge, and tighten a single screw. There are no wires to attach and no settings to make. Everything is automatically adjusted. Moreover, by not requiring the extra height to lift a pivoted tonearm, a linear-tracking turntable can be made with a sleeker appearance.

The lowest priced linear-tracking turntable in Technics' line, the Model SL-5, at a suggested retail price of $200 (typically heavily discounted), is the one we chose to examine here. We also tested P-type Technics and Shure cartridges in both the linear-tracking turntable and a conventional pivoted-arm turntable that accommodates P cartridges.

The Linear-Tracking Turntable. The Model SL-5 has a two-speed direct-drive motor. Speed and arm indexing are automatically selected by the record size, although provision is also made for manual speed selection. The cover (whose width and length are the same as a 12" record jacket) contains the servomechanism and a short radial arm, designed to accept only a special plug-in cartridge. The arm is balanced to give a vertical tracking force of 1.25 grams with the cartridge installed. A screwdriver adjustment permits varying the force between 1.0 and 1.5 grams should this be desirable. Overall dimensions are 12½" W × 3½" D and weight is 9.7 lb.

A feeler arm emerging from the platter (through a slot in the rubber mat) senses the presence of a record on the turntable and prevents the arm from indexing or descending if no record is present. Also, a record-size sensor outside the turntable diameter moves in to check on the size of the record. If it encounters the edge of a 12" disc, the turntable speed is set to 33⅓ rpm and the arm indexes to a 12" (30-cm) diameter. If no disc is found, the player speed automatically switches to 45 rpm and the arm indexes to a 7" (17-cm) diameter. A retractable center-hole adapter for 45-rpm records is built into the platter.

Nonstandard record sizes, in general, must be played by manual indexing and (if necessary) speed selection. A partial exception is made for 10" (25-cm) records, for which a special sensing adapter is placed on the record edge sensor. Although this sets the speed to 33⅓ rpm, the arm must be cued manually.

All the operating controls of the Technics SL-5 are pushbuttons located on the front edge of the base (the speed selector, with settings for 33/AUTO/45, is a slide switch on the motorboard base). Power is switched by a square button at the left, and an illuminated red arrow beneath the plastic cover above the arm shows its position against a scale calibrated in millimeters.

After a record is placed on the turntable and the cover is lowered, a light touch on the large rectangular START button initiates the operating cycle. The platter rotates, and the arm moves to place the stylus over the lead-in groove and lowers smoothly to the record surface. Holding in the START button causes the arm to slew slowly inward. It stops when the button is released, remaining raised until the CUEING button is pressed. (This control can be used at any time, raising and lowering the pickup on alternate operations.) At the end of play the arm lifts and returns to its rest position above the outer groove of a 12"

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record, shutting off the motor. Pressing the STOP button stops the platter and returns the arm to rest. Holding the STOP button in for more than a second causes the arm to slew toward the outside of the record so that the pickup can be cued to any point by alternate pressures on the START and STOP buttons. If the cover is raised while a record is being played, the turntable stops and the arm returns to its rest position. If power is interrupted during play, the arm lifts and remains in place until power is restored, at which time the arm returns to its rest and the unit shuts off.

These protective features make the Technics SL-5 virtually foolproof, with the exception of trying to play a 10″ disc without using the special sensing adapter. It appears to be impossible to damage either the record, the cartridge, or the player mechanism without making a deliberate attempt to do so.

Cartridges. Although its original limitation to a single type of specially designed cartridge appeared to promise that acceptance of this novel system would be restricted, it soon became so popular that compatible cartridges were announced by a number of other manufacturers, and a de facto standard has come into being for P-type cartridges. Their key requirements include physical compatibility with the Technics tonearm, correct stylus position and angle for the Technics arm geometry, an overall weight of precisely 6 grams (to give a net downward force of 1.25 grams), and the ability to track properly at that force. They also are compatible with the 150-pF wiring capacitance of the Technics arm and cable. At present, such cartridges are available from most of the better-known manufacturers, including Audio-Technica, Empire, Ortofon, Shure, and Stanton, as well as Technics. The popularity of these cartridges and the reduction of total effective arm mass that they make possible has led Technics to produce a line of conventional record players whose pivoted tone arms are designed to accept the plug-in P-type cartridges. In addition, Technics and Shure (and no doubt most of the other cartridge manufacturers) can provide mounting adapters so that their P-type cartridges can be plugged into standard arms equipped with the EIAJ 4-pin headshell socket.

Test Program. One of the finest P-type cartridges offered by Technics is its P205CMK3 ($210). It is a moving-magnet cartridge with a samarium cobalt magnet and a boron pipe cantilever claimed to give it an effective tip mass of less than 0.15 mg. Its 0.2 × 0.7 mil elliptical diamond stylus is in a user-replaceable assembly.

In addition to testing the Technics SL-5 turntable and its P205CMK3 cartridge, individually and as a record playing system, we wished to judge the degree of overall flexibility of the P-type system, which seems destined to become a permanent part of the hi-fi record playing scene. To this end, we also used a Shure V15 LT cartridge ($190), a P-type equivalent to its V15 Type IV, to which it is mechanically and electrically identical. Like all P-type cartridges, it is designed to resonate at about 12 Hz in the Technics linear tracking arm. It is near the top of it's manufacturer's line.

For comparison, we also tested a Technics SL-D30 record player ($170), a conventionally styled single play automatic unit with performance, price and features generally similar to those of the SL-5, but using a conventionally pivoted tonearm designed to accept only P-type cartridges. The SL-D30 measure 17″W × 4$^{3}/_{8}$″H × 14$^{3}/_{4}$″D and weighs 10.6 lb. Both of our test cartridges were used in both turntables.

Test Procedures. The cartridges were checked for frequency response and crosstalk in the arm of the SL-5 record player (using the CBS STR100 test record). The actual capacitance shunting the standard 47,000-ohm load resistance was measured, and the effect of reasonable variations in capacitance on frequency response was determined. The vertical stylus angle of each cartridge was evaluated as were the output voltage and channel unbalance.

The tracking ability of each cartridge was judged by playing high-velocity test records, including the German Hi-FI #2, Fairchild 101, Cook 60, and Shure Audio Obstacle Course ERA IV and ERA V. The low-frequency resonance between the stylus compliance and total effective arm/cartridge mass was measured (approximately) with the aid of the Shure records. These procedures were then repeated with each cartridge plugged into the arm of the SL-D30 record player.

The record players themselves were evaluated for rumble, flutter, speed error and range of control (in the SL-D30), automatic cycling time, and susceptibility to base-conducted vibration. The accuracies of the tracking force and anti-skating calibrations of the SL-D30 arm were checked. (The vertical force of the SL-5 arm cannot be measured, and it has no need of anti-skating correction.)

Test Results. The two record players, which appear to be very similar in their specifications, measured nearly identically and were unaffected by the choice of cartridge. The unweighted rumble of the SL-5 was −40 dB, and with ARLL weighting it was −62 dB, both excellent figures. The SL-D30 rumble readings were nearly as good: −38 and −60 dB. The two units had nearly identical flutter readings, although their frequency spectra were slightly different. The SL-5 had a DIN weighted peak flutter of ±0.07%, and the SL-D30 reading was ±0.08%. (The difference between the two was well within the normal range of measurement uncertainty.) In the SL-5, however, the flutter was concentrated between 5 and 10 Hz, while in the SL-D30 it was randomly distributed up to about 20 Hz.

Operating speeds of the two turntables were correct. (In the SL-D30 they could be varied over a range of +7.0% to −8.5%.) Tracking force of the SL-D30, when set for 1.25

grams, was 1.35 grams, and its antiskating calibration was reasonably accurate (although we preferred to set it to 1.5 grams for best correction at the "1.25 gram" force). There was no lateral arm shift during a cueing lift and descent cycle with either turntable.

It was not possible to judge the tracking error variations in the servo-driven arm of the SL-5, although it was evident that the arm had a small amount of free movement to accommodate record eccentricity. In the case of the SL-D30, the tracking error was very low—less than 0.4 degrees per inch over the surface of a 12-in. record. The SL-D30 arm had an effective mass of 14 grams including the cartridge (8 grams net, which is a relatively low figure for a conventional pivoted arm). The rated mass of the SL-5 arm plus cartridge is 9 grams; we could not measure it because of the design of the unit. These data indicate that the resonance frequency of a given cartridge in the SL-D30 should be about 20% lower than in the SL-5 and this was confirmed by our measurements. The SL-5 resonance was at 10 to 12 Hz, with a clearly visible vertical arm vibration when using the Shure test records. The SL-D30 resonated at 8 Hz, though with a considerably lower amplitude.

The auto start and stop cycle operations of the SL-D30 required about 12 seconds each. It can be operated manually, however, by simply lifting the arm from its rest (which starts the motor) and cueing it. The SL-5 requires only 6 seconds to reach the lead-in groove after START is pressed, and it takes about 10 seconds from the time it lifts out of the eccentric groove at the end of the record to the shut-down of the player. Its arm cannot be moved manually, except by holding the slewing buttons in to servo-drive the arm. This movement is at a rate of about 0.6 cm per second.

In their responses to base-conducted vibration in the audio range (20 to 1000 Hz) both turntables were typical of the recent models we have tested; except for the range between 30 and 60 Hz they were much alike. However, between 30 and 60 Hz the SL-D30 was some 10 to 20 dB better than the SL-5 in its rejection of transmission from the mounting feet to the stylus.

Both cartridges proved to be outstanding performers. The Technics P205CMK3 had a slightly flatter overall response, within ±0.5 dB up to 12,000 Hz and rising to +2.5 dB at 20,000 Hz. A load capacitance increase from 200 to 335 picofarads boosted the output only slightly, by about 1 dB above 8000 Hz. Its channel separation was 20 to 25 dB up to 10,000 Hz, and 10 dB at 20,000 Hz. The output at 3.54 cm/s was a fairly low 2.4 millivolts, and the channels were matched within 0.5 dB.

The Shure cartridge had a somewhat similar frequency response, extremely flat (within 0.5 dB overall) up to 14,000 Hz, but rising more abruptly to +5 dB at 20,000 Hz. The change in load capacitance also had a very small effect on the frequency response. The channel separation was 25 to 30 dB up to 10,000 Hz, and about 10 dB at 20,000 Hz. Its output was a relatively high 4.1 millivolts, with the channels balanced within 0.85 dB.

The tracking ability of the Shure cartridge was excellent, including its perfect tracking of the 100-micrometer level of the German Hi-Fi record (a feat matched by very few cartridges). Except for a trace of mistracking on the highest level of the flute (ERA IV) and the highest level of the trackability test of the new ERA V Shure record, it easily coped with every signal we applied to it.

The Technics cartridge tracked everything on the ERA IV record without trouble, but mistracked on the two highest levels of the ERA V record. It was also able to track only as high as the 70-micrometer level of the German Hi-Fi record.

User Comments. The measured differences between the two record players were essentially what could have been predicted from their specifications, and there were no audible differences. The two cartridges were also so closely matched in performance we could detect no audible differences between them on a variety of records played, other than the very apparent level difference. As with most good cartridges, the sound was effortless and uncolored, since the high-frequency emphasis in each case was well above the normal frequency range of recorded music.

This does not in any way imply that these two record players are equally suitable for every user. The linear tracking SL-5 is, in most respects, a uniquely simple and functional instrument whose features are unavailable in any other unit we know of selling for anywhere close to its price.

In respect to freedom from rumble, hum, or mechanical noise, the SL-5 would be hard to match. Perhaps the integrated design of the cartridge and its plug, which eliminates all the unshielded wires that normally connect a shell-mounted cartridge to its plug, combined with the muting system that shorts the audio outputs when the pickup is not on the record, is responsible for this. Whatever the case, we were struck by the total silence, even at a very high playback volume, when using this record player. The same comment applies to the SL-D30, and probably for the same reasons.

The choice between these two units—and, obviously, between any conventional player and a fully automatic type—must be made on the basis of one's listening habits and desire for involvement with the hardware of a hi-fi system. The SL-5 is ideally suited for playing a record from beginning to end, or at least, for starting at the outside of the disc. Although the arm can be slewed with adequate ease and precision, it is difficult to see the (unlit) record grooves through the cover.

On the other hand, the open construction and manual cueing capability of the SL-D30 (or any other conventional player) is a great convenience if one wishes to listen to a selection within a record. Balancing this is the total protection offered to one's records and cartridge by the SL-5, to say nothing of the ease with which it can be used by anyone, even a young child, without the risk of damaging a valuable record or pickup.

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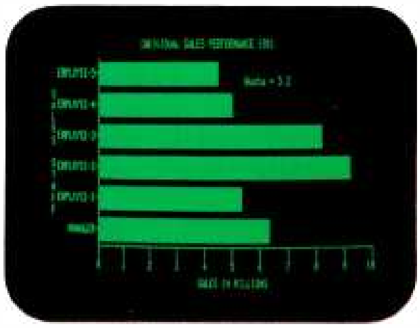
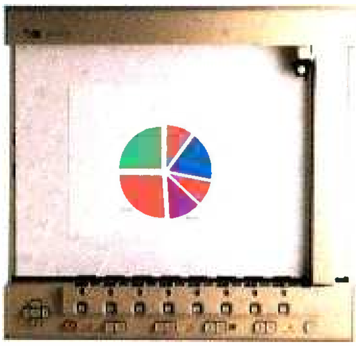
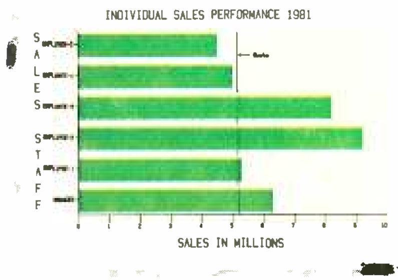


	Apple	VisiTrend/ VisiPlot	pfsGraph
Graph Types			
Line	Yes	Yes	Yes
Vertical Bar	Yes	Yes	Yes
Horizontal Bar	Yes	No	No
Side-by-side Bar	Up to 4	2	4
Pie	Yes	Yes	Yes
Partial Pie	Yes	No	No
Scattergram	Yes	Yes	No
Curve Fitting	5 Kinds	1	None
Data Points (Max.)	3500+	645	36
Plotter Compatible	Virtually Any	None	H-P7470A Only
Compatible File Types	Pascal BASIC VisiCalc	BASIC VisiCalc	pfs VisiCalc
Math Functions	Yes	Yes	No
Available Colors	6	4	4

Apple Business Graphics is available for both the Apple II and Apple III.





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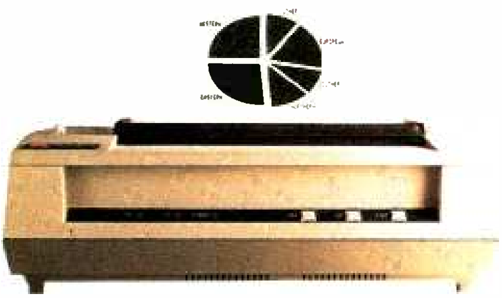
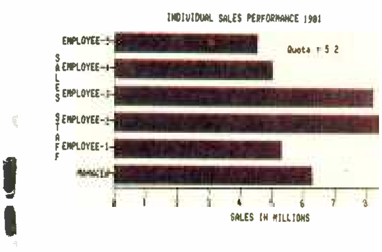
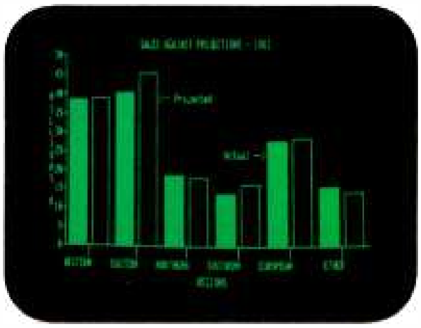
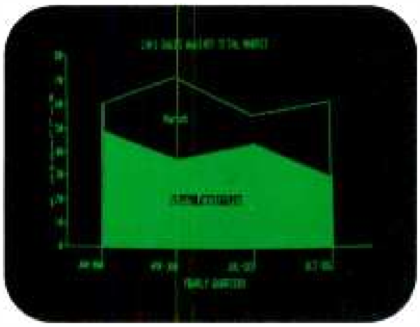
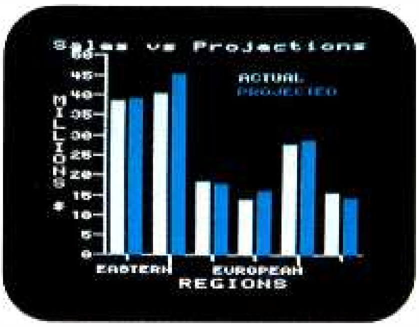


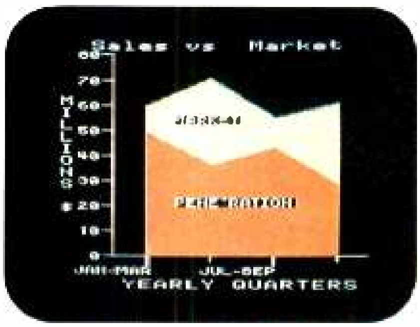


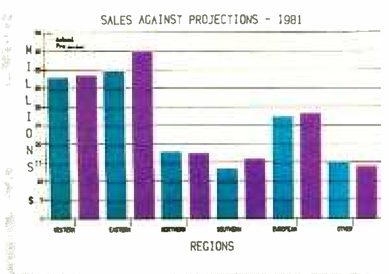
graphics are alike. pictures to prove it.

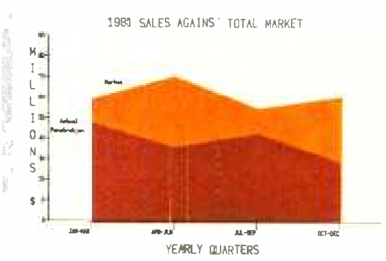


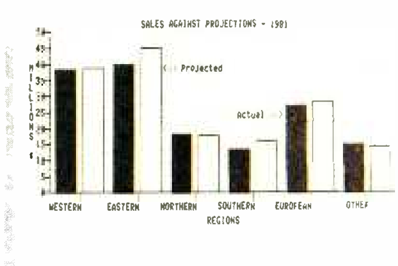


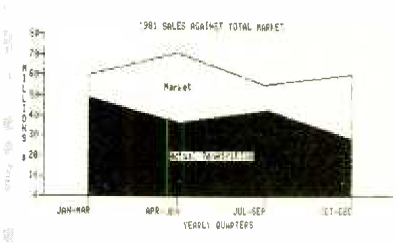












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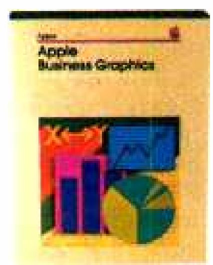

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CIRCLE NO. 62 ON FREE INFORMATION CARD

Apart from operating convenience and protection features, there is one salient advantage to both these units (especially the SL-5). Namely, the low mass of the arm/cartridge combination provides an outstanding ability to play warped records. The SL-D30, whose low arm mass is matched by only a few units we have tested, could play most of the warped records in our collection. The SL-5, as might be expected from its extremely low-mass arm, was at least the equal of any record player we have used. It tracked easily and with no tendency to leave the groove or even betray the presence of a warp by its sound on every record we used that has been tracked by any other pickup.

The only limitation we found on the warp-tracking ability of the SL-5 resulted from the very small clearance between the edge of the record and the covering of the arm servo. This sometimes caused a rubbing contact against a badly warped record.

What about the virtues of the P-type cartridges for use in conventional arms? The principal one, as we see it, is their low mass of 6 grams, contrasted with 15 to 25 grams for most conventional cartridge and headshell combinations. In an arm such as the one on the SL-D30, this provides a much improved warp tracking ability—no trivial advantage. The reduction in hum and noise pickup due to a more complete shielding of the cartridge area is another plus. The only disadvantage we can see to the P-type cartridge is its incompatibility with standard arms without the mounting adapter. Use of the adapter, however, would negate most of the advantages we have discussed. Also, one's choice of cartridge types is not too wide. For example, Shure's top-of-line V15 Type V is not available as a P-type.

My experience with the Technics linear-tracking turntables and the P-type cartridges convinces me that they represent a worthwhile advance in phono reproduction equipment for many people. Their growing popularity is easily understood. —*Julian D. Hirsch*

CIRCLE NO. 102 ON FREE INFORMATION CARD

McIntosh Model MA6200 Integrated Stereo Amplifier

THE McIntosh MA6200 integrated amplifier, rated at 75 watts per channel into 8-ohm loads (or 100 watts into 4 ohms), features the company's exclusive Power Guard circuit that makes it impossible to clip the output waveform. The amplifier can drive up to three pairs of speakers simultaneously, and has control facilities for two tape decks.

The MA6200 is styled like other McIntosh products, with a gold-accented black panel, pale gold and black knobs, and a black metal cover. The panel markings are softly back-lit in green. The amplifier is fitted with Panloc shelf and back panel fittings, a McIntosh feature that simplifies making a neat, flush panel installation, yet permits instant withdrawal of the unit.

The front panel of the MA6200 is 16″ wide and 5$\frac{7}{16}$″ high. The chassis is 13″ deep, and the amplifier weighs 30 pounds. Suggested retail price is $1649.

General Description. The phono preamplifier of the MA6200 is a low-noise operational amplifier, whose open loop gain of 100,000 is reduced to 42 dB at 1000 Hz by the precision low-noise feedback components that provide the RIAA playback equalization. The low output impedance of the op amp permits it to drive the low-impedance feedback network (used in the interest of minimum noise) without distortion.

The following high-level section provides the loudness compensation, which is unlike the usual loudness control system in other amplifiers. Two op amp stages are used, providing a fixed 20-dB gain at middle frequencies, regardless of the setting of the loudness knob. Advancing the knob from its counterclockwise (OFF) position introduces a bass boost below about 300 Hz. Above 1000 Hz the output is boosted with a "shelved" characteristic, to a maximum of +2.5 dB. The loudness compensation is independent of the volume control.

Instead of the usual bass and treble tone controls (or a third midrange control), McIntosh has chosen to use a 5-band equalizer in the MA6200. Controlled by conventional rotary knobs, it is not actually a "graphic equalizer," but is equivalent to one in its operation. Each channel uses an op amp at the input and output of the equalizer, plus five more to synthesize the filter characteristics. The center frequencies of the adjustments are 30, 150, 500, 1500, and 10,000 Hz, and each control has a nominal range of ±13 dB.

The power amplifier section is separated electrically from the preamplifier, to which it is joined by jumpers inserted into rear apron jacks. If the jumpers are removed, signal processing accessories such as dynamic expanders or noise reducers can be inserted into the signal path. The output stages are push-pull, dc-coupled, complementary-symmetry amplifiers. They are protected by thermal sensors that disconnect the speakers if

(Continued on page 100)

THE GRAPHIC DIFFERENCE

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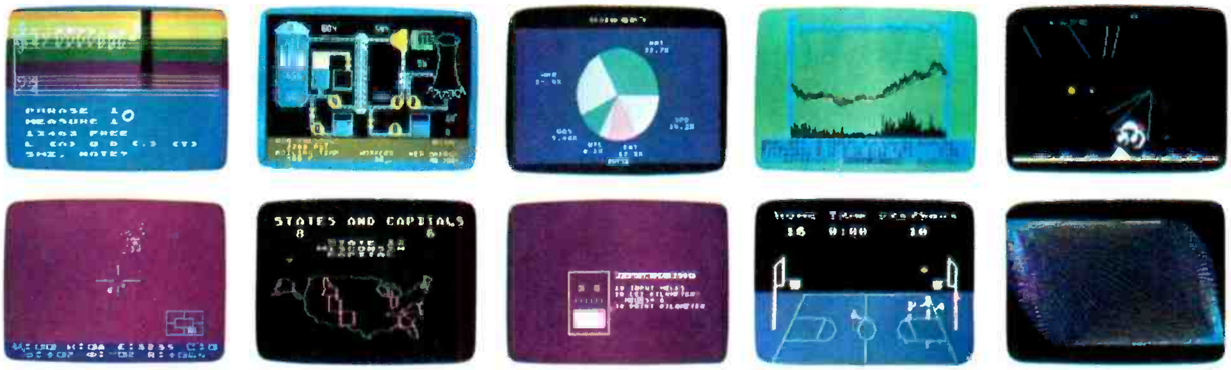

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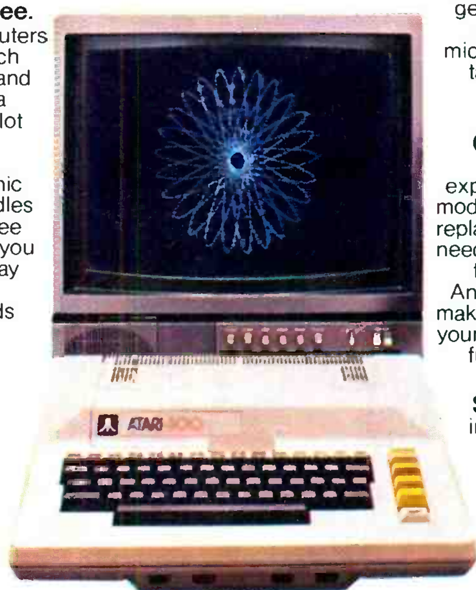

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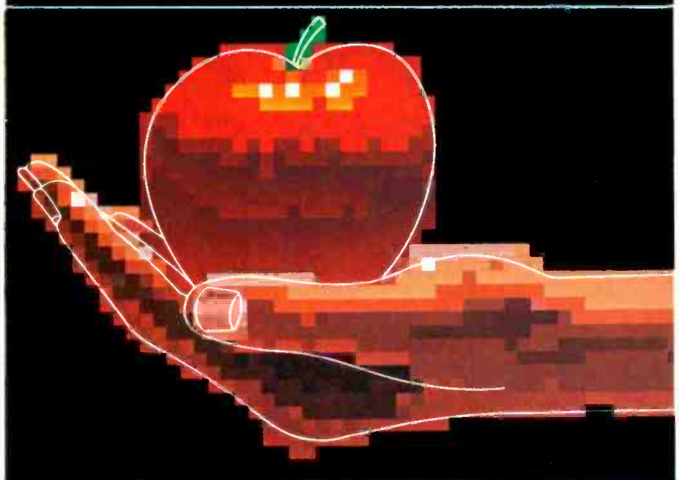


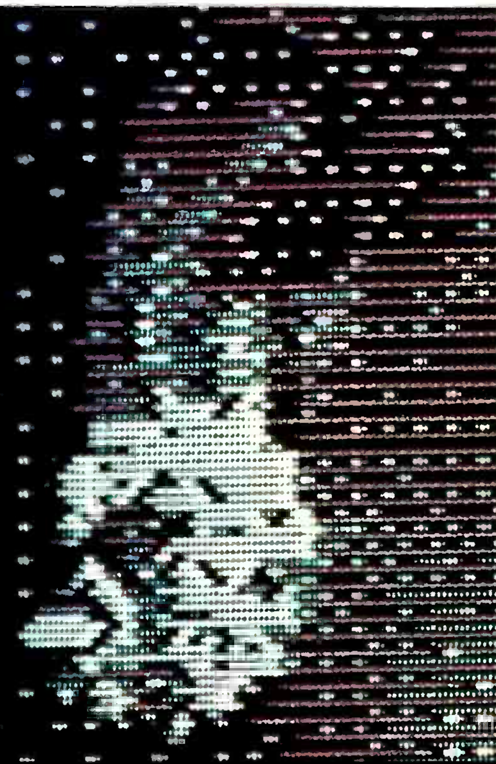
A low-cost plug-in board turns an Apple II computer into a graphics giant with 240 color choices

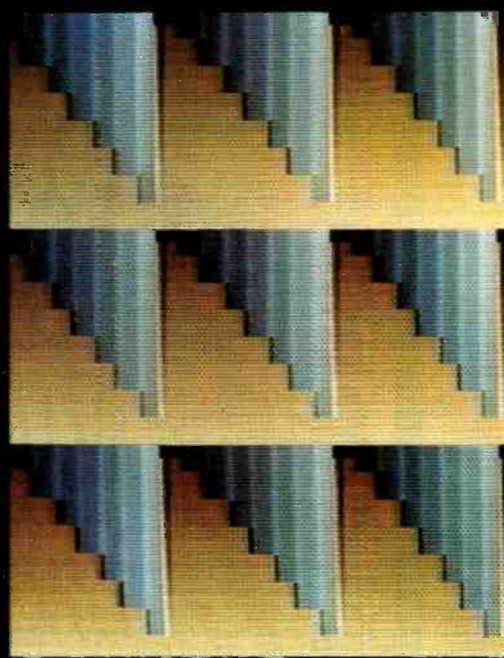
By Ray Dahlby

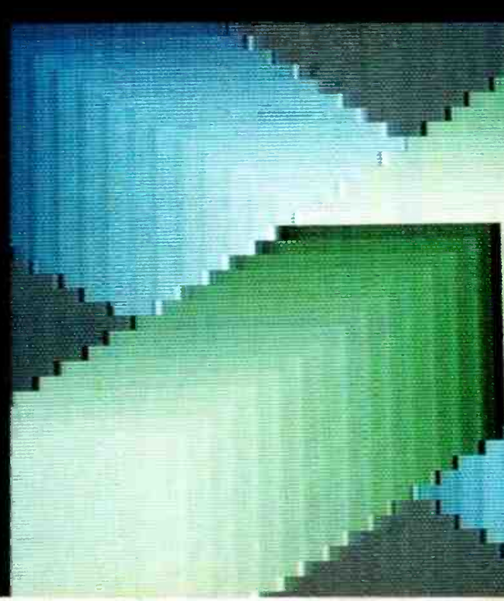
ENHANCING the utility of his/her computer is among the most fruitful accomplishments that a computerist can achieve. It separates the appliance operator from the innovative enthusiast. An Apple II microcomputer, for example, can produce the dramatic displays shown at right by simply plugging in an under-$100 hardware board (assembled in about an hour with the plans presented here) and running some software.

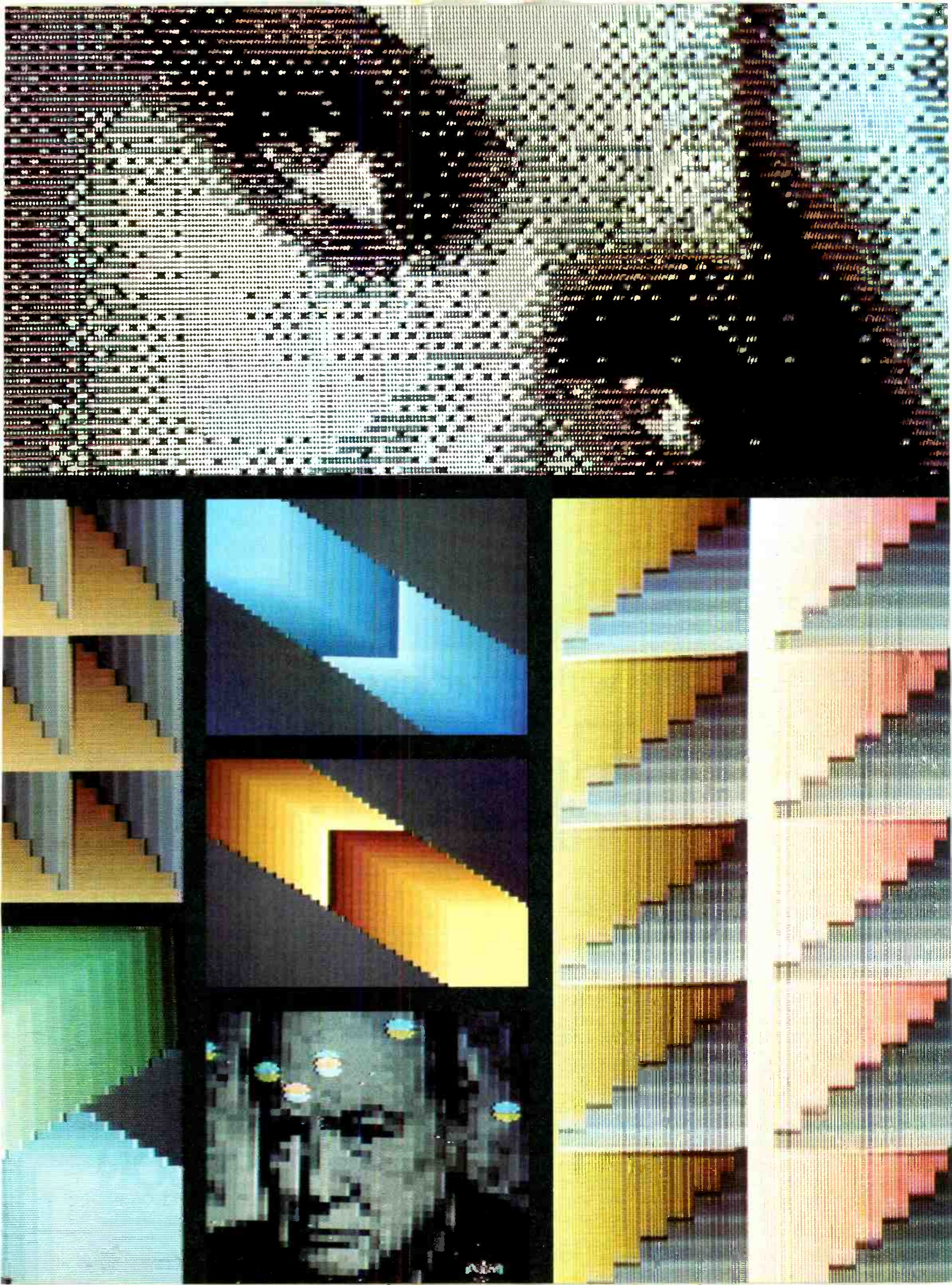
This accessory luminance board enables an Apple II to block-shade text with one of 16 brightness levels for 240 low-resolution colors in place of the normal 16 colors, and simultaneously display bar graphs with high resolution. In addition to luminance control, the circuit adds a video interrupt mechanism for synchronous video-screen page flipping and screen splits. This makes it possible to expand the Apple's mixed text and graphics mode so that text can be displayed above or below the graphics.

Using the board you can even display part of page-1 hi-res graphics with part of the graphics on page 2, or you









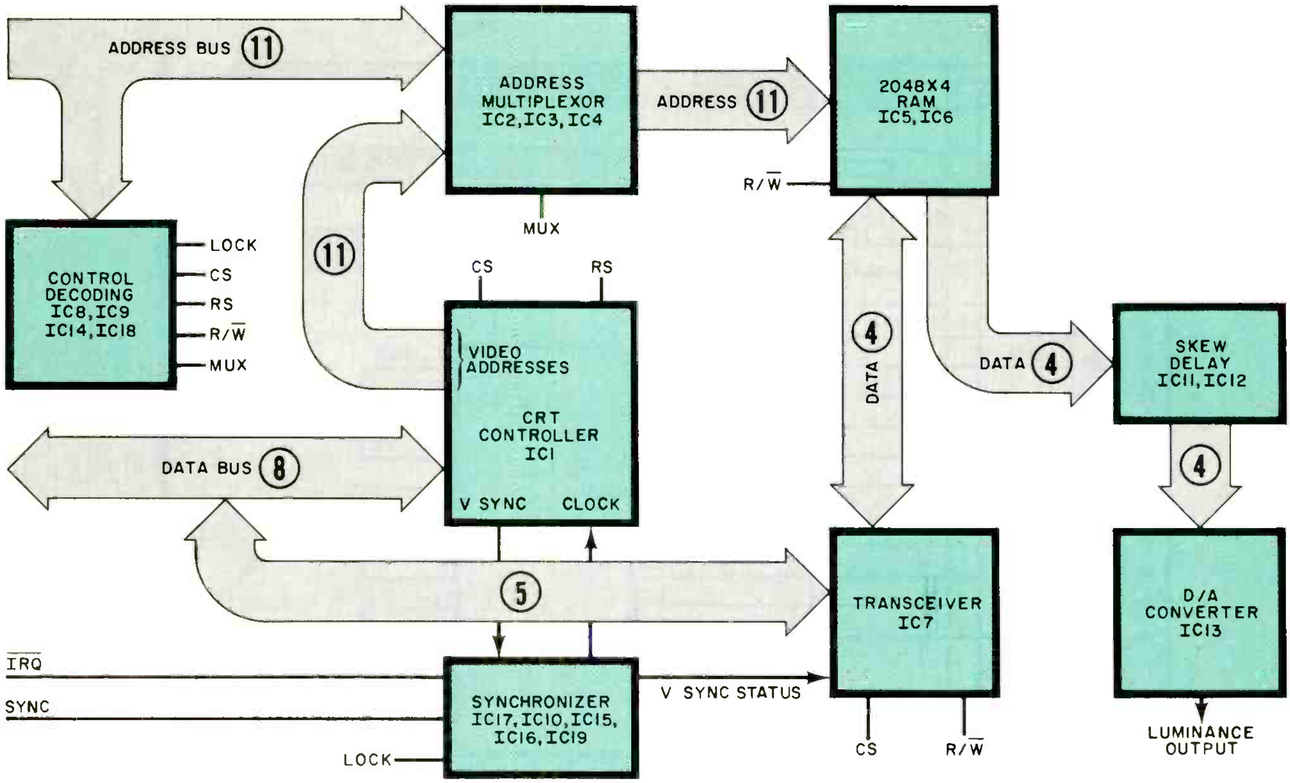
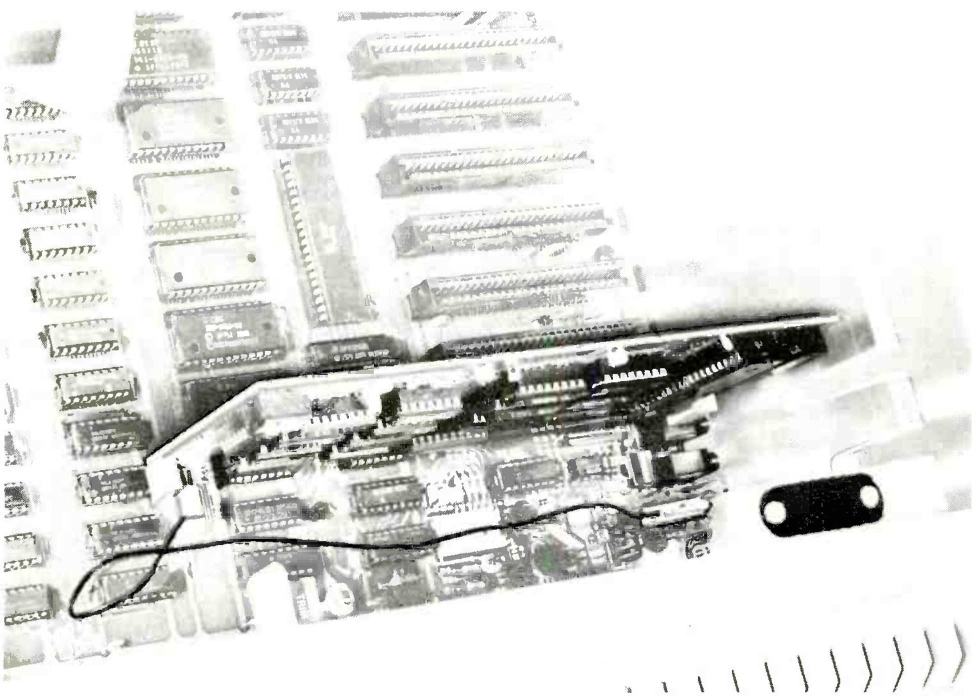


Fig. 1. The most important element of the system is the 6845 CRT controller.

can display them simultaneously for a double-resolution graphics display of 560 x 192 pixels. All of this is accomplished without complex modifications to existing Apple equipment and without losing the normal display modes. The card plugs into slot 7 as shown in the photo below.

The luminance component of a television signal contains brightness information about the image being viewed. Similarly, to add luminance capabilities to a computer, brightness information must be added to its video output. The circuit card supplies this information from a 2048 × 4-bit RAM memory. Data is mapped to overlay the Apple's screen in a 40 × 48 array of pixels. Data written to each



The accessory luminance board plugs into slot 7 on the Apple bus.

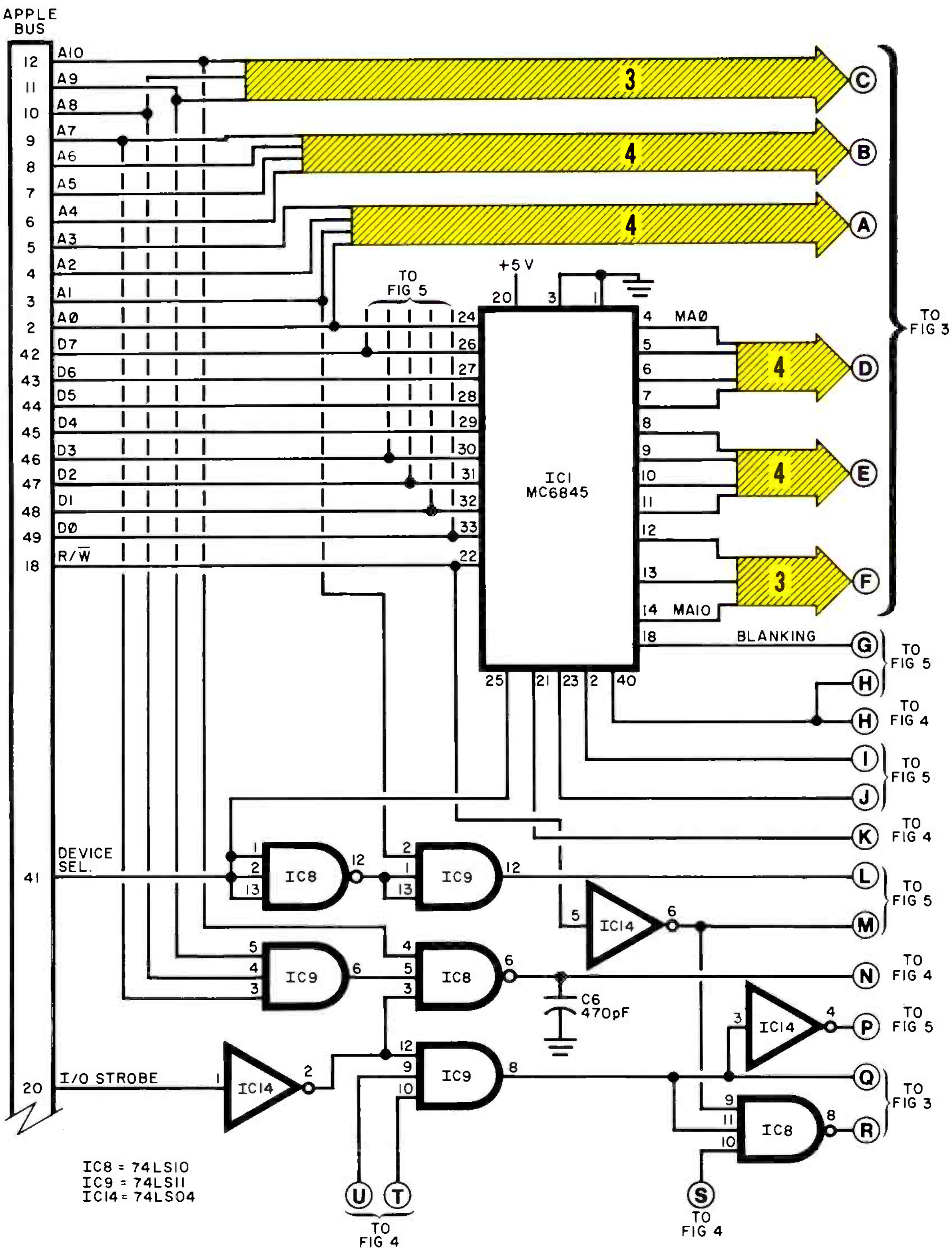


Fig. 2. The 6845 synchronously regenerates the video RAM addressing.

memory location determines the brightness level of the corresponding pixel.

Since 16 tone levels rival the quality of photographic film, 4 bits was considered adequate. The spatial resolution of 40 × 48 or 1920 pixels was chosen for high-speed animation and memory-size reduction.

Each luminance pixel precisely overlays a 7 × 4 dot area of the screen, adding luminance attributes to one block of low-res or an equivalent area of hi-res. Two luminance pixels stacked vertically will shade one text character.

The circuit's interrupt mechanism is derived from its on-board scan generator and can be programmed to produce an interrupt request on any multiple of four scan lines. This feature allows smooth animation plus synchronous page flipping. The 60-Hz interrupts can also be used as a real-time clock. A block diagram is shown in Fig. 1, with the complete schematic shown in Figs. 2 through 5.

Circuit Operation. The central element of the board is 6845 CRT controller *IC1* (Fig. 1). It is used to

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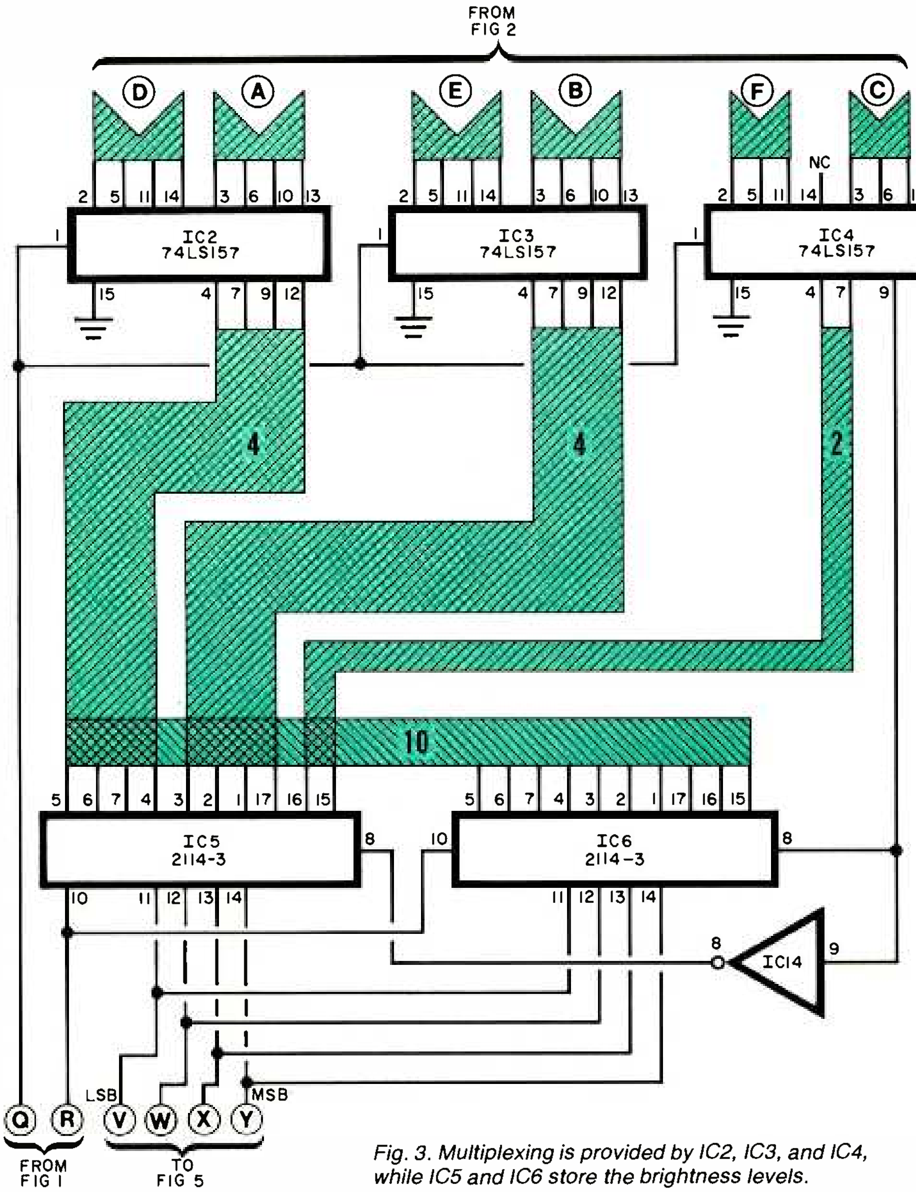


Fig. 3. Multiplexing is provided by IC2, IC3, and IC4, while IC5 and IC6 store the brightness levels.

synchronously regenerate the video RAM addressing not available on the Apple bus. This IC is programmed for the Apple video timing, then phase locked to the sync pulse on pin 19 of slot 7.

The circuit then runs in step with the Apple video, providing addressing for the on-board 2K × 4 luminance RAMs *IC5* and *IC6*, which store the brightness level of each luminance pixel. The RAMs can be read from, or written to, transparently by the Apple during phase 2 of the processor clock. This removes the "glitches" that are common to many 80-column plug-in boards. Address multiplexing is taken care of by *IC2*, *IC3*, and *IC4* (Fig. 3).

During phase 1 of the processor clock, contents of the luminance RAM addressed by *IC1* are fed to *IC12* (Fig. 5) which in turn drives the four-bit D/A comprised of elements of *IC13* and its associated resistor/ladder network. This converts the digital data into a 16-level analog signal. The output of this network, preset by *R11*, is coupled to the Apple baseband video output.

In *IC17* (Fig. 4) and its associated circuit the vertical sync signal is extracted from the composite signal that appears on pin 19 of slot 7. The resulting output provides a reference for the phase locking. The remainder of the phase-lock circuit is formed from *IC10*, *IC15A*, *IC16*, and elements of *IC19* in Fig. 4, and a portion of *IC12* of Fig. 5.

TABLE I
SWITCH POSITIONS

Revision	S1	S2	S3	S4
0-6	On	Off	*	On
7	Off	On		Off
8 and up	On	Off		Off
Future	Off	On		On

*S3 enable interrupts and is independent of revision number.

Construction. The circuit can be built on any Apple prototyping board using wire wrap or, alternatively, on a pc board such as that shown in Fig. 6. Since some elements of the circuit operate at 7 MHz, take care when using the point-to-point wiring technique.

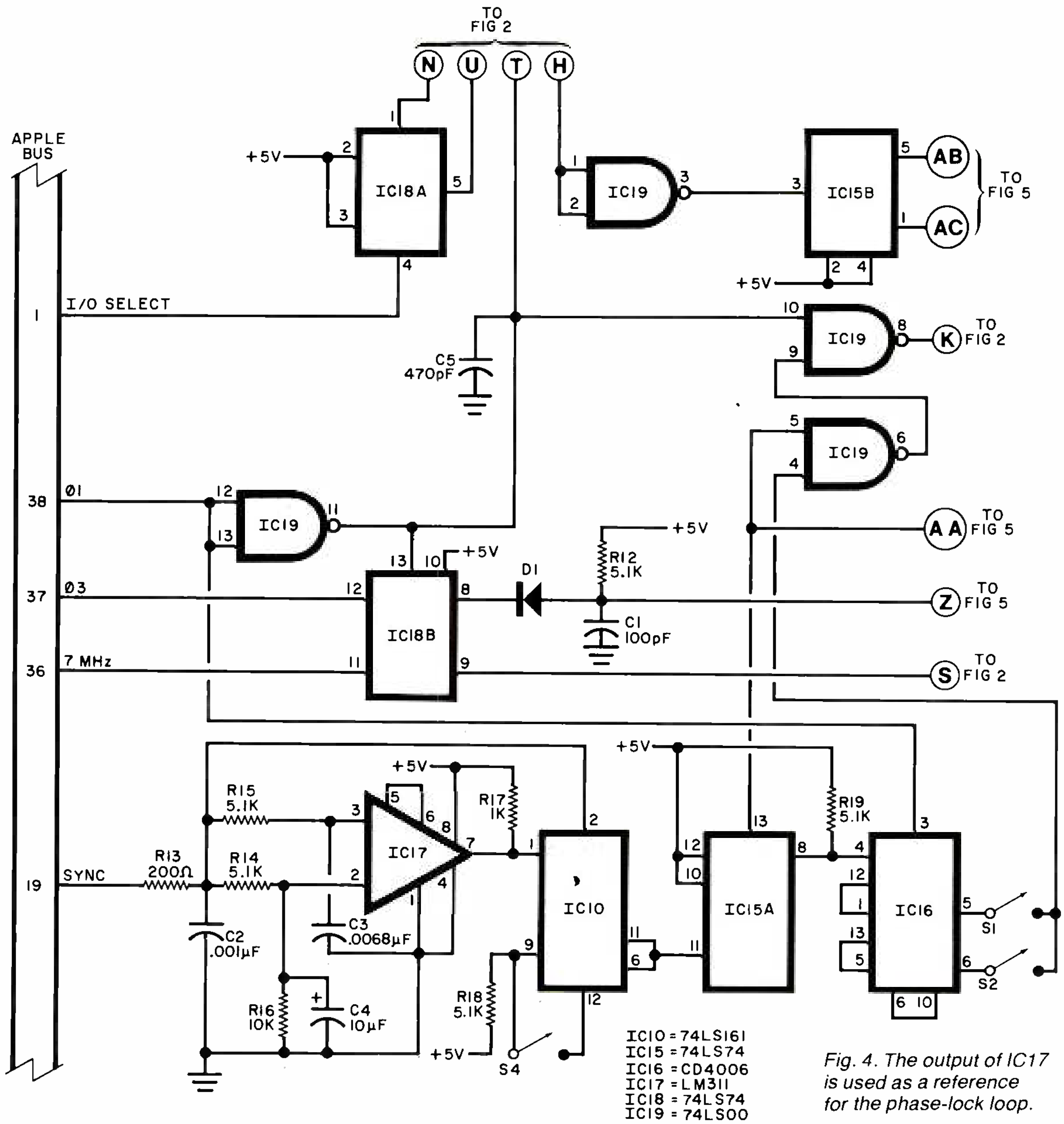


Fig. 4. The output of IC17 is used as a reference for the phase-lock loop.

PARTS LIST

C1—100-pF ceramic disc capacitor
C2—0.001-µF capacitor
C3—0.0068-µF capacitor
C4—10-µF, 15-V electrolytic
C5, C6—470-pF ceramic disc capacitor
C7 through C11—0.1-µF ceramic disc capacitor
D1—1N914 diode
IC1—MC6845 CRT controller
IC2 through IC4—74LS157 quad 2-input data selector
IC5, IC6—2114-3 1024 x 4 static RAM
IC7—74LS245 octal bus transceiver
IC8—74LS10 triple 3-input NAND
IC9—74LS11 triple 3-input AND
IC10—74LS161 4-bit binary counter
IC11, IC12—74LS174 hex D flip-flop
IC13—74LS08 quad 2-input AND
IC14—74LS04 hex inverter
IC15, IC18—74LS74 hex D flip-flop
IC16—CD4006 shift register
IC17—LM311N comparator
IC19—74LS00 quad 2-input NAND
Q1—2N3904
The following are ¼-W, 5% resistors unless otherwise noted:
R1, R16—10 kilohms
R2, R12, R14, R15, R18, R19—5.1 kilohms
R3 through R7, R13—200 ohms
R8, R9, R10—100 ohms
R11—200-ohm trimmer potentiometer (Bourns 3386W or equiv.)
R17—1 kilohm
S1 through S4—4-position DIP spst switch
Misc.—Sockets, 6" to 8" length of insulated lead, small alligator clip.

Note: The following is available from Ray Dahlby Electronics, Box 7600, Vancouver, B.C. V6B 4X9, Canada: Printed-circuit board, $29.95; sub-interpreter diskette, $10 check or money order in U.S. funds.

The use of sockets is recommended for the ICs, and caution must be observed with static-sensitive MOS devices *IC1*, *IC5*, *IC6*, and *IC16*.

After all components are installed (Fig. 7), carefully check all connections. A miniature DIP switch can be used for the four switches called for in the circuit. Attach a short length (6" to 8") of insulated lead to the luminance output (top of *R11*), and terminate the lead with a small alligator clip.

The Apple II has undergone several revisions in video timing to accommodate new TV receivers. This circuit handles these timing changes via the four DIP switches on the board. After determining the

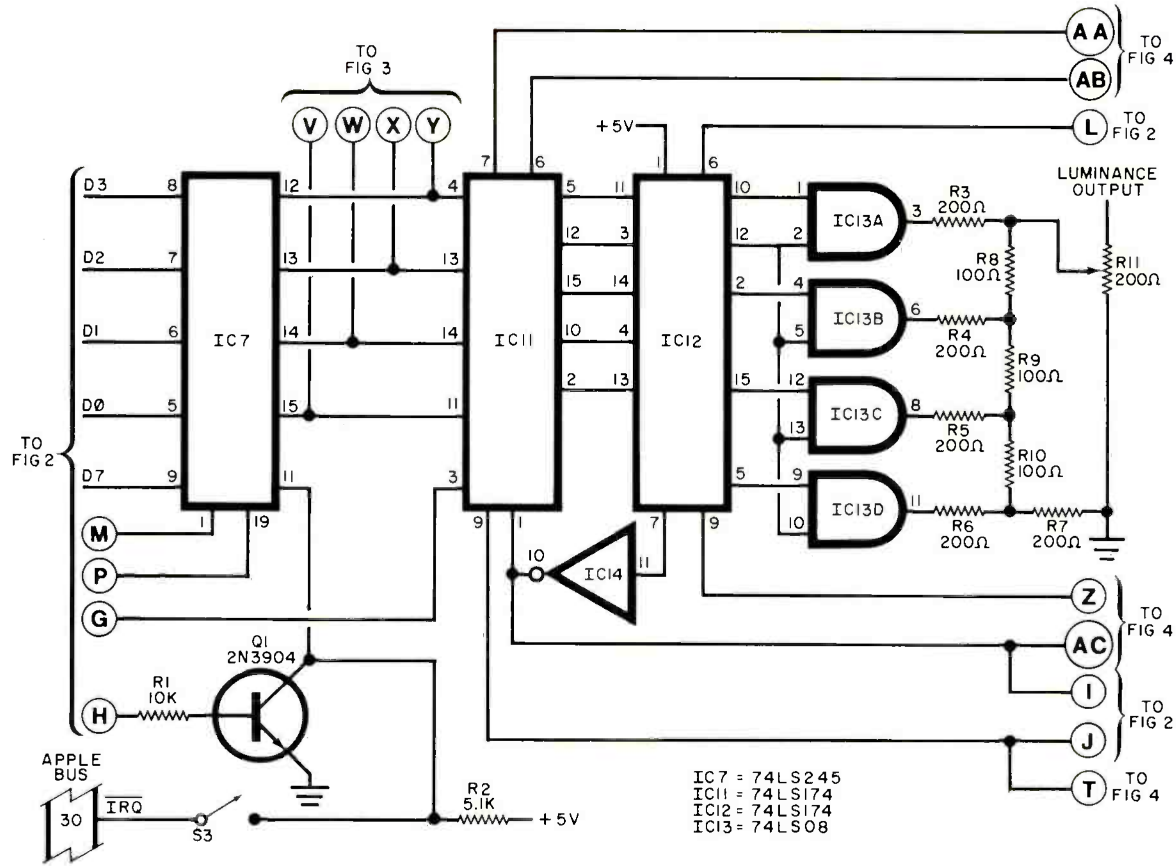


Fig. 5. Luminance output is obtained from D/A IC13.

TABLE II—INITIALIZATION (ASSEMBLY)

RS	EQU	$C0F0
LOCK	EQU	$C0F2
	ORG	$0300
	SEI	
	LDX	#00
INIT	STX	RS
	LDA	TABLE, X
	STA	RS+1
	INX	
	CPX	#16
	BNE	INIT
	JSR	WAIT
	BIT	LOCK
	RTS	
WAIT	LDX	#01
	LDY	#255
HERE	DEX	
	BNE	HERE
	DEY	
	BNE	HERE
	RTS	
TABLE	DFB	64,40,48,08,63,06 48,53,00,03,32,00 00,00,00,00

(HEX OBJECT CODE)

78, A2, 00, 8E, F0, C0, BD, 23, 03, 8D, F1, C0, E8, E0, 10, D0, F2, 20, 18, 03, 2C, F2, C0, 60, A2, 01, A0, FF, CA, D0, FD, 88, D0, FA, 60, 40, 28, 30, 08, 3F, 06, 30, 35, 00, 03, 20, 00, 00, 00, 00, 00

revision number of your system, set the four DIP switches in accordance with Table I.

The initialization software shown in Table II can be entered and assembled with any compatible editor/assembler. If desired, the hex object code of the listing can be directly entered. In either case, save the object code on disk.

With the Apple II power turned off, connect the luminance lead alligator clip to the center connector of the video output connector at the rear of the motherboard. Install the Syncard in slot 7.

If you are using a video modulator that gets its video from the four-pin connector in the Apple, it will have to be modified. In the case of an M&R Supr-Mod, cut the brown lead coming from the modulator and patch the video from the rear of the Apple to the auxiliary input of the Supr-Mod. Rotate the modulator level control full clockwise and re-install it. Even without the board, the modulator will work normally. Other r-f modulators should be similar.

With the initialization program of Listing 1 loaded in the computer, CALL 768. You should see a random pattern of gray-scale blocks overlaying the screen, aligned exactly with the normal video output. If the luminance display is not precisely positioned, the DIP switches must be reset. After experimenting with the DIP switches (note that *S3* is always off), re-run the initialization routine.

When the board is running, adjust luminance control *R11*, and the video output level of the Apple for a good picture without tearing. There will be a loss of vertical sync until the Syncard is initialized. If desired, this can be avoided by tem-

TABLE III PROGRAM PARAMETERS

$C0F0	6845 register select*
$C0F1	6845 data register*
$C0F2	Lock
$CFFF	Disable access to luminance RAM
$C700	Enable access to luminance RAM
$C800-$CF7F	Luminance RAM

*See 6845 data sheet.

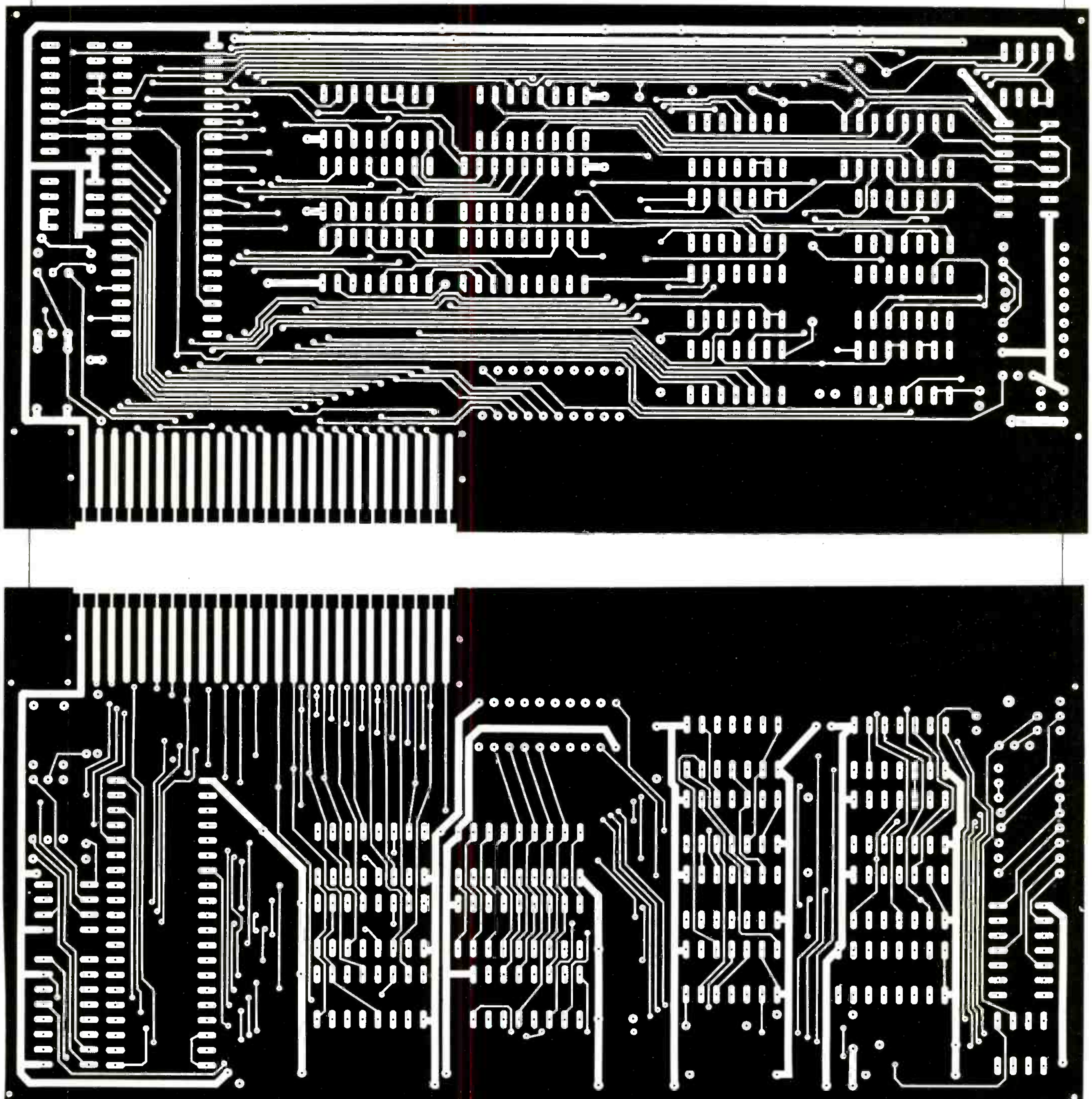


Fig. 6. Foil patterns for the double-sided printed circuit board.

porarily disconnecting the alligator clip from the video connector (the board will not deliver an output when this is done).

Programming. With the luminance board running, a machine-language programmer can start experimenting immediately. Program parameters are shown in Table III.

The gray-scale RAM is located in $C800 to $CFFF. By writing values between 0 and 15 into this area,

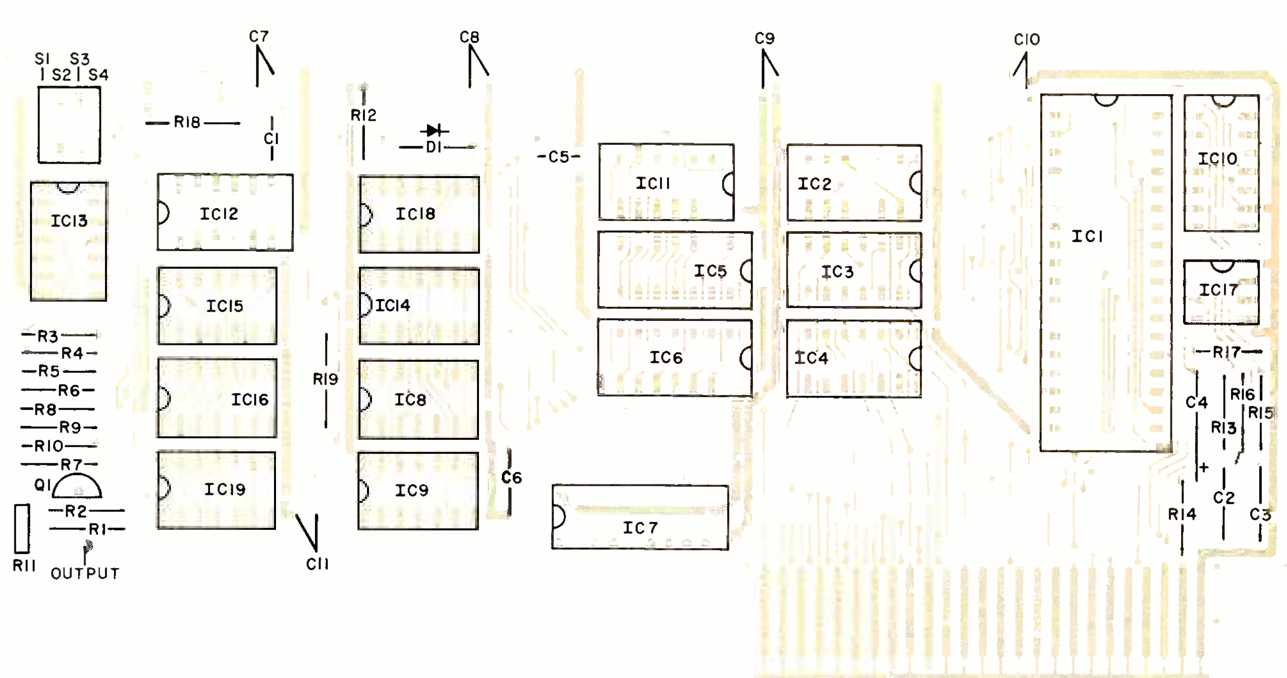


Fig. 7. Component layout for the printed circuit board.

TABLE IV—SPECIAL COMMANDS

&LOCK	Synchronizes the timing of the board to the Apple. It executes an &NOSHOW, so after locking, you must &SHOW to see the luminance screen.
&SHOW &NOSHOW	Switches the luminance display on and off. Does not alter the content of the luminance RAM.
&CLR,X	Clears the luminance screen to the shade indicated by the expression after the comma. (0-15)
&SHADE,X	Sets the shade for the &PLT and &FILL commands.
&PLT,X,Y	Plots a pixel of the shade specified by the last &SHADE command. Same screen coordinates as lo-res
&RTN,X,Y	Used to return the shade of the indicated X,Y location. Like the "SCRN" function of Applesoft except the value is returned through location 255 ($FF)
&FILL,X,Y, X1,Y1	Fills a rectangular block with the shade specified by the previous shade command. Same restrictions on X and Y values as lo-res.
&MOSAIC,1 &MOSAIC,2	Converts a picture on hi-res page 1 or 2 to a 40 x 48 grey scale mosaic.
&S1 (text1) &S2 (text2) &S3 (lo-res 1) &S4 (lo-res 2) &S5 (hi-res 1) &S6 (hi-res 2)	Synchronous screen switches used for flipping pages.
&I1,X	Split screen into text and hi-res 1
&I2,X	Split screen into text and hi-res 2
&I3,X	Split screen into hi-res 1 and hi-res 2
&SEI	Sets the interrupt disable flag
&CLI	Resets the interrupt disable flag

pixels can be set to the desired brightness level. The screen is linearly mapped with $C800 at the upper left corner. The high bit of each location in the luminance RAM indicates vertical synchronization status. This signal can be used to flip pages synchronously with the video frame rate.

If you don't use machine language, a special operating system has been written for the Apple that forms a subset of Applesoft BASIC. Twenty special commands have been added, as shown in Table IV. This sub-interpreter is too lengthy to be listed here, so it is being made available on diskette from the source shown in the Parts List. The floppy diskette also contains demonstrations.

When the sub-interpreter is run, it installs itself just below DOS, and it resets Hi-Mem so that BASIC programs will not overwrite it. Three demonstration programs and pictures of the results accompany this article to show what can be done with the luminance board and the sub-interpreter.

The result of "polishing" your Apple with these low-cost additions will clearly expand the utility of your computer, providing you with astounding video results and a new challenge. ◇

Still Using a "Model T" TV/Game Antenna Switch?

Electronic circuit automatically switches a TV antenna input to video game or computer and back.

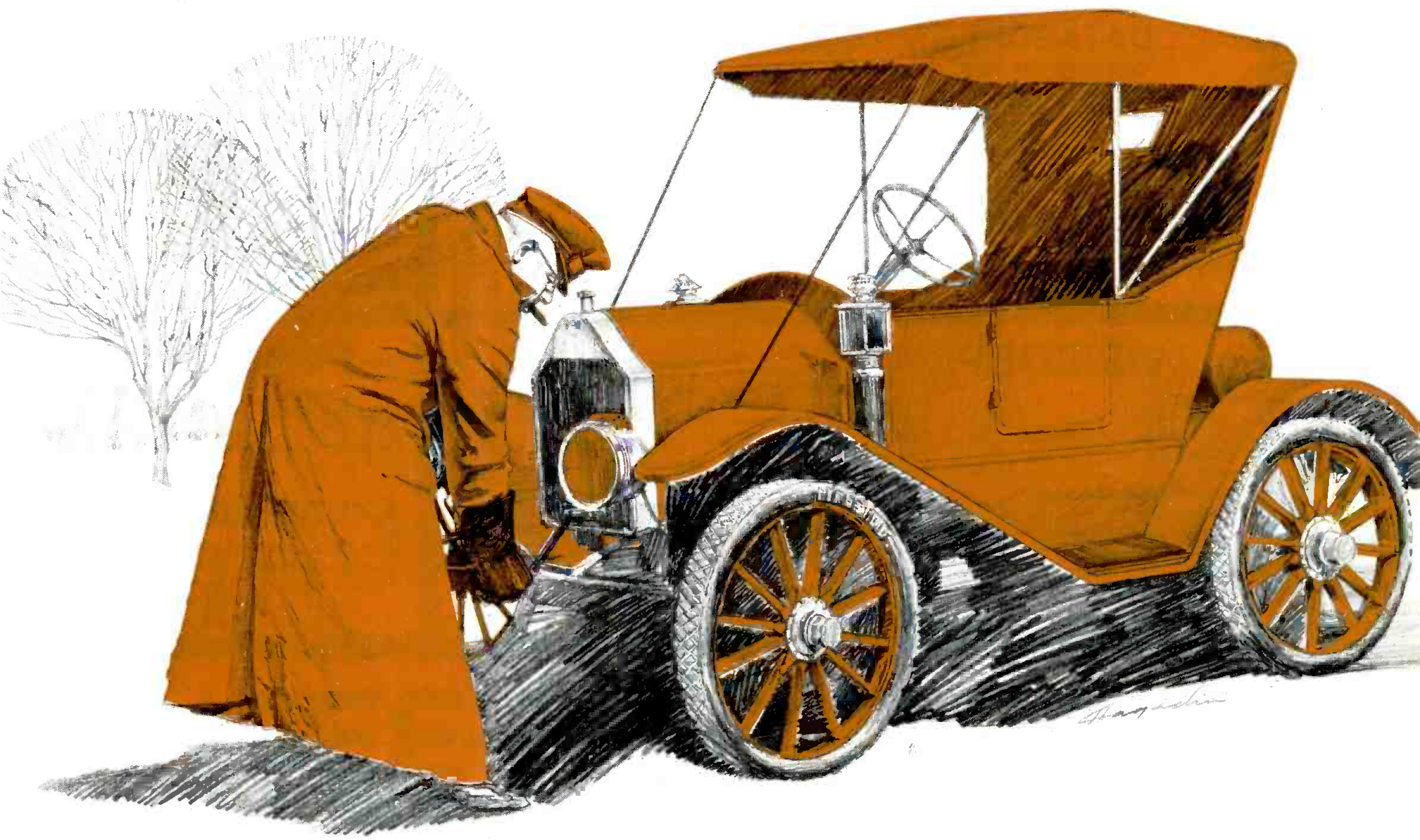
By Gary Kloesz, Motorola, Inc.

TV receivers are commonly used as a means of displaying the outputs of video games and personal computers. To prevent interference with neighbors' TV reception, it is imperative that an FCC-approved isolation switch be used, of course. This requires the user to manually move a switch lever to the desired source.

Invariably, the user forgets to switch back to the TV position after using another device. Therefore, when another person switches on the set, he or she sees only picture "snow" until the switch is moved to its TV position. This bothersome situation can be eliminated with the use of the automatic electronic switch presented here.

Circuit Operation. The key to this electronic circuit is the MPN3401 PIN diode. This type of diode can switch from a low-value resistor to a low-value capacitor depending on whether it is turned on or off. The circuit in Fig. 1 uses this property either to conduct (low resistance) or block (small capacitance) the incoming signal.

To pass a signal from the antenna input to the output, diodes *D1* and *D2* are turned on. At the same time *D3* and *D4* are off, resulting in a high impedance to the unwanted



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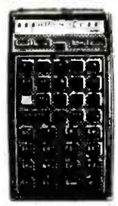

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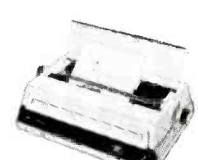

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signal from the game/computer input. To attenuate the unwanted signal further, *D6* is also turned on. This creates a low resistance to ground between *D3* and *D4.* Figure 2 illustrates the ac path when the antenna, or A, input is selected.

An advantage of this type of switch is that it can be activated through remote control. For example, turning on the game or computer can automatically "throw" the switch. The switching signal is supplied by the game or computer. It is simply a dc voltage of 5 to 10 V, which is found on the switched side of the game/computer power supply. The signal is transmitted via the cable that connects the game/computer to the TV set. Another advantage is that an electronic device is immune to problems caused by dust, dirt, and wear. There is one disadvantage, however. This switch requires a minimum of 5 mA continuous power to operate because one set of diodes is always on.

With regard to FCC requirements, the electronic switch meets them easily. It provides low (0-dB) insertion loss and high isolation (60 dB) between inputs as shown in the oscilloscope photos of Fig. 3.

Construction. The antenna switch can be constructed on a pc board. The foil pattern is shown in Fig. 4, with the corresponding parts-placement diagram given in Fig. 5. Since this is an r-f circuit, take care to leave as much ground plane as possible and to trim component leads short. If desired, enclose the circuit in a box.

For remote control switching, a dc blocking capacitor must be added to the cable that connects the game or computer to the antenna switch. It should be added at the game/computer end to isolate the switching voltage from the modulator output. Also a 1-kilohm resistor should be connected as shown in Fig. 6. These two components should be housed in a separate adapter box. If the automatic switching feature is not required, the transistor network can be replaced by an ordinary dpdt switch (Fig. 7).

The power supply for the switch can be any 5-to-10-V, calculator-

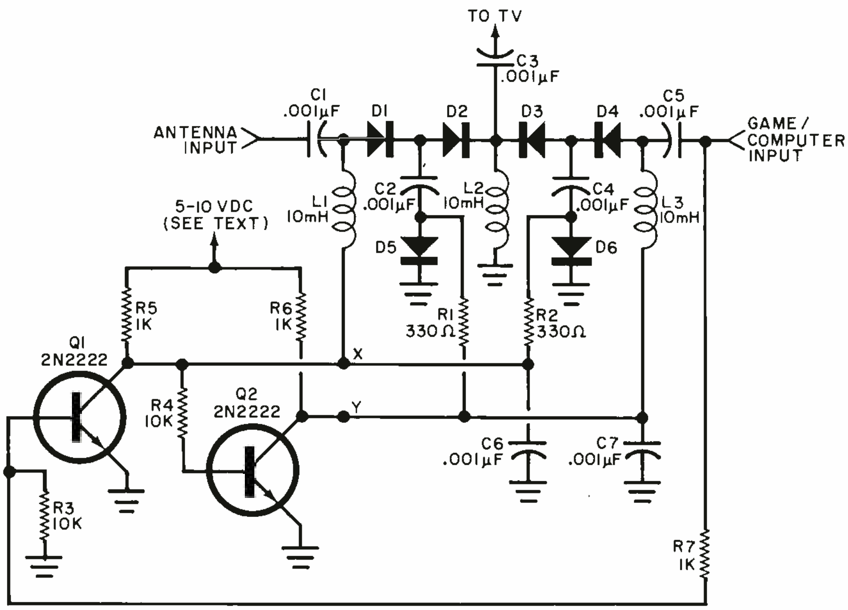

Fig. 1. Circuit operation depends on the switching diodes, D1 through D6.

PARTS LIST

C1 through C8—0.001-μF ceramic disc capacitor
D1 through D6—Silicon PIN switching diode (MPN3401 or similar)
L1 through L3—10-μH molded choke (J.W. Miller #9320-30 or similar)
Q1,Q2—General-purpose npn transistor (2N2222 or similar)
R1,R2—330-ohm, ¼-W carbon resistor
R3,R4—10-kilohm, ¼-W carbon resistor
R5 through R8—1-kilohm, ¼-W carbon resistor
Misc.—Power supply (see text), F connectors (1 male, 1 chassis-mount female), RCA phono connector (1 male, 1 female), short piece of 75-ohm coax cable (RG-59U), two 75/300-ohm matching transformers (if required), dpdt switch (if automatic switching feature is not used).

Note: The following is available from Circuit Specialists, Inc., 738 S. Perry Lane, Tempe, AZ 85281: complete kit of parts including pc board at $28.95 postpaid. Also available separately: pc board at $4.95 postpaid and Motorola MPN3401 PIN diode at $1.00 each postpaid. Arizona residents, add 4% sales tax.

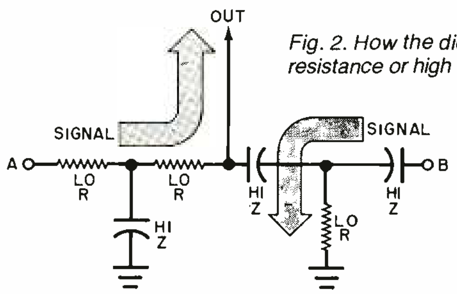

Fig. 2. How the diodes present either low resistance or high capacitance to the input.

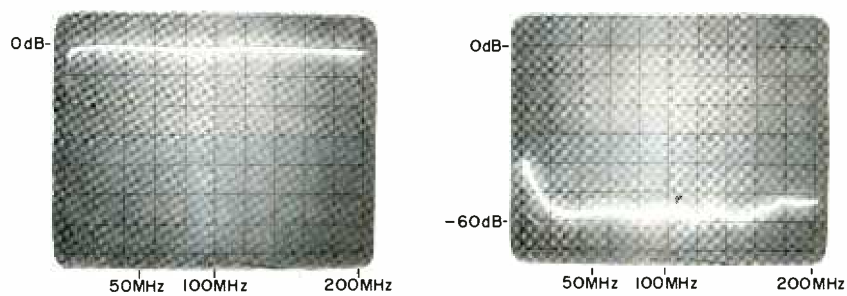

Fig. 3. Scope photos show low (0 dB) insertion loss (left) and high (6 dB) isolation between inputs using the switch.

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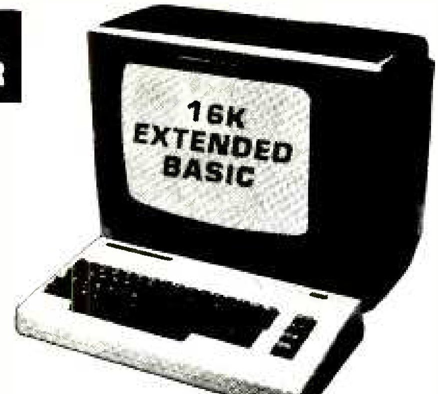

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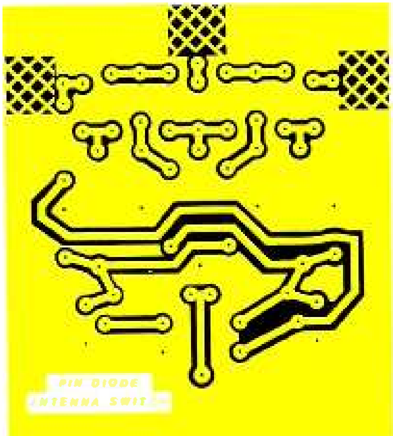

Fig. 4. Foil pattern for the printed circuit board.

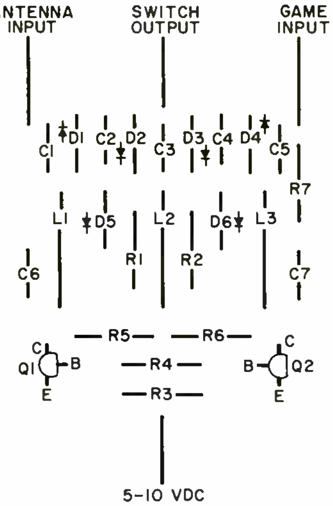

Fig. 5. Component layout for pc board.

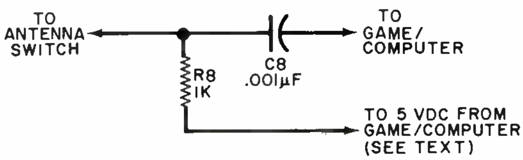

Fig. 6. Circuit for adapter box connected to game or TV.

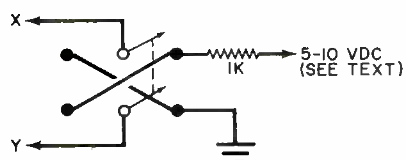

Fig. 7. Use a switch to cut out the automatic circuit.

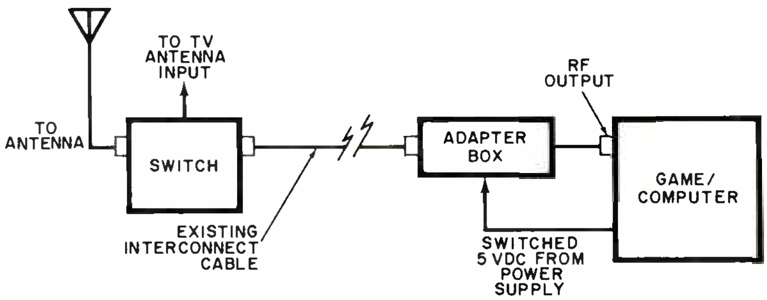

Fig. 8. Use this diagram to connect the automatic switch to the TV and the adapter box and game/computer.

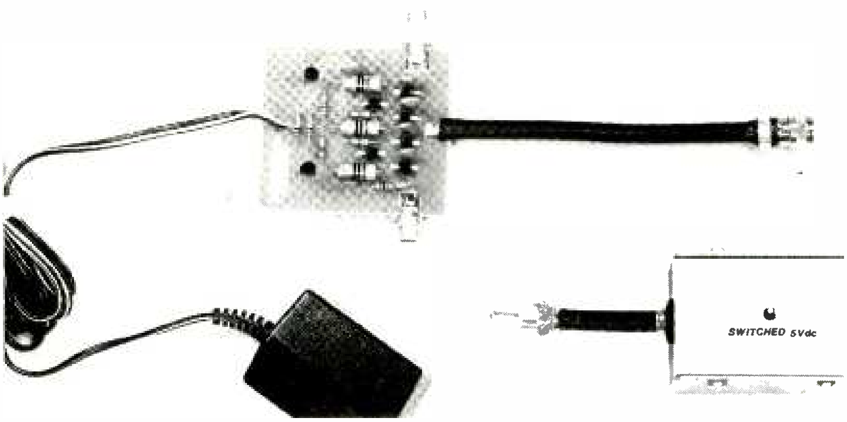

Photo showing the automatic switch, adapter box, and power converter.

type, plug-in, dc power supply such as a 9-V battery eliminator.

The switch is designed for a 75-ohm antenna system. If you have a 300-ohm system, matching transformers are required at both the antenna input and TV output. The game/computer input does not require a matching transformer because it is already a 75-ohm source.

Connect the switch to your system as shown in Fig. 8. You're now ready to watch TV or run your microcomputer or video game. Whichever you choose, your TV will give you the proper display automatically and you won't have to switch the antenna. ◇

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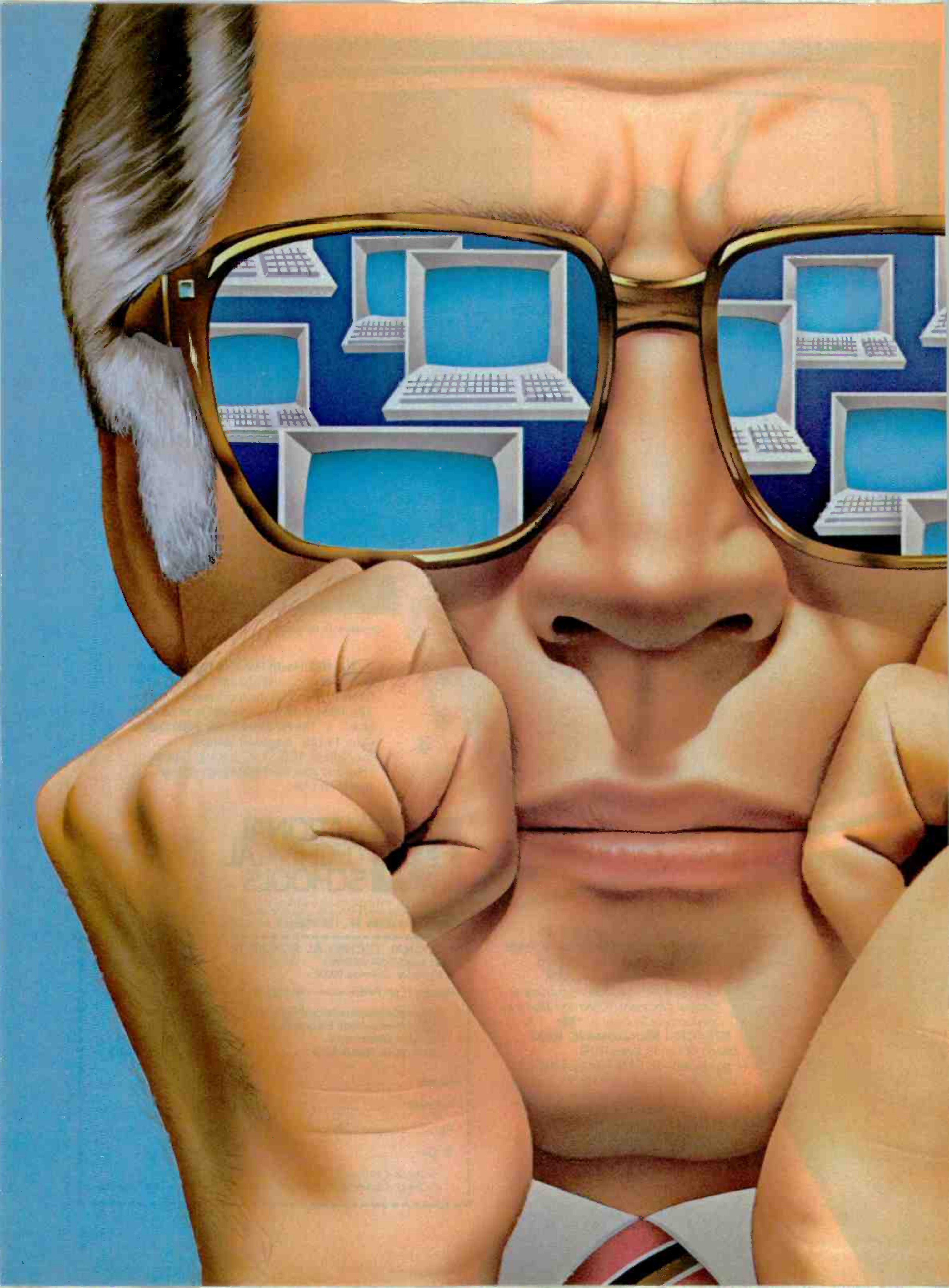

COMPUTER CLONES

Comparing computer variations with their originals—TRS-80 Apple II, and IBM-PC

By Stan Veit

Technical Editor

IMITATION is the sincerest form of flattery, the saying goes. But don't expect makers of personal computers that dominate the field to look kindly on computer "clones" of their products. These functional copies run the same software as the originals and, in most cases, interface easily with the same peripherals. Are the copycat machines cheap imitations? Are they better thanthe originals? To answer these and other questions, here are the results of our detailed examination of many such models.

TRS-80 Clones

Tandy's TRS-80 Model I was a pioneer product that quickly spread the personal computer gospel across the nation through its easy sales availability in many thousands of Radio Shack stores. The machine's great popularity spurred an enormous number of small entrepreneurs to develop and sell software programs for use with the Mod I. And hardware makers took advantage of some of the Mod I's design shortcomings by making available select improvements such as adding lower-case letters, making cassette-tape loading easier, etc. Better or less costly peripherals for the Mod I were also developed by independents.

As time progressed, Radio Shack began to catch up with improvements and enhancements for the Mod I, until it was finally displaced by the company's Model III, which might be considered an upgraded, all-in-one Model I.

Meanwhile, other brands that use the same software material sprang up to emulate Radio Shack's original products. Here are what two leading types are all about.

The PMC-80 Computer. The PMC-80 is a TRS-80 Mod I clone that is made in Hong Kong and imported into the United States by Personal Microcomputers of Mountain View, CA. It is a Z80-based computer that is functionally identical to the TRS-80 Mod I but has no physical resemblance to the Radio Shack computer. The console unit has simulated wood sides and a front panel on which are mounted the keyboard and a built-in cassette recorder. It includes either 16K or 4K of RAM memory. There is also a PMC-81 model that includes a numerical keypad in place of the built-in cassette recorder. Since both machines are otherwise identical, we shall only discuss the PMC-80.

Although there is a video interface supplied with the computer, no video display comes with the machine. The user can employ either a monochrome video monitor or a built-in r-f modulator and a TV set. This dual output concept is also carried over to the cassette mass storage facility. There is a DIN connector on the rear panel to connect the standard Radio Shack TRS-80 cassette cable. This is used to connect an additional recorder or, in the case of the PMC-81, the prime recorder.

The PMC-80 allows for a choice of two video formats. There is a 64-character display and an enlarged 32-character display for use with TV sets. The selection of video formats is done with the VIDEO CUT button on the rear panel. When the computer is turned on, the 64-char-

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acter display is in force. When the VIDEO CUT button is pressed, the 32-character format is selected. In this mode, the PAGE button on the front will select either of two possible pages of video display.

The keyboard includes the following special function keys:

PAGE—Displays either the left half or the right half of the video display when in 32-character format.
F_1—Controls the cassette recorder and isolates it from the computer during fast-forward and rewind operations.
BREAK—Stops program execution and returns control to the active command mode.
NEWLINE—Enters line of program or data.
BACKSPACE—Cancels the character previously typed.

The cassette recorder mounted on the front panel is equipped with a three-digit counter and a VU meter for setting the audio level during record or playback. The latter greatly improves data loading accuracy. The optional secondary data recorder is used to read data files into the machine and record them on another file after processing. The quality of the built-in recorder surprised and pleased us. We loaded commercial tapes from several software publishers and tapes we had made on another recorder. Using the VU meter as a guide, we were able to load the programs and data without a single bad load! Using the secondary cassette recorder (one we used with a TRS-80 Mod I) we had some trouble setting the level; but once set, the loads were very reliable.

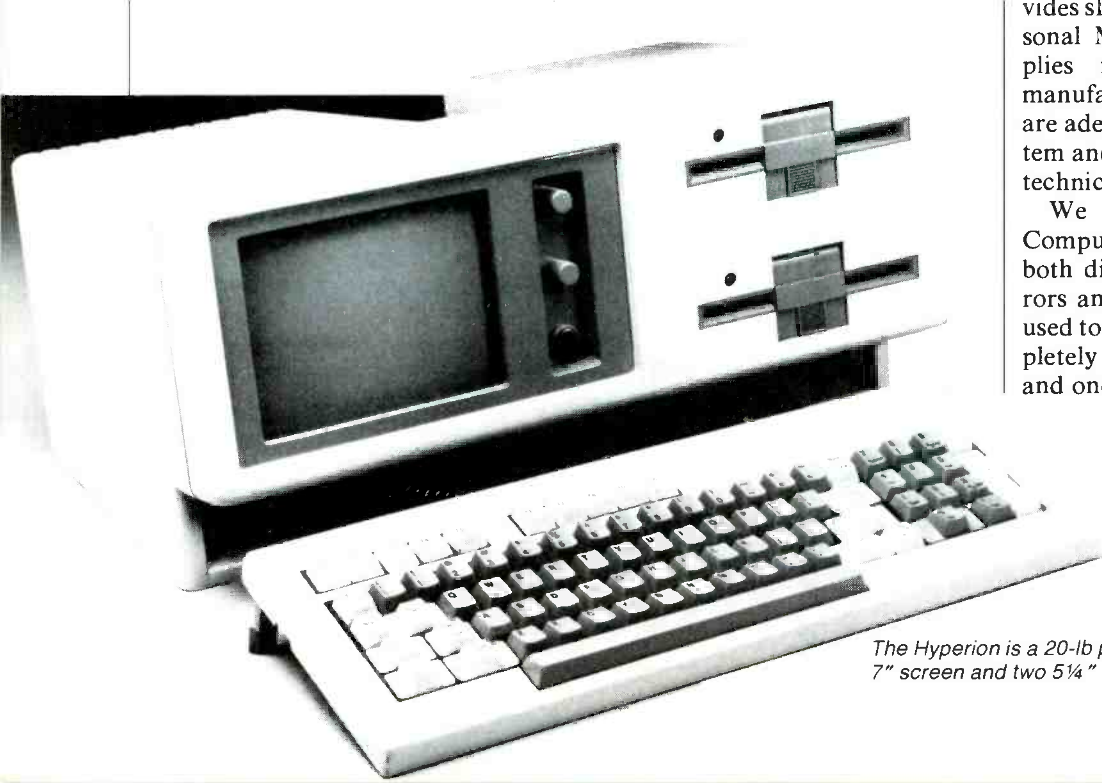
Both memory expansion and I/O are accomplished by connecting the computer to the company's EXP-100 Expander, the same method used with the old Mod I's interface adapter. The Expander has provisions for adding additional RAM memory, external disk memory, and I/O devices. Sixteen sockets have been provided to permit the installation of 4116 dynamic RAM chips to expand the internal memory from 16K to 48K, the maximum the system can use. This is identical to the TRS-80 Mod I.

The memory map of the PMC-80 uses memory area from \$0000 to \$2FFF (0 to 12,287) for ROM-based programs such as the system monitor and Microsoft BASIC. The area from \$37FFF to \$3800 (14,335 to 14,336) is used for the keyboard. The video display area occupies the memory locations from \$3C00 to \$3FFF (15,360 to 16,383), while 16K of RAM in the computer unit is located from 3FFF to 7FFF.

The PMC Expander interface can handle from one to four single-sided drives. It can also be wired to handle double-sided drives; but in that case, one double-sided drive takes the place of two single-sided drives. The disk drives offered by PMC are made in Japan by TEC. They are 40-track units capable of 102K of formatted data in single-density or 184K of formatted data in double-density. The PMC company does not sell a doubler for double-density, but either the one made by Percom or the one made by LNW can be used. The interface does have a built-in data separator, which corrects a major deficiency in the Radio Shack TRS-80 Mod I. We found the TEC drives to be quiet and reliable.

The parallel interface in the expander is Centronics compatible and works with all of the popular printers with this type of interface. We used it with Epson printers and with the TP-1 from Smith Corona. If an RS-232C interface is needed, it is supplied as a \$95 option. The PMC bidirectional serial interface is a board that plugs into the Expander main board and features the ability to set the baud rate in software. Another interesting option available with the Expander is the S-100 board interface. This provides slots for two S-100 cards. Personal Micro Computers Inc. supplies manuals printed by the manufacturer in Hong Kong. They are adequate for setting up the system and for operation, but offer no technical details for maintenance.

We liked using the PMC-80 Computer. It loaded software from both disk and cassette without errors and repeats. A person who is used to the original would feel completely at home with this machine, and one just starting with comput-



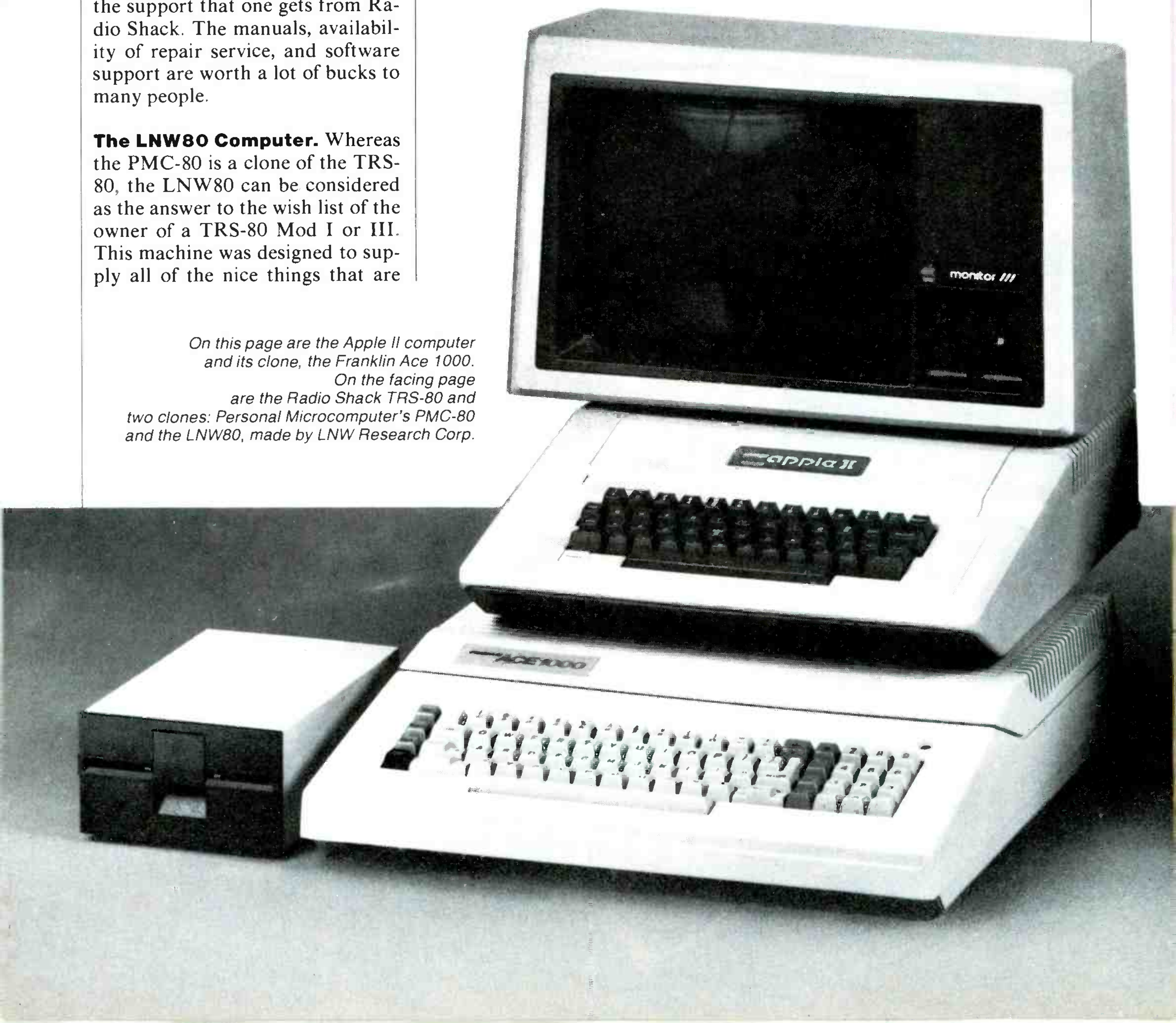
The Hyperion is a 20-lb portable with 7" screen and two 5¼" disk drives which run PCDOS.

ers should have no trouble setting up and using this system. There's no doubt that the PMC-80 is significantly better than the TRS-80 Mod I was. However, since the I is no longer available, one has to pit the PMC-80 against the TRS-80 Model III.

Total price of the units required to equal the capabilities of the TRS-80 Mod III comes to a little over $2000. This is just $225 less than the price of a TRS-80 Mod III at the local Radio Shack store. While the PMC-80 may sell for a lower price at its dealers, it seems to us that it lacks one important feature: the support that one gets from Radio Shack. The manuals, availability of repair service, and software support are worth a lot of bucks to many people.

The LNW80 Computer. Whereas the PMC-80 is a clone of the TRS-80, the LNW80 can be considered as the answer to the wish list of the owner of a TRS-80 Mod I or III. This machine was designed to supply all of the nice things that are lacking in both TRS-80's. In fact it can compete on some counts with the TRS-80 Mod II. It is a machine that can be many things to different people. For the new user, it can be a cassette-based beginning computer complete with built-in Microsoft BASIC and with the capacity to grow with the experience of the user. For the advanced TRS-80 users, it is a computer that will give color graphics, and the possibility of using 8″ disk drives without giving up the operating system and software they are used to.

Physically, the LNW80 is a neat metal-cased machine with a full keyboard (upper/lower case) including a 12-key numeric keypad. All the connectors and switches are located on the rear panel and they include both parallel and RS-232C serial connectors, video outputs for monochrome, NTSC color and RGB color. The floppy-disk system has both single- and double-density controllers and provisions for either 5¼″ or 8″ drives. It is designed to run any of the popular disk operating systems that have been written for the TRS-80 computers. Furthermore, it will also run either Mod I or Mod III software. The cassette storage system will operate at either 500 or 1000 baud, and can use the same cassette



On this page are the Apple II computer and its clone, the Franklin Ace 1000. On the facing page are the Radio Shack TRS-80 and two clones: Personal Microcomputer's PMC-80 and the LNW80, made by LNW Research Corp.

recorder and cable supplied with the Radio Shack computers.

Internally, the LNW80 uses a Z80 microprocessor with a 4-MHz clock. Interestingly there is a switch on the rear panel to reduce clock speed so that the computer can run the TRSDOS operating system from Radio Shack which is designed to run with a 1.77-MHz clock. The LNW80 is equipped with 48K of user RAM memory and a 12K ROM containing the Microsoft BASIC interperter and 1K for the video screen. In the graphics mode the BASIC is switched out and 16K is used for graphics.

The LNW80 has three versions of the BASIC language available and they can be used for different conditions. First, there is Microsoft Level II BASIC, which is in the 12K ROM. This is identical to the Level 2 used in Radio Shack TRS-80 computers. The second BASIC is a DOSPLUS 3.4 Tiny BASIC, which is on the DOSPLUS diskette. It provides an extension to the Level 2 BASIC and adds disk file handling, advanced keyboard I/O, in-string search commands, and user-defined BASIC commands. DOSPLUS Extended Disk BASIC is also on diskette and it adds other features to the DOSPLUS BASIC.

LNWBASIC is supplied on a separate single-density diskette and it provides 40 additional commands to the other BASIC versions. It is the language that controls the high-resolution graphics and color, machine-language calls, sound commands, print spooler, RS232 communications from BASIC, and do/until constructs. It is LNWBASIC that gives this computer much of its power! Although DOSPLUS is supplied with an LNW disk system, the computer is capable of running NEWDOS, NEWDOS80 or LDOS, as well as TRSDOS.

Video display of the LNW80 may be either an RGB color monitor, an NTSC color monitor, or a high-quality monochrome monitor. An r-f modulator and a TV receiver can also be used with reduced screen width. The computer has the capability of displaying 80 characters by either 16 or 24 lines; 40 characters by either 16 or 24 lines; 64 characters by 24 lines; or 32 characters by 24 lines. The exact video display format depends upon the selection of software. The 80- and 40-character displays are only

available to users of disk operating systems when the applicable driver programs are run. In addition, these drivers have limitations—they cannot be used in word-processing applications unless the software has been specially configured for that purpose.

The LNW80 is equipped to display both upper- and lower-case characters without modification once the proper driver programs are executed. This does not apply to the use of any of the standard disk operating systems or word-processing software systems that have their own internal drivers for the upper/lower case functions.

The LNW80 Computer has the capacity to use up to four disk drives. These may be either $5^1/_4''$ or 8″ drives, a combination of both, or even hard disk drives. Dual-headed drives (two read/write heads) may also be used; but in this case, only three disk drives can be connected. The diskettes may be formatted for either single- or double-density. This gives users who have accumulated a great deal of single-density software the ability to expand from the original TRS-80 Mod I or Mod III. The possibility of using existing software and at the same time expanding disk capacity is one of the most attractive features of the LNW80. It can also operate with any of the popular disk operating systems such as TRSDOS, DOSPLUS, NEWDOS, MULITDOS, LDOS, and VTOS.

The LNW80 is not a cheap computer. It is thoughtfully designed and well made in the United States. The base computer unit, which includes 48K user RAM, the disk controller, upper/lower-case keyboard, complete data and video I/O, cassette interface, and all the graphics and color features, costs $1695. To use the computer, you must add a video monitor and a disk system, plus the DOS and LNWBASIC software. An average black-and-white system will cost over $3000 while a color monitor will add from $250 to $750 to this price. A new model that will add CP/M capability (additional memory and CP/M software) will cost $2495 for the base unit. Although there are a few dealers, at this time, the machine is sold through mail order directly by LNW Research Corporation, Tustin, CA 92680.

The LNW80 does not appear to be a machine for the first-time computer user. Features such as color and graphics are not easy to use since they require the use of specialized software to initialize and run them. However, for the software developer, graphics artist, and advanced computer hobbyist, this machine offers all the things they always wanted in a TRS-80 type of computer. We do not think the business user will find a machine with as little support as the LNW80 very practical, though. With the proper back-up from a systems house, however, this should prove to be a powerful tool that's rugged, versatile and expandable.

Apple Clones

The Apple computer was also an early entry in the personal computer stakes. Its product distribution was largely through independent retail stores. Today, the Apple II is one of the most popular and useful small computers built. It employs a 6502 microprocessor in contrast to Radio Shack's Z80 CPU, and contains a lot of complex programs in ROM that make color, graphics, and audio easy for a user to learn and apply. Until recently, though, functional copies of the Apple II were not produced. Now at least two compatible brands have appeared, as well as blatant replicas being manufactured and promoted in the Orient. Let us examine the two types promoted in the U.S., the Franklin Ace Computer and the Basis Computer.

Franklin Ace 1000. The Franklin Computer Company's Model Ace 1000 is not only a functional copy of the Apple II+, but it has also been designed to look like the Apple II+. It has almost all the features of the the Apple II+ except color and a cassette interface. Moreover, it includes some features that the Apple lacks unless it is modified (like printing upper- and lower-case characters) and 64K of RAM.

To a large section of the computing public, the addition of color is "frosting on the cake." Certainly graphics and games look much better in color than in monochrome but color isn't needed for accounting applications, spreadsheet applications, or word processing; neither do file management programs or data bases. Nevertheless, a Franklin spokesman advises that all of its users who want color will have that option soon. The audio cassette was omitted because it was not considered to be an effective mass storage system for anything more complicated than games. It lacks a file structure and takes too long to load business programs.

Since Apple terminated many distributorships and mail-order retailers, there has been a ready market for the Franklin Ace Computer. The first model was the Ace 100, which was built into a standard case. Apple Computer sought an injunction to stop its sale, but that threat seems to have been eliminated by the courts. The company's new Ace 1000 features a sturdy new plastic case.

Like the Apple II+, the Ace 1000's case has a snap-off lid. Removing the lid, you will see the switching power supply on the left. It has plenty of power for all the extra boards you may plug into the computer. There is a fan built into the front of the power supply to prevent overheating.

The Ace main circuit board is somewhat larger than the Apple and it contains 64K of user RAM rather than 48K. Both units have eight slots for plug-in cards and a joystick/paddle connector for game controls.

The Ace 1000 keyboard has excellent quality and feel. It has typewriter styling and includes an illuminated Alpha shift/lock and a keypad with both numeric and special Visicalc markings. On the left side of the keyboard are four keys marked ESC, BREAK, PAUSE, and CTRL. Locating the BREAK adjacent to the ESC key might cause problems with some software; however, the location of the CTRL key is an unfamiliar positioning that takes some time to get used to if you have some prior computer experience. There are five keys that must be typed differently on the Ace-1000 as compared to the Apple II, including some common symbols like brackets. Due to these differences and the upper/lower-case type, some Apple II programs must be re-configured to run on the Franklin computers. Thus, the user will have to check carefully before buying Apple II software for the Ace 1000. This type of minor difference can assume major proportions when software with a lot of color commands is run.

The RESET key on the Franklin Ace has been placed in a position where it is easy to get at, but impossible to hit accidentally, the latter being an annoying occurance on the Apple. Franklin installed it on the underside of the keyboard, on the left-hand side.

The DOS supplied with a Franklin disk system is completely compatible with Apple DOS 3.3; it even has the utility to run the older 13-sector Apple diskettes. It contains both floating point BASIC (FPBASIC) and integer BASIC (INTBASIC). The copy of FPBASIC on the disk is only on the disk for diagnostic purposes since the identical BASIC is always stored in the machine. The INTBASIC is automatically loaded into the computer at power-on. Once it is read in, it usually stays in memory until the power goes off. Franklin has collected a group of utility routines into a program called FUD (Franklin Utility for Diskettes). When FUD is run, it gives the user a Main Menu from which utilities can be selected to copy, delete, lock, unlock, or verify files, and to format diskettes and make a master diskette. FUD is a very handy concept because it gives single-key entry to several interrelated programs.

We liked using the Franklin Ace. It is a well-designed computer. Of course it is much easier to "reverse-engineer" a machine to correct the faults of a model than it is to conceive a completely new design. The suggested price of the Franklin 1000 is $1530 and the disk with controller is $579. However, the actual selling price in stores is much less. The price of the Apple II with comparable equipment is about $250 higher.

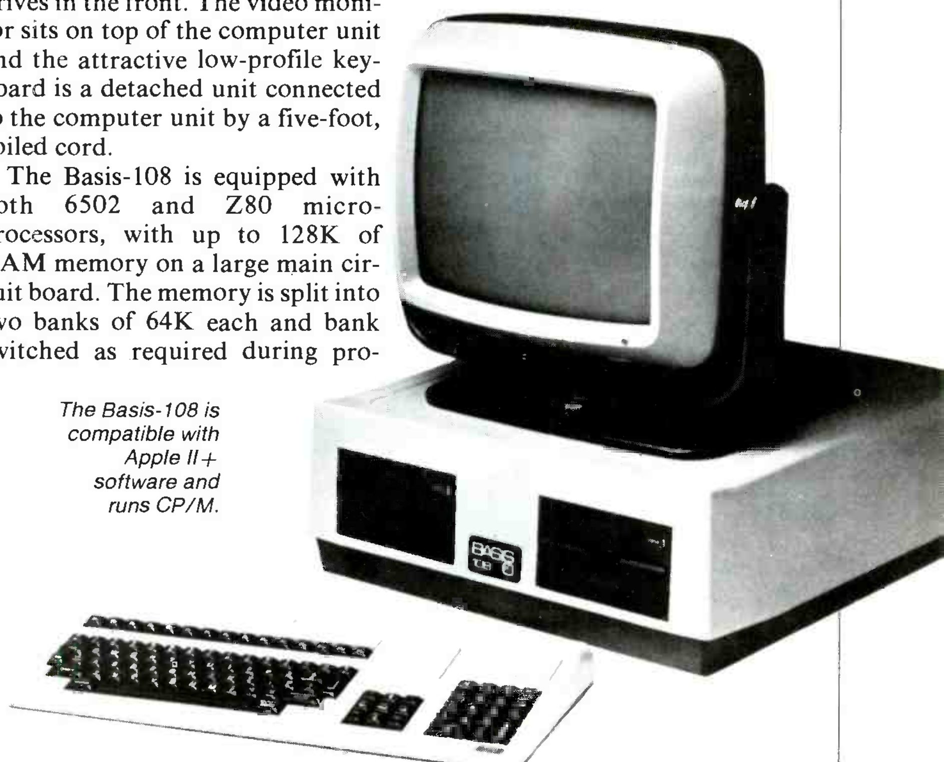
Basis-108. The Basis-108 is an Apple II+ compatible computer since it runs Apple II software and has six slots for the use of Apple II boards. It cannot really be called an Apple copy, though, since its configuration is not based upon the Apple II design and because Apple II software is only a portion of its software library. Its features and utility go beyond what the Apple II can offer.

Basis was originally Apple Computer's distributor in West Germany and it worked with Apple on design of a Euro-Apple that was never built. Apple took over the distributorship in Europe as they had in the United States, and Basis proceeded to produce the Basis-108 in Germany. It is sold and supported in the U.S. by Basis Inc. of Scotts Valley, CA.

The Basis-108 looks somewhat like the IBM-PC, with a rectangular computer unit having disk drives in the front. The video monitor sits on top of the computer unit and the attractive low-profile keyboard is a detached unit connected to the computer unit by a five-foot, coiled cord.

The Basis-108 is equipped with both 6502 and Z80 microprocessors, with up to 128K of RAM memory on a large main circuit board. The memory is split into two banks of 64K each and bank switched as required during processing. The system has a monitor program occupying 2K of ROM and 5 additional sockets for additional ROM or EPROMs for a total of 10K of ROM memory. There is provision for internal mounting of two disk drives. Either Apple drives or other compatible drives can be used. All the system power, video and I/O connectors are located on the rear panel. These consist of power input, two switched-power utility sockets, one DB25 connector for keyboard I/O, two DB25 connectors for system I/O, three video connectors for composite video, one DB9 connector for RGB video, and one DIN connector for cassette I/O. The rear panel also has three additional slots for extra DB25 connectors.

The low profile, detached keyboard is among the nicest of this genre we have seen. The keyboard consists of 100 keys that are divided into four groups according to function. There is the standard ANSI typewriter keyboard group, a numerical keypad, a cursor control block, and programmable function keys. The keyboard is decoded by a ROM on the main circuit board, and the keyboard configuration can be changed by changing the ROM.



The Basis-108 is compatible with Apple II+ software and runs CP/M.

The Basis-108 has a wide range of video dispays. There are two text modes and three color graphic display modes. The text display can be either 40 columns by 24 lines or 80 columns by 24 lines. The graphics display can be 40 horizontal by 48 vertical with 15 colors; 80 horizontal by 48 vertical with 15 colors; or 280 horizontal by 192 vertical with 6 colors. It is also possible to have high-resolution graphics and up to four lines of text. The video display can be either black-and-white composite video, composite color video, or RGB color video. There is also a built-in loudspeaker for sounds and music programs.

The Apple DOS is supplied with the disk system; either the standard Apple DOS 3.3 can be used or one supplied by Basis that is menu driven but otherwise identical to Apple 3.3. The CP/M disk is supplied by BASIS with a BIOS designed for the BASIS-108. Microsoft BASIC is built into the system.

The Basis-108 represents an alternate upward path from the Apple II. Some dealers report that there are customers who are trading their Apple II computers for the Basis-108. Several users have said that this is what the Apple II's successor should have been.

The Basis 64K unit with no drives, but. with a cable set and game paddles, sells for $2050, not a bad price if you add up all the equivalent options being supplied. The 128K Basis costs $2350. A 64K Apple computer with one drive and 35 tracks costs $2625, with two drives, $3100. A 128K Basis-108 with two drives "lists" for $3400. These prices do not include the video display, which will add from $150 to $995, depending on selection. These are suggested prices from Basis Inc. Selling prices in the stores will vary a great deal, of course. In any event, the Basis-108 is a good-quality product, has exceptional versatility, and, expectedly, does not come cheap. Having a 6502 CPU with Apple compatibility down to the card slots plus a Z80 CPU with CP/M certainly offers a world of computing opportunities in a single system.

IBM-PC Clones

The IBM Personal Computer has now been on the market for one year and has become one of the best-selling machines in the industry. IBM has limited the number and location of computer stores and dealers selling its machine thus far. It is likely that the IBM PC compatible market will become a large part of the microcomputer business, with many companies building boards to plug into the IBM-PC and writing software to run on these machines. Some companies are also building functional clones of the IBM-PC Computer. It is difficult to define just what an IBM-PC clone is because this computer does not come with bundled software. IBM offers a choice of operating systems, all of them being written by other companies. The most popular DOS has been PCDOS, also known as MDOS or SB86 DOS. Running second and third are Digital Research CPM/86 and the UCSD-P System. Phase One Oasis 16 is also being offered for the PC.

We cannot define every computer with an 8088 CPU that runs the same software as the IBM-PC as a clone, anymore than all the different machines that run CP/M are clones. We will therefore define an IBM-PC clone as a computer that uses either an 8088 or an 8086 CPU, runs the same software, and uses the same plug-in circuit boards as the IBM PC. There are several of these either in production or about to go into production.

Columbia Data Products' 8088 Multi-Personal Computer, an IBM clone.

The Hyperion Computer. From Dynalogic Info-tech of Ottawa, Canada, this is a 20-lb portable computer with a 7" amber screen, two $5^1/_4$" disk drives, a detached keyboard compatible with the IBM PC keyboard, and 256K of RAM. The Hyperion is one of the outstanding designs in portable computers as well as a very powerful computer.

The CPU is the 8088 16-bit processor and there is provision for the 8087 floating-point processor. The 256K user RAM is equipped with parity checking and there is also a 20K video RAM and an 8K ROM containing diagnostics and the monitor program. The display has 25 lines of 80 characters with five pages of display data. The character set has 256 characters, including Greek, foreign language special characters, and mathematical symbols. The graphics display format is 640 dots wide by 250 (or 200) dots high, fully addressable array; or 320 dots wide by 250 (or 200) dots high, with 4-level grey scale. The I/O includes the RS-232C standard with an asynchronous 75-to-19.2K baud rate or synchronous 100K with bisync and bit-oriented protocols. The parallel port is compatible with IBM/Epson or Centronics printers.

The Hyperion system also includes a built-in 300-baud modem with auto answer capabilities. The CRT and the disk drives automatically shut down when not in use to conserve energy and prolong life. Other features include a time and date clock with battery back-up, a programmable sound system, and an optional expansion chassis with a 10M-byte Winchester cartridge drive and four IBM-compatible I/O slots. The keyboard fits into an opening at the bottom of the computer and the whole thing fits into a vinyl traveling case.

The software for the Hyperion includes MS DOS, Microsoft Advanced Disk BASIC, Microsoft Multiplan electronic spreadsheet, an Executive text editor and electronic mail system, a telephone management system, and optional languages including Pascal, COBOL, FORTRAN, and a BASIC compiler.

The Hyperion contains everything one could possibly want in a small computer, with the added advantage of being portable. The only drawback is the price; the Hyperion costs $5000. This is not high if all the features provided are considered; but since the equipped IBM-PC costs about $1000 less, it will appeal only to those who need IBM compatibility in a portable machine.

The Eagle Computer. The BC1600 series of computers made by Eagle uses the Intel 8086 16-bit microprocessor and is compatible with the IBM PC. The single- user Model 1610, offers 128K of user RAM and an 8088 CPU running at 8 MHz. It has two built-in disk drives with a total of 1.6M bytes, formatted. The Eagle is built into an integrated cabinet which contains the central processing unit, 12" video monitor, full keyboard with 95 keys including 14 with user-designated functions, and the disk system. All I/O connectors are on the rear panel and they include both RS-232C serial and Centronics compatible parallel ports. The Eagle BC1600 series also has provisions for adding up to seven IBM-compatible plug-in boards. Color graphics is also available as an option. The single-user BC1610 runs MS-DOS or CPM-86 as an operating system. Oasis-16, Xenix and IRMX-86 operating systems are also available as options.

The Model 1630 offers 512K bytes of user RAM with integral floppy and hard disks for a total storage capacity of 10M bytes. The Model 1630 also contains asynchronous serial ports to support up to eight local or remote terminals. The Eagle Model BC1630 is the only IBM-PC compatible unit we have seen that is equipped for multi-user operation.

The single-user Model 1610 will sell for around $5000 complete except for software, while the multi-user Model 1630 will sell for about $9000. At the time of writing this article, the final prices had not yet been set.

We did not have a chance to test the Eagle BC1600 series since only the prototypes had been completed in time for the Comdex show in Atlantic City. We did have a chance to operate the Model 1610 at Comdex. In all, we found it to be as promoted. The Model 1630 as a multi-user IBM-PC clone will appeal to businesses with distributed workstation requirements.

The Columbia 8088 Multi-Personal Computer. Columbia Data Products has introduced a computer that seems to be a clone of the IBM-PC in appearance as well as function. The Model 1600-1 is an 8088-based computer with 128K of RAM, two RS-232C serial ports, a Centronics-compatible parallel port, and dual floppy disks with 640K bytes of storage. The computer has a detached keyboard and slots for up to eight IBM-PC-compatible plug-in boards. The Model 1600-1 has a suggested price of $2995, a low price considering the features offered. The Winchester technology hard disk models, 1600-2 and 1600-3 are equipped with a 320K floppy disk and either a 5M- or 10M-byte hard disk. These units feature a cache-buffer hard-disk controller with an independent 64K processor system that provides enhanced disk access performance in both single- and multi-user configurations. The 1600-2 has a suggested price of $4995 and the 1600-3 has a suggested price of $5495. These computers were displayed at the Comdex Show, but were not available for test at the time this article was written. They appear to take the concept of the IBM-PC one step beyond the single-user computer.

Conclusions

There seems to come a time in the development of every branch of the electronic industry when a leader is established and all the other manufacturers devote their efforts to copying the leader. After that the public has a choice between tweedledee and tweedledum. This seems to be happening in the personal computer industry, especially in the portion of it that is concerned with making desktop units.

Until now the computer industry has been marked with spurts of great innovation as manufacturers rushed to build machines using the newest microprocessors. With the availability of such advanced microprocessors as the Motorola 68000, the National 16000, and the Z8000, it would indeed be a shame if computer manufacturers simply restricted their output to copies of popular machines. There is some reason to build TRS-80 or Apple II clones if they contain advanced features not found in the originals and also make use of the vast stock of available software. However, we see no reason to build IBM-clone after IBM-clone during a time when volume deliveries of IBM-PC's are just underway and there is no great store of software. ◇

Build the Mailbox Sentry

LED and tone indicators announce mail arrival at remote location

By Les Svoboda

A RURAL mailbox is often located a good distance from the house, which makes it difficult to tell when mail has arrived. The "Mailbox Sentry" helps solve this problem by sounding a tone and lighting a LED in the house when the mailbox door is opened. The tone stops after approximately 20 seconds, but the LED remains on until it is manually cancelled by operating a pushbutton.

Circuit Operation. As shown in the schematic, Fig. 1, a CMOS 4001 chip, *IC1*, is set up as a dual set-reset latch. Each latch is triggered by the leading edge of a positive-going pulse provided by switch *S1* at the mailbox. The pulse remains high as long as the mailbox door is open (switch is closed). During this time a reset is not possible. In fact, if your mailbox is left open, you'll know about it because you won't be able to perform a reset.

When the mailbox is opened, pin 11 of *IC1* goes high and turns on transistor *Q1*. This activates the alarm circuit, which consists of 555 timer *IC2* (operating in the astable mode) driving an 8-ohm speaker *SPKR1*. The alarm times out in about 20 seconds due to the RC time constant of the 10-µF capacitor *C1* and 2.2-megohm resistor *R8*. A normally open pushbutton switch, *S3*, is placed across the capacitor so the alarm can be prematurely silenced, if desired.

Pin 4 of *IC1* also goes high when the mailbox is opened, and turns on

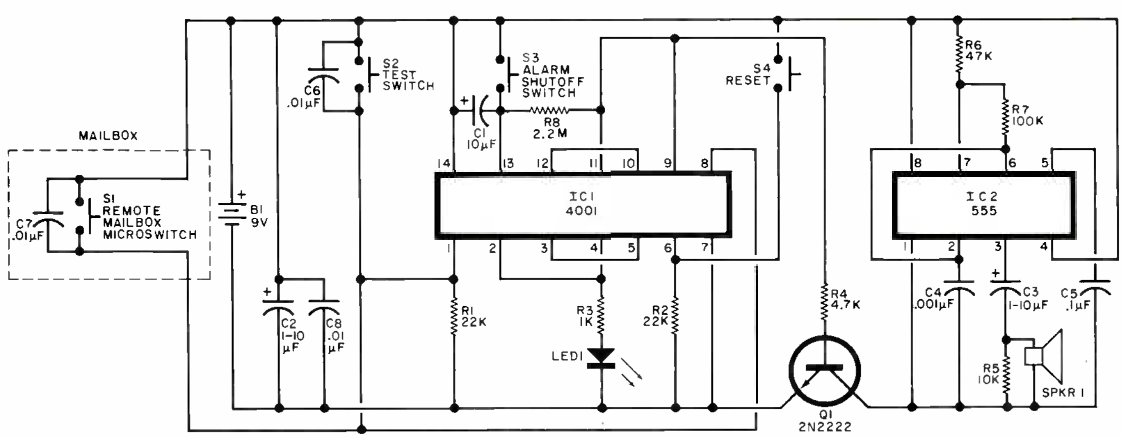


Fig. 1. Heart of the circuit is the 4001 chip set up as a dual set-reset latch.

PARTS LIST

B1—9-V battery
C1—10-µF, 25-V electrolytic
C2,C3—1-10-µF, 25-V electrolytic
C4—0.001µF, 25-V ceramic disc capacitor
C5—01.-µF, 25-V ceramic disc capacitor
C6,C7,C8—0.01-µF, 25-V ceramic disc capacitor
IC1—4001 quad NOR gate
IC2—555 timer
LED1—Red or green light-emitting diode
Q1—2N2222 npn silicon transistor (or similar)
The following are ¼-W, 10% resistors:
R1,R2—22 kilohms
R3—1 kilohm
R4—4.7 kilohms
R5—10 kilohms
R6—47 kilohms
R7—100 kilohms
R8—2.2 megohms
S1—Normally open microswitch, magnetic reed switch, or mercury switch
S2 through S4—Normally open pushbutton switch, panel mount
SPKR1—8-ohm, 2" or 2½" speaker
Misc—14-pin DIP socket, 8-pin DIP socket, battery clip, Veroboard™ or perf board, #8451 Belden audio wire, hookup wire, case, mounting hardware, construction adhesive, etc.

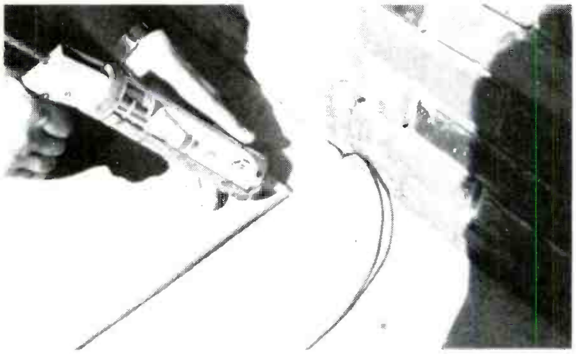


Fig. 2. Cement the wire into a groove in the sidewalk using some sort of construction adhesive.

visual indicator *LED1*. A normally open pushbutton switch, *S4*, provides for a reset to turn the LED off.

A normally open pushbutton switch, *S2*, is used as a "test" switch. It bridges the switch located at the mailbox and provides a check of the system. A single 9-V alkaline battery, such as that used in transistor radios, is used to operate the unit.

Construction. The circuit is simple enough to be constructed on Veroboard™ or perf board. DIP sockets are recommended for the ICs.

After the unit's case has been drilled for switch openings and sound emission, the speaker can be mounted on the inside front of the case using a few dabs of silicon sealant.

Installation. A microswitch is mounted under the mailbox where it can close when the door is opened, and open again when the door is closed. (A magnetic reed switch or mercury switch can be used if desired.)

A shielded cable such as Belden's #8451 shielded audio pair is run from the switch to the house. This type of wire was chosen because it has a heavy and durable plastic covering that will last a long time buried underground. It is also of a fairly small diameter so that it fits nicely within the breakaway grooves of a sidewalk. With a caulking gun, place a bead of construction adhesive such as Liquid Nails (trademark of Macco Adhesives—SCM Corp.) within the groove, imbedding the wire into the bead. Place another bead over the wire and smooth it with your finger. This makes a permanent installation below the surface of the sidewalk in a few minutes (Fig. 2).

The rest of the cable is then conveniently routed into and through the house, and connected to the "Mailbox Sentry" unit. The shield can be connected to a convenient ground if desired. The unit should be mounted where it can be easily seen or heard, and where it can be reset after the mail is picked up. ◇

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74LS33	.55	74LS162	.95	74LS366	.89
74LS37	.55	74LS163	.95	74LS367	.69
74LS38	.35	74LS164	.95	74LS368	.69
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74LS42	.49	74LS166	1.95	74LS374	1.69
74LS47	.75	74LS168	1.69	74LS377	1.40
74LS48	.75	74LS169	1.69	74LS378	1.15
74LS49	.75	74LS170	1.69	74LS379	1.35
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74LS76	.39	74LS192	.89	74LS447	.75
74LS78	.49	74LS193	.89	74LS490	1.89
74LS83	.75	74LS194	.89	74LS668	1.65
74LS85	.95	74LS195	.89	74LS669	1.85
74LS86	.39	74LS196	.79	74LS670	2.10
74LS90	.65	74LS197	.79	74LS674	9.50
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74LS93	.59	74LS241	.95	74LS684	2.39
74LS95	.79	74LS242	1.79	74LS685	2.39
74LS96	.79	74LS243	1.79	74LS688	2.39
74LS107	.39	74LS244	.95	74LS689	2.39
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		4035	.85	4518	1.20
		4040	.90	4519	1.20
		4041	1.20	4520	1.20
		4042	.75	4522	1.20
		4043	.75	4526	1.20
		4044	.75	4527	1.90
		4046	.90	4528	1.20
		4047	.90	4531	.90
		4049	.50	4532	1.90
		4050	.50	4538	1.90
		4015	.90	4539	1.90
		4053	.90	4543	2.70
		4060	1.39	4555	.90
		4066	.75	4556	.90
		4068	.39	4581	1.90
		4069	.30	4582	1.90
		4070	.35	4584	.90
		4071	.30	4585	.90
		4072	.30		
		4073	.30	80C07	.90
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Printing Computer Graphics

Dot-matrix printers with bit-image graphics provide exciting hard-copy illustration opportunities for small-computer owners

By Stan Veit
Technical Editor

Created by Ame Flynn using "Printographer."

CREATING computerized illustrations and other images on a video screen and reproducing them on a printer has become an important application of personal computers. All that is required to enjoy this function is a computer with a memory-mapped video system, a dot-matrix printer with bit-image capability, and a suitable graphics print program.

Virtually any personal computer with self-generated video can be used to "draw" pictures on a screen. With some machines, this might be done by putting a computer's graphic characters on a screen in sequence to form the desired images. Other computers utilize bit-mapped graphics, where the screen is assumed to be a matrix of dots turned on or off to form images.

With the advent of the low-cost dot matrix printer, it has become possible to directly print dot graphics from the data stream of the computer. It is quite simple to print the graphic characters providing the printer includes them in its internal character set. However, doing a "screen dump" of a complex video graphic program is another matter. The printer must be built so that the user can control the printing of each dot and the spacing of the print image. It must be possible to turn off the standard character set while the print logic takes its orders from the program being executed. Most of the dot matrix printers that have this capability are listed by manufacturer in Table I.

Bit-Image Graphics. All of the dot-matrix printers with bit-image capability work the same way. The print head consists of a series of print wires that are individually fired by solenoids. The print wire strikes the paper through an inked ribbon and leaves a dot on the paper. As the print head is moved across the line, the printed dots form characters or graphic images. At the end of the print line, the operation is stopped and the paper is advanced one line. In some printers, the print head is returned to character position 1, and the next line is printed in the same way. This is unidirectional printing. In other printers, logic is included to permit printing in either direction—bidirectional printing.

Figure 1 shows how the print wires form a printed character. Normally, the computer sends the printer the code for a character. The printer has a ROM memory chip called a character generator and the program in this memory sets the wire firing pattern for each character in the set. A printer that has provisions for bit-image graphics recognizes a certain code sent by the computer as an instruction to turn off the character generator and bypass the print logic that controls the firing order of the wires. Then, the printer interprets the data stream following the turn-off code as direct orders to fire certain wires. This control permits the printing of a pattern of dots on the paper to form a graphic image. In some printers, the dot printing is done through a multi-colored ribbon and the result is the same as color printing. The shading and color resolution is the result of the closeness of the printed color dots. Some printers have only the capacity to print graphic images in one density; others can print more than one density to give much higher resolution.

As an example of what a printer can do with bit-image graphics, we will consider the Epson printer. Some of this information was obtained from manuals published by Epson America and from a paper, "Bit Image Graphics On The Epson Printers" by Robert Diaz, Applications Engineer.

The Epson MX-70 Printer can print graphics in the normal graphics mode only. The MX-80 series of printers require the Graftrax option in order to print graphics in normal or dual-density modes. The MX-100, with a built-in Graftrax option, can print graphics in both modes.

On the Epson printers, the graphics mode is entered by sending the printer an ESCAPE code followed by the character "K," and two hexidecimal numbers each consisting of two digits (n1, n2) to define the amount of bit-image data to be transferred. The n1 represents the low-order two bits, and n2 the high-order two bits. In the MX-100, the maximum line width is equal to 816 dot positions in the normal-density mode and 1632 dot positions in the dual-density mode. Any values of n1 and n2 over 816 in the normal-density mode are ignored and the graphic image represented by that number will not be printed. After printing the maximum number of dot positions in the line, the printer automatically returns to the text mode to print the next line. If another line of graphics is to be printed, it must start with ESCAPE K once again. The code for the dual-density mode is ESCAPE L instead of ESCAPE K.

When BASIC is being used to control the printer, the values for n1 and n2 are obtained by using the BASIC function CHR$( ). This should allow the computer to send any number to the printer. However in the real world many computers use certain numbers not available to the operator.

Look at the bit image program in Table II. On some computers, this program may not function correctly due to software limits imposed by the BASIC operating system. Otherwise, when the program has been entered and run properly the pattern in Fig. 2 will be printed. Since the program listed the characters "ABCDEFGH" for printing, where did the pattern come from?

In the program, CHR$(27) is the ASCII code for ESCAPE. The letter "K" sets the printer into the normal-density mode. CHR$(8) is n1, CHR$(0) is n2. The total number of bytes is n1 + (n2*256) or 8 + (256*0) = 8. If n2 had equalled 1, then 8 + (256*1) = 264 and the printer would have been programmed to receive 264 characters. In Fig. 2, however, the printer was programmed to receive 8 characters.

When the computer sends a character to the printer, it is sent in binary form. The printer then converts it into a predefined form as described in its character generator ROM. The ASCII code defines each binary number up to the value 127 decimal and each of these numbers has a predefined function or printable symbol. This standard is followed by most computer and peripheral manufacturers.

When it is in the bit graphics mode, the printer does not print the letters sent to the printer; rather, it prints a pattern of dots equivalent to the binary value of the ASCII code of the letter sent to the printer. The letter "A", for example, is 65 decimal, 01000001 (binary, base 2). Compare the printed image in Figure 2 with Table III.

Now compare Table III to the relationship between the input data and the dot wires in Fig. 3. Where the data contains a "1," a dot will be printed. The TRS-80 Mod I will not run the sample program correctly because it cannot send a decimal 0 as shown in line 20 CHR$(0). Also the TRS-80 Mod I cannot send decimal 10 or 12 from the BASIC CHR$( ) function.

The TRS-80 Mod III cannot send decimal 10 or 12 from the CHR$( ) function.

TABLE I—BIT-IMAGE GRAPHICS PRINTERS

Antex Data Systems	ADS 80001
Anacom General Corp.	Anacom 16OZ
Anadex	DP9500/9501
	DP 8000AP
	DP 9620
Apple Computer	Silentype
Atari	B22
Centronics Data Corp.	Centronics 739
Data Impact Printers	DP92
	DP-84G
Data South	DS180
Epson	MX-70
	MX-80/Graftrax
	MX-80FT/ Graftrax
	MX-100
Heath Co.	Heath H25
Integral Data Systems	IDS 460
	IDS-560/G
	IDS Prism 80
	IDS Prism 132
C. Itoh	Prowriter
	Comet II
Malibu Electronics	Malibu 200
Okidata	Microline 82A
	Microline 83A
	Microline 84
	Pacemark 2350 (2 color)
NEC	NEC 8023A
Radio Shack	Line Printer VII
Sharp/Radio Shack	Pocket Computer Printer
Star Micronics Inc.	Gemini-10
	Gemini-15

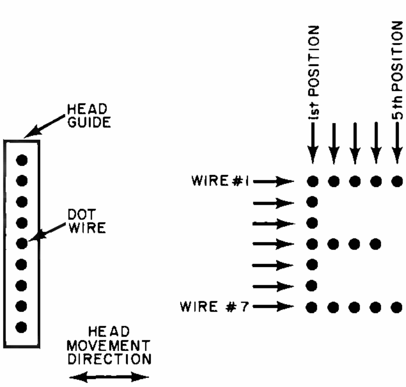


Fig. 1. Different print wires make dots in rows to form characters.

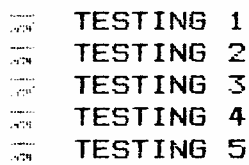


Fig. 2. Pattern created by Table II.

The TRS-80 Color Computer cannot send any number above the value 127.

Apple II cannot send a decimal 9 or 13 nor any number from 128 to 255. A decimal 9 is stopped by the software in the interface card. The decimal 13 (CR) is sent to the printer, but it is followed by a decimal 10 (LF). Numbers above 127 are not sent due to firmware limits within the computer.

Other computers may have some other oddity in this operation that stops a user from sending some numbers to the printer. Most often, conflicts occur in the control codes, numbers 0 to 31. A few have upper limits on the numbers sent, like the Apple II and the TRS-80 Color Computer. It will be necessary to experiment with your computer to determine the system limits.

A possible solution to the limits imposed by the system would be to write your own printer driver routine in assembly language, or to use a short BASIC subprogram that talks to the printer port directly. The subroutines in Table IV may help to avoid problems.

Once you have a subroutine for your system, the next thing to do is to combine your subprogram with a main program for printing graphics as shown in Table V. This program prints two parallel horizontal lines. Apple and TRS-80 Color Computer owners will find that their systems can't send any numbers above 127 correctly. This problem is in the firmware and cannot be corrected by any subroutine.

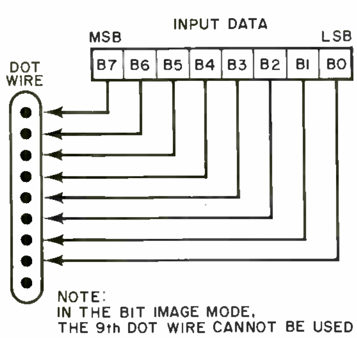


Fig. 3. Relationship between input data and print wires.

You might want to try the following changes:

```
100 FOR X2 = 0 TO 255: REM X2 = 0
WITH THE APPLE OR TRS COLOR
COMPUTER
150 X = X2: GOSUB 10
175 NEXT X2
```

This prints out all possible combinations of graphics characters. When the program has been run, a clear pattern will appear. Refer to Table VI.

If you want to print a shape, it must be broken up into numbers as shown in Fig. 4. A box is drawn on a sheet of graph paper, with the rows numbered the same as the pins and columns numbered according to how many you need. In Fig. 4, the total number for column 1 is 64 + 32 + 16 + 8 + 4 + 2 = 126. Columns 2 through 6 add up to 66 and column 7 is the same as column 1. Thus the data for the program to draw the figures is 126,66,66,66,66,66,126. Now add the subroutine for your computer to the program in Table VII.

When this program is run, it will print a rectangle. By changing line 180 to 8, 8, 8, 8, 20, 34, 65, you can change the shape printed to look like the one in Figure 5.

Line 105 of the program in Table VII sends the ESC K. Line 110 sends n1 and line 120 sends n2. For

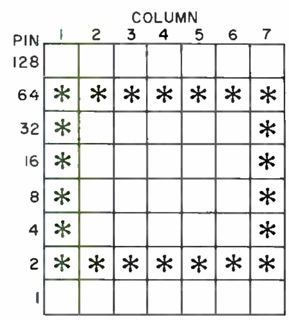


Fig. 4. Converting a shape to numbers.

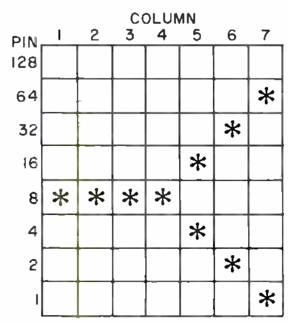


Fig. 5. Changing numbers changes shape.

TABLE II—BIT-IMAGE PROGRAM

```
10 FOR I = 1 TO 5
20 PRINT CHR$(27); "K"; CHR$(8);
CHR$(0); "ABCDEFGH"; "TESTING";I
30 NEXT I
40 END
```

TABLE III—ASCII CODE

Value	Bit	A	B	C	D	E	F	G	H
128	8	0	0	0	0	0	0	0	0 top
64	7	1	1	1	1	1	1	1	1
32	6	0	0	0	0	0	0	0	0
16	5	0	0	0	0	0	0	0	0
8	4	0	0	0	0	0	0	0	1
4	3	0	0	0	1	1	1	1	0
2	2	0	1	1	0	0	1	1	0
1	1	1	0	1	0	1	0	1	0 bottom

TABLE IV—SUBROUTINES

TRS-80 Mod I

```
10 IF PEEK(14312)< >63 THEN GOTO
   10: REM WAIT FOR PRINTER TO
   BE READY
20 POKE 14312,X: REM SEND THE VAL-
   UE X TO THE PRINTER
30 IF PEEK(14312)< >63 THEN GOTO
   30: REM SAME AS LINE 10
40 RETURN
```

TRS-80 Mod III

```
10 IF INP(251)< >63 THEN GOTO 10:
   REM INP(248) ALSO WORKS
20 OUT 251,X: REM IF THAT DOES NOT
   WORK TRY OUT 248,X
30 IF INP(251)< >63 THEN GOTO 30:
   REM INP(248) ALSO WORKS
40 RETURN
```

Apple II with Applesoft BASIC

(With the Epson 8131 parallel interface board. If this does not work with other boards, contact manufacturer for peek and poke locations.)

```
10 IF PEEK(49601) 127 GOTO 10: REM
   WAIT FOR PRINTER TO BE READY
20 POKE 49296,X :REM SEND X TO THE
   PRINTER
30 IF PEEK(49601) 127 GOTO 30: REM
   WAIT FOR PRINTER TO BE READY
40 RETURN
```

Atari

```
 1 OPEN #1,8,0, "P:"
10 PRINT #1; CHR$ (X);
40 RETURN
```

All Others

```
10 LPRINT CHR$(X);
40 RETURN
```

beginners, it is best to use a range of 1 to 255 for n1 (on an Apple use 1 to 127) and set n2 to 0. A beginner is less likely to have problems, or crash his program if shorter lengths are used.

While printing bit-image graphics, a single number controls 8 rows in one column. This type of printing is useful for simple jobs like defining your own character set, but is somewhat limited for doing drawings on a printout. The solution to this problem is to print the image in multiple passes. Thus, if you were printing the drawing in three sections, you would print the top first, then the middle, and then the bottom. However, the printer is designed to leave spaces between passes (rows). One additional command must be given to change the line feed spacing so there are no gaps between the passes. This command in BASIC is:

```
PRINT CHR$(27); "A"; CHR$(7);: REM
FOR APPLE AND COLOR COMPUTERS
PRINT CHR$(27); "A"; CHR$(8);: REM
ALL OTHERS
```

Once you are done printing graphics, you must restore the printer to the original line spacing with the command:

```
PRINT CHR$(27); "A"; CHR$(12); OR
PRINT CHR$(27); "2";
```

Some systems add a carriage return/line feed after 80, 127, 132, 255, or 256 characters have been printed. If your system does this, you will find that a small gap appears in your graphics printout. Should that occur, either limit the length of your drawings or bypass the operating system in your computer.

Once the printer has been programmed to receive a number of graphics characters, sending it too few will make it appear as if the printer did not receive them. When the program is re-run several times, the printer may start to print subsequent drawings on the same line. Sending more characters than the printer was programmed for may put "garbage" at the end of the line. Watch out for a condition in which your BASIC is adding or removing any data.

When printing long lines above 240 characters (80 on the Epson MX 70), BASIC slow-speed will cause the printer buffer to fill, then stop, and print the first part of the line. Next the program will continue, home the print head, and print the rest of the line. This is a normal procedure.

Only experience and patience can help you in the execution of complex graphic images. The printing of graphic pictures requires precise layout using graph paper and pencil before any programming is done.

The use of the new Prism printers from Integral Data Systems requires the additional element of commands to control the position of the multi-color ribbon. It not only requires that the printhead print the graphic image, but that the printing be done in the desired color.

Graphic Print Software. In order to print a graphic image, you can start with a picture, design, or character and lay it out on graph paper. You can then convert the black, white or grey areas into program statements that will activate the dot matrix wires in the print head and print the picture as a type of half tone.

Very few people go to this kind of trouble anymore. There are much simpler methods to print computer graphics.

Artists can compose a drawing and put it into a computer with the aid of a graphics program. They utilize either a light pen or graphics tablet to convert the artwork into digital form. In this way it becomes a high-resolution, screen video program and it can be viewed and corrected before printing. The screen image can then be "dumped" to a graphics printer and reproduced on paper. It is a good idea to use a color graphics program to compose the image and then to look at it on a black and white monitor. In this way the gradations of the image will exist and can be seen as tones of grey.

Because the Apple II was one of the first personal computers to have color graphics capability, the largest body of graphics printing pro-

TABLE V—GRAPHICS PROGRAM (TWO PARALLEL LINES)

```
  5 GOTO 100
 10 YOUR SYSTEM'S SUBROUTINE
 ..............................
100 REM GRAPHICS PROGRAM
105 PRINT CHR$(27); "K";: REM
    SENDS ESC FOLLOWED BY A K
110 LET X = 60: GOSUB 10: REM SEND
    n1
120 LET X = 0: GOSUB 10: REM SEND
    n2
130 REM n1 + (256*n2) = TOTAL
    NUMBER OF GRAPHICS CHARAC-
    TERS THE PRINTER WILL BE
    PRINTING
140 FOR I = 1 TO 60
150 LET X = 65: GOSUB 10
160 NEXT I
170 PRINT "    X =    "; X
180 END
```

TABLE VI—PINS AND VALUES

Top Pin	Pin No.
*	128
*	64
*	32
*	16
*	8
*	4
*	2
*	1
*	not used

If X = 0, no pins will fire
If X = 1, pin 1 will fire
If X = 2, pin 2 will fire
If X = 3, pins 1 and 2 will fire
If X = 4, pin 4 will fire
If X = 5, pins 1 and 4 will fire
If X = 65, pins 64 and 1 will fire
To get all 8 pins to fire, X = 255

TABLE VII—GRAPHICS PROGRAM (RECTANGLE)

```
  5 GOTO 100
 10 YOUR SUBROUTINE
 ..............................
 40 RETURN
100 REM PRINT A SHAPE
105 PRINT CHR$(27); "K";
110 X = 7: GOSUB 10
120 X = 0: GOSUB 10
130 FOR I = 1 TO 7
140 READ X
150 GOSUB 10
160 NEXT I
170 PRINT
180 DATA 126,66,66,66,66,66,126
190 END
```

grams exist for that computer. We will mainly discuss Apple II software, although we will describe graphics printing programs for other computers. They all operate in a similar manner; either they link to a screen graphics program or they permit the user to load the screen graphics file directly into the program. These graphics printing programs offer optional selection of program parameters in order to accommodate various interface boards and printer characteristics. Some offer the option of size changes and aspect rotation. When the program is run, it figures out the correct numbers to send to the printer mechanism to print the correct pattern of dots in the right position to form a graphic image.

Before going into discussing graphics printing programs on the market, we must point out that there are many such programs in the public domain. It is well worth the time spent to research the catalogs of the various User Groups and the indices of magazines which print utility software for your computer and operating system.

Computer Stations, 11610 Page Service Drive, St. Louis, MO 63141 was one of the first publishers of Apple graphics software and it has an extensive line of graphics printing programs.

"Combined Enhanced Graphics Software," by David K. Hudson, covers the broadest possible range of Apple II parallel interface cards and printers. When the diskette is booted, a menu asks for the printer being used, the type of interface card and the card slot number. A diskette can be customized to always have these parameters if so desired.

The next menu asks for a user selection of options including page size, image type (plot or picture), justification, catalog (of disk in drive), display graphics (on screen), print graphics, and new page (form feed). Before you can print a graphic image, it must be loaded into the high-resolution page (an area of memory reserved by the Apple II for displaying graphics). There are two hi-res pages in memory. There are many methods of doing this: 1) Use graphics or a plot program to generate the graphics file. 2) Load the hi-res area by drawing the image using a graphics tablet and saving the result in the memory. 3) Use a video digitizer to scan the image and use an a/d converter to load the result into memory.

Computer Stations makes a video digitizer called Ditherizer II which uses a video camera to load the hi-res page into memory. It saves it as a binary file which can be printed by Enhanced Graphics Software. We have used this program and it works very well. Computer Stations also has #8502 Combined Graphic Writer for Applesoft 3.3 and a large selection of printers and interfaces, including the latest IDS Prism color printers and the Epson 100.

The Ultra High-Res Graphics program for the Epson MX-80 and MX-100 by Mark Allen and David Hudson is a plotting utility program that will produce output as large as a full page of printer output. This is a very useful type of graphics program. All Computer Stations programs are self teaching and easy to use.

"Image Printer" by Jerry Rivers is published by Sensiable Software, 6619 Perham Dr., West Bloomfield, MI 48033 for Apple II with 48K and Applesoft or Epson MX70, MX-80 or MX-100 with Graftrix. This hi-res graphics program also comes in versions for daisy-wheel printers and for the C. Itoh "Prowriter" and the NEC 83023.

When booted, it presents a menu that permits printing from a picture in memory or from a picture stored on a disk, or to print the inverse of picture now in memory. It also configures the printer card set-up, views the picture in memory, or sets the picture parameters. There is an option to reduce the picture by 1/4. There is no rotate option which is found in most other graphic print programs. In spite of the fact that the MX-100 Printer is listed, it would not center the picture on the 14-inch paper. It seems to be written for 8-inch printers. Although Image Printer works, it is full of little annoying things that should not exist in commerical software.

"Graphtrix" from Data Transforms, 906 East Fifth Ave., Denver, CO 80218, at $65.00, is not only a graphic image printing package, but it also permits the inclusion of footnotes, superscripts and graphics in documents written in Apple Writer, word processor, or Data Transform's editor called Editrix. It can be used with the Apple II+, 48K and a wide range of printers and printer interface boards. It comes on a bootable disk and includes a "hand-holding screen dump" which is an instructional discussion of how to use the program to print a high-resolution page on the printer. The program shows the picture on the screen exactly as it will be seen as a printed copy. This is the reverse of the display of most other programs. There is also a GTRX DUMP that is a separate utility that you can call from an Applesoft program. It includes all of the same parameters of the main program.

If Apple Writer is your word-processing program, then you can specify the Graphtrix parameter as text formatting commands within the files. A conversion program is used to change the Apple Writer file to one that Graphtrix can use. Then another routine is used to print the picture data file. You then specify the printer and the slot parameters. When the printing starts, it prints both the text and the picture in the correct position. This is Graphtrix's outstanding characteristic. To see the text, illustration, footnotes and superscripts printed in proper layout form is an amazing demonstration of The Graphtrix program capabilities. Although this system costs almost twice as much as some other graphic printing packages, it does offer greater utility.

"Zoom Grafix" by Dav Holle, published by Phoenix Software Inc., 64 Lake Zurich Dr., Lake Zurich, IL 60047, costs only $39.95 and is one of the better graphic printing programs for the Apple II. This package offers over 400 combinations of I/O boards and printers. It is similar to the other programs discussed in this article, but it has some very attractive additional features. The principal new feature is the one that gives this package its name. The user has the ability to focus in on a detail of a picture and to enlarge it through a broad range of magnification just like a zoom lens on a camera. It also permits completely controlled cropping. The user can select both the size and proportions of the printed graphic image from over 65,000 combinations. One unique feature of Zoom Grafix is the ability of the user to rotate the graphic image and print the new aspect.

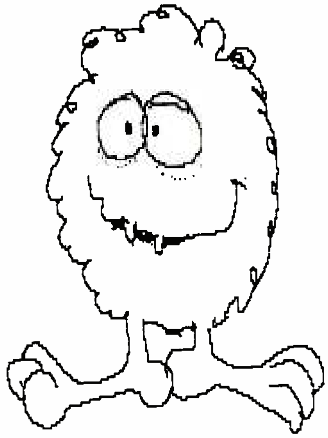
Pictures can be centered automatically, or the margins can be set by the user to place the printed picture exactly where it should be printed. Printing can be either positive, or negative and either upright or rotated.

A number of graphic images from the Apple System master disk are supplied with the Zoom Grafix diskette to give the user something to practice with.

"Printographer" by Stephen L. Ballard is published by Southwestern Data Systems for the Apple II. It costs $49.95 and it is another menu driven graphics print package with desirable features. It includes a selection of every popular printer and I/O board combination on the market. This package will work with the Qume Sprint and NEC Spinwriter daisy-wheel printers as well as the dot matrix printers. Pictures can be printed in normal or reverse, horizontal or vertical position, and they can be magnified up to nine times the original size. The picture can be moved and printed anywhere on the page. The Printographer lets you print either the entire hi-res screen or any portion of it using the cropping features. The Printographer has a subroutine that can be used within your own Applesoft programs so you can print out any hi-res screen in a few seconds. The package comes with the best manual of any of the graphics packages for the Apple II. It is almost a course in printing graphics by itself. Although this package is one of the higher-priced efforts, it is well worth the extra money.

"Super Quality Epson Hi-Res Dump" by Roger Doss, published by Avant Garde Creations, P.O. Box 30160, Eugene, OR 97403 is for the Apple II with 48K and the Epson MX-80 or MX-100 Printers. This $25.00 package enables the user to print hi-res graphic pictures with several unusual options available. The picture is printed without any streaks or grey. The printout will always be true black and white. The user can select mirror images, negative images, flip images, or rotated images. Images can be saved and loaded from disks, while footnotes, titles and superscripts can be added and printed with the pictures.

"The Grappler," Orange Micro, 3150 E. La Palma, Anaheim,CA 92806 is an interface board for the Apple II that works with most of the dot matrix printers with graphic capabilities. It is included in this discussion of graphic printing software because it has graphics printing firmware built-into the board circuits. Since there is no standardization among printer manufacturers for dot graphics, there is a separate version for each printer. The graphics image is drawn with a graphics perhiperal and saved as a file by the computer. To print it using the Grappler, the printer is sent a control sequence of CTRL-I followed by G and then one of several optional characters. These sequences will cause the graphic image to be printed at the selected location on the paper. One of the options permits the rotation of the graphic image 90 degrees in a clockwise direction.



Created by Zoom Grafix

Atari Graphics. Graphic image print programs for the Atari computers have been featured in several of the magazines devoted to 6502 software. There are also many of them available through user groups. Commercial programs to print graphics are just starting to appear because up to now very few Atari owners had disk systems. With the growing population of Atari disk-based systems, several software houses have released graphic print packages.

"Color Print" from Datasoft Inc., 19519 Business Center Dr., Northridge, CA sells for $39.95 and works with a 40K Atari Computer. It is menu driven like the Apple II programs and works with the Epson MX-80. The Color Print package is capable of printing black-and-white graphics in 2, 3 or 4 high-resolution colors.

"Atari Screen Dump II" from Computer Age Software, 9433 Georgia Ave., Silver Springs, MD 20910 costs only $26.95 for the cassette version and $29.95 for the disk version. Both versions are designed to be used with the Epson MX-80, or MX-100 printers and support all the features of the printers.

Other Computers. Since the printing of hi-res graphics is a rather new application, there are few commerical packages for computers other than the ones mentioned here. For example, there's such software for Radio Shack's TRS-80 Color Computer. However, software for the IBM-PC, the VICTOR, the FORTUNE 16/32 and other machines are being written at this time. "Print-Graf" from Micro-Z Company, P.O. Box 2426, Rolling Hills, CA 90274 is a $79.50 graphics printing package designed for the IBM-PC. It works with the IBM, Epson MX-80 printer and the Graftrax PROMS. It requires the IBM Color Graphics Board and one or two disk drives. This package prints out graphic image from hi-res or med-res graphics screen. It reproduces the color image in tones of black and grey. It can print black on white or reverse. ◊

The 68000 CPU

What makes this powerful 16-bit processor tick?

By Hunter Scale*

IN 1972, Intel Corporation introduced the first microprocessor—the 4004. It was a primitive 4-bit processor, primarily intended to be a cost-reduction replacement for TTL logic in computer peripherals. From that humble beginning, microprocessors have grown in size (measured in instruction word or data bus width) and processing power. They grew first to 8 bits, as exemplified by the 8080 family, the 6800, 6502, etc. Then it went to 16 bits and the word now is that 32-bit micro machines will make their debut soon.

As the computing power grew, applications began to change. The 8-bit processors became powerful enough to support high-level languages such as BASIC, Pascal, and others; and the personal computer became a reality. The new breed of 16-bit micros is so powerful that it is spawning another new product—the personal workstation. Typical of the new 16-bit processors are the Intel 8086, Zilog Z8000, and the NC68000. The 68000 is second-sourced by a number of companies, including Motorola, Mostek, and Signetics. Some of these are so powerful that they are being used in special applications such as digital signal processing and high-resolution computer graphics. These are areas that, not long ago, were the province of expensive custom bipolar bit-slice machines. To see just what makes these new processors "tick," let's look at the 68000.

Architecture. To find out how the 68000 meets the requirement of some of the new applications, we have to examine how it "looks" to a programmer: its registers, instruction set, and other capabilities. These make up what the computer scientist calls the architecture. Things to look for include:

- How many registers does it have and how large are they? *The more registers it has and the larger they are the better.*
- Are the registers general purpose or special? *Special registers are those that require the programmer to spend time and effort to use the right ones at the right time.*
- How large is the addressing space? (How much memory can it have?) *This is particularly important in view of the massive size of modern programs and where graphics are involved.*
- How general is the instruction set and how easy is it to remember? *A small number of powerful instructions is easier to use than a larger number of more primitive ones.*
- How fast do the instructions execute? *The best instruction set in the world is worthless unless the processor is fast enough for the application. This is particularly important in real-time applications.*

*Motorola, Inc.

The 68000 is called a 16-bit microprocessing unit because the data bus is 16 bits wide. However, all the registers in the chip are 32 bits wide, hence the 16/32 title is sometimes used. By comparison, the 8086 and Z8000 use 16-bit-wide registers. The data registers of the 68000 can handle 8-bit bytes, 16-bit words or 32-bit words.

The programming model of the 68000 is shown in Fig. 1. There are eighteen 32-bit registers in the device, eight data registers (labeled

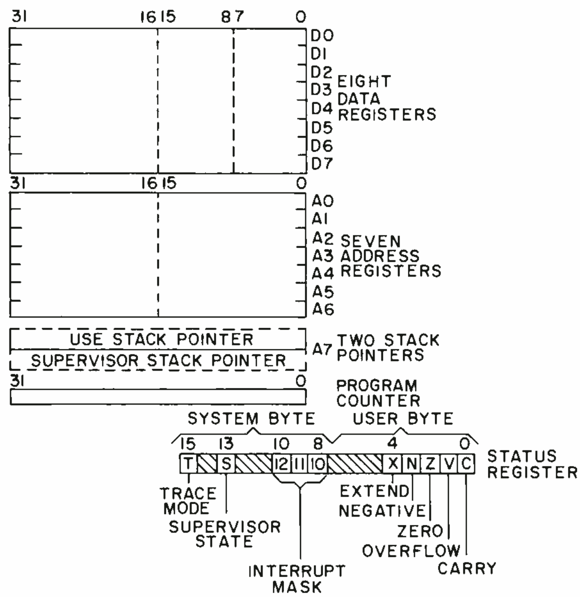


Fig. 1. Programming model of the 68000 microprocessor.

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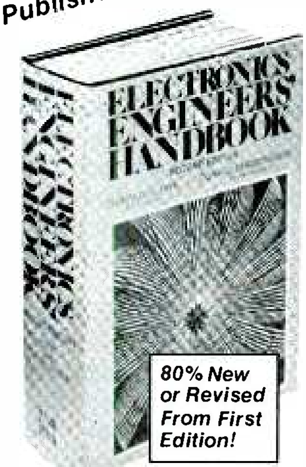

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D0-D7), nine address registers (A0-A7 and A7') and one program counter (PC). The status register is 16 bits wide and consists of a user byte and a supervisor byte. Data can be manipulated in bits, bytes (8 bits), words (16 bits), and long words (32 bits).

The memory organization used by the 68000 (Fig. 2) can directly address 2^{24} (16,777,216) bytes arranged in a linear sequence. Addresses are always byte addresses. That is, words are located at even-byte addresses and can only be referred to at those addresses. Long words must also start at word addresses. A byte can be addressed at an even or odd location and the upper or lower half of the word is used. A word is obtained in one access while it takes two accesses to fetch a long word—the upper half (lower word address) and then the lower half (next word address). The I/O is memory mapped.

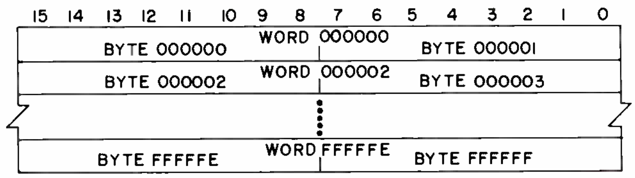


Fig. 2. The memory organization can directly address 2^{24} bytes.

Instruction Set. The instruction set of the 68000 is given in Table I. Note that there are only 56 *basic* instructions, though many of these have variations. This is in keeping with the philosophy that a small number of instructions is easier for the programmer to remember and, therefore, more desirable, provided the instructions are powerful enough.

The usual instructions are found in the set: arithmetic (including multiply and divide), logic set (AND, OR, EOR, etc.), branches, bit shifts and rotates, and compares. The data movement instruction is MOVE—one of the most powerful in the set. The MOVE instruction can take any of the effective addressing modes for either operand. MOVE can move data from anywhere to anywhere (that is, memory to memory, memory to register, etc.). The power of MOVE will become apparent when the addressing modes are discussed.

In addition to the basic instructions, here are some special-purpose instructions intended specifically to support the code generators of high-level languages such as Pascal. These include the LINK and UNLK (unlink), LEA (load effective address), PEA (push effective address), and CHK (check register against bounds).

LINK implements the high-level language procedure call. As shown in Fig. 3, the old stack frame pointer, A2, is saved by pushing it onto the stack. The new frame pointer is created by placing the stack pointer in A2 and, finally, local variables are allocated on the stack by adding an offset to the stack pointer. A jump subroutine instruction is then used to enter the procedure. The UNLK instruction reverses this process by restoring the stack pointer (de-allocating the local variable space) and pulling the previous frame pointer. Re-entrant programs are very fast and painless to implement with these instructions.

One of the most useful instructions is the decrement and branch on condition code (DBcc). This is a looping primitive that will branch if the condition is not met or the counter has not decremented to −1. Thus, it replaces a five-instruction sequence—CMP, BRct, SUB, CMP, and BRcc. This speeds up the very common loops found in all programs.

Addressing Modes. One of the reasons the 68000 can get away with such a small number of instructions is by having a set of very powerful addressing modes that, when combined, result in over

TABLE I—INSTRUCTION SET SUMMARY

Mnemonic	Description	Mnemonic	Description
ABCD	Add Decimal with Extend	MOVEP	Move Peripheral Data
ADD	Add	MULS	Signed Multiply
AND	Logical And	MULU	Unsigned Multiply
ASL	Arithmetic Shift Left	NBCD	Negate Decimal with Extend
ASR	Arithmetic Shift Right		
Bcc	Branch Conditionally	NEG	Negate
BCHG	Bit Test and Change	NOP	No Operation
BCLR	Bit Test and Clear	NOT	One's Complement
BRA	Branch Always	OR	Logical Or
BSET	Bit Test and Set	PEA	Push Effective Address
BSR	Branch to Subroutine	RESET	Reset External Devices
BTST	Bit Test	ROL	Rotate Left without Extend
CHK	Check Register Against Bounds	ROR	Rotate Right without Extend
CLR	Clear Operand	ROXL	Rotate Left with Extend
CMP	Compare	ROXR	Rotate Right with Extend
DBcc	Test Condition, Decrement and Branch	RTE	Return from Exception
		RTR	Return and Restore
DIVS	Signed Divide	RTS	Return from Subroutine
DIVU	Unsigned Divide	SBCD	Subtract Decimal with Extend
EOR	Exclusive Or		
EXG	Exchange Registers	Scc	Set Conditional
EXT	Sign Extend	STOP	Stop
JMP	Jump	SUB	Subtract
JSR	Jump to Subroutine	SWAP	Swap Data Register Halves
LEA	Load Effective Address		
LINK	Link Stack	TAS	Test and Set Operand
LSL	Logical Shift Left	TRAP	Trap
LSR	Logical Shift Right	TRAPV	Trap on Overflow
MOVE	Move	TST	Test
MOVEM	Move Multiple Registers	UNLK	Unlink

53,000 different instructions. See Table II for addressing modes.

Two of the most commonly used addressing modes are the address register indirect with predecrement and postincrements. In this mode, the contents of an address register point to the operand. The address register is either decremented first and then used (predecrement), or used and then incremented (postincrement). The register is decremented or incremented by the number of bytes in the operand to maintain the pointer with different sizes of data. Using these two addresssing modes with the MOVE instruction implements the POP and PUSH instructions that are used with push-down, pop-up stacks. For example, MOVE.B D0,−(A7) will "push" the lower byte (.B) of D0 onto the system stack. The advantage here is that each of the eight address registers can be used as stack pointers. Since stacks are used extensively by compilers, this is a handy thing to have.

The 68000 has 14 different addressing modes that can be broken into six basic types. These are: (1) Direct Register Addressing, which consists of data register direct and address register direct; (2) Direct Memory Addressing, formed by absolute short and absolute long; (3) Indirect Memory Addressing, consisting of memory indirect, post-increment register indirect, pre-decrement register indirect, register indirect with displacement, and register indirect with index and displacement; (4) Implied Register Addressing; (5) Program Counter Relative Addressing, containing PC-relative with displacement, and PC-relative with index and displacement; and (6) Immediate Data Addressing, formed from immediate, and quick immediate. This broad range of addressing help creates a powerful instruction set.

System Protection Features. Since the 68000 was designed to be used in applications that require a mini-computer, much attention was paid to making it a "secure" processor for multi-user environments. For instance, any op codes not implemented on the 68000 get trapped in an illegal op code handler routine. There is also provision for protecting the system against untrustworthy programs via user-supervisor separation.

The processor can be in one of two modes—User or Supervisor. Certain "privileged" instructions can only be executed in the Supervisor mode. The Supervisor and User modes have separate stack pointers. Thus, in program-sensitive applications, system software, executed in the Supervisor mode, can be separated from application programs executed in the User mode. The Supervisor mode is equivalent to the System mode of the Z8000, while the User mode is equivalent to the Normal mode of the Z8000. The 8086 offers no similar operating modes.

In the User mode, the machine cannot execute "privileged" instructions, and any attempt to execute them while the processor is in the User mode will result in privilege trap to the Supervisor mode, removing control from the user program. These control instructions include some special hardware-support instructions, such as RESET, which allows the processor to reset peripheral devices. This provides a certain amount of control over the user programs. In the Supervisor mode, the entire instruction set can be executed, including the privileged ones. In this way, the operating system has complete control over user programs and system resources. Privileged instructions are shown in Table III.

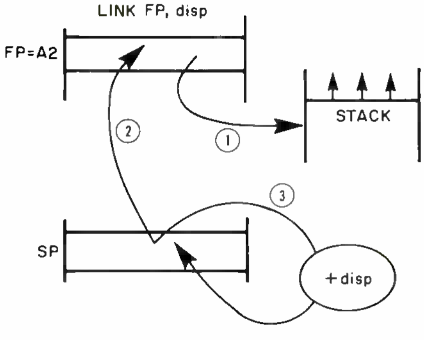


Fig. 3. How the LINK basic instruction is implemented.

Instruction Execution Speed. An extensive register set and rich instruction set are only part of what makes a powerful processor. The instructions must also be fast enough to do justice to the rest of the architecture. One rule of thumb used is "bus bandwidth utilization," which is simply how much of the time the processor is fetching instructions or data via the bus. The higher the percentage of time spent using the data bus, the better a job the processor is doing in using that bus. The 68000 uses about 85% of the bus bandwidth for a typical instruction mix. This means that this data processor is fast enough to use almost all of the speed that memory will allow.

TABLE II—SUMMARY OF ADDRESSING MODES

Addressing Mode	Syntax	Example
Data register direct	Dx	ADD.L D0,D1
Address register direct	Ax	MOVE.L A0,A1
Address register indirect	(Ax)	MOVE.L D0,(A0)
Address register indirect with postincrement	(Ax) +	SUB.L (A0)+,D0
Address register indirect with predecrement	− (Ax)	MOVE.L D0,− (A0)
Address register indirect with displacement	d(Ax)	MOVE.L 8(A0),D0
Address register indirect with index	d(Ax,Ri)	MOVE.L 8(A0,D0),D1
Absolute short	XXX.W	BRA $400
Absolute long	XXX.L	BRA $FF0020
Program counter with displacement	d(PC)	MOVE.L
Program counter with index	(PC,Ri)	T(D2),TABLE
Immediate	#XXX	MOVE #100,D0

The execution time of instructions depends on many things—the processor clock frequency, memory speed, addressing mode used, and the length of the data to be used. Currently, the standard clock frequency is 10 MHz. Assuming that the processor can access memory without wait states (without having to wait for the memory to respond) and that the clock is 10 MHz, some typical instruction execution times would be as given in Table IV.

Bus Structure. Now that we have seen how the 68000 looks from the inside, we need to look at it from the outside. A pinout is shown in Fig. 4. The processor is housed in a 64-pin dual-in-line pack and requires a single 5-V power supply.

The bidirectional data bus is 16 bits wide and is nonmultiplexed. The address bus is 24 bits wide, allowing the processor to directly access 2^{24} or 16 megabytes of memory. Note that A0, the least significant bit of the address bus is not output. This bit is used internally in conjunction with the data size specification of each instruction to generate the $\overline{\text{UDS}}$ and $\overline{\text{LDS}}$ signals. The bus is asynchronous; that is, it is not synchronized to a clock. Instead, it uses a handshake method of bus access. The address strobe signal ($\overline{\text{AS}}$) indicates the beginning of a memory access and the data transfer acknowledge ($\overline{\text{DTACK}}$) signal is returned by the memory board to signal the end of the data transfer. A timing diagram of a byte read cycle is shown in Fig. 5.

At time (1), the address is placed on address lines (A1-A23) and the read/write (R/$\overline{\text{W}}$) line is set to show a read of memory. At time (2), the address strobe ($\overline{\text{AS}}$) signal is asserted to indicate the beginning of a bus cycle, and the lower data strobe ($\overline{\text{LDS}}$) signal is asserted to show that the read is on the lower eight bits of the data bus. The memory responds by placing the data to be read on the lower eight data lines (D0-D7) as shown at time (3), and then asserts the $\overline{\text{DTACK}}$ signal to show that the data is available. The processor then latches the data into the chip and negates the $\overline{\text{AS}}$ to show that the cycle is over as shown at time (4). The advantage of this scheme is that it allows the use of different speed memory boards to be intermixed on the bus. Thus the processor can accommodate a wider range

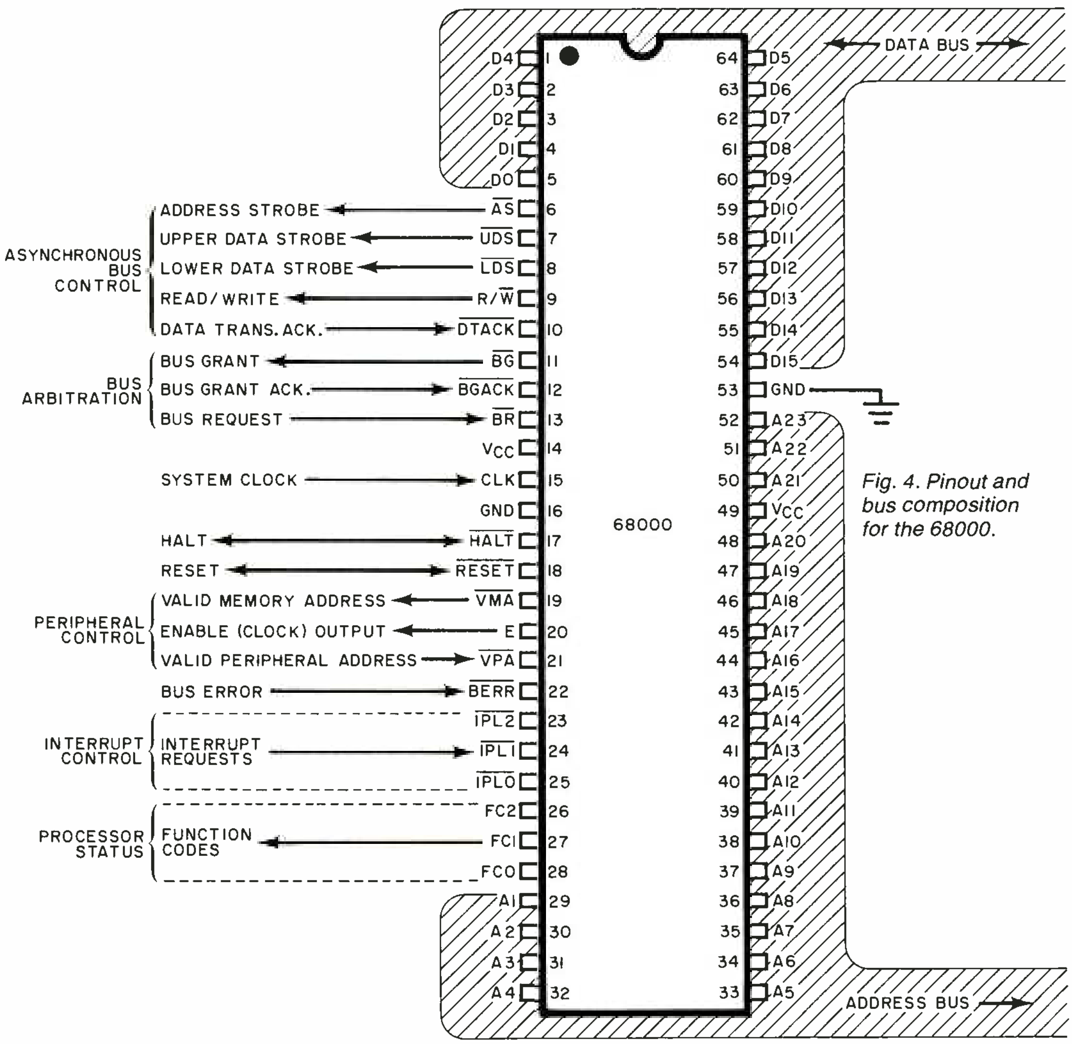


Fig. 4. Pinout and bus composition for the 68000.

of memories and peripherals, which may be quite far from the processor itself.

Some signals are provided to allow interfacing to synchronous 6800 peripheral devices. These include: enable (E) which is the standard enable signal for 6800-type devices, valid peripheral address ($\overline{\text{VPA}}$) input that indicates that the device or region addressed is a 6800 family device and that data transfer should be synchronized with the enable signal. Valid memory address ($\overline{\text{VMA}}$) output is used to indicate to 6800 peripheral devices that there is a valid address on the address bus and the processor is synchronized to enable. This signal only responds to a valid peripheral address ($\overline{\text{VPA}}$) input which indicates that the peripheral is a 6800-family device.

Interrupts. To support real-time applications, some means must be provided to interrupt the processing of the normal instruction stream to take care of some urgent event. This is called the *interrupt*. For instance, a printer might want to signal the processor that it has printed a line of text and needs more data. The printer peripheral controller would then transmit a signal to request an interrupt.

The 68000 has seven levels of interrupt priority. The levels that it will recognize are set by the interrupt priority mask in the supervisor byte of the status register. The latter can be programmed to allow the recognition of any level and those above it. The interrupts themselves are signaled by setting the encoded level of the interrupt being requested on the interrupt priority request lines ($\overline{\text{IPL}_0}$-$\overline{\text{IPL}_2}$). The processor will then stop the execution of the current program and read the interrupt vector from the data bus in an operation called "interrupt acknowledge cycle." The peripheral device which requested the interrupt places the vector number on the data bus. This number will be used as a pointer into a memory location at which an address is to be found. The processor will read this address and start executing the routine contained there. To return to the execution of the interrupted program, a return from exception (RTE) instruction is executed.

Conclusion. Sixteen-bit processors are being used in greater numbers in low-cost products because they can accommodate more functions and have faster operation than conventional 8-bit processors. Since they can directly address 16 megabytes of memory, very extensive programming can be used without having to wait for disk accesses. This time-saving feature opens new doors to high-resolution graphics and process-control applications.

The three major manufacturers of the 68000 (Motorola, Mostek, and Signetics) are producing a number of 68000-peripheral chips. For instance, the Motorola MC68008 is an 8-bit version of the 68000. Any software written for this 8-bitter can be run without change on the 68000 processor.

TABLE III—PRIVILEGED INSTRUCTIONS

Instruction	Operation
RESET	Reset external devices
RTE	Return from exception
STOP	Stop program execution
ORI to SR	Logical OR to status register
MOVE USP	Move user stack pointer
ANDI to SR	Logical AND to status register
EORI to SR	Logical EOR to status register
MOVE EA to SR	Load new status register

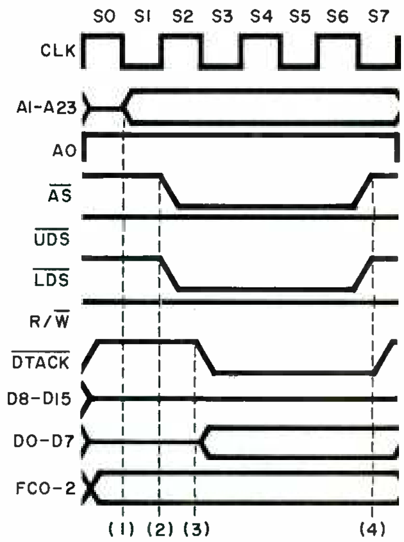


Fig. 5. Timing diagram of a byte read cycle.

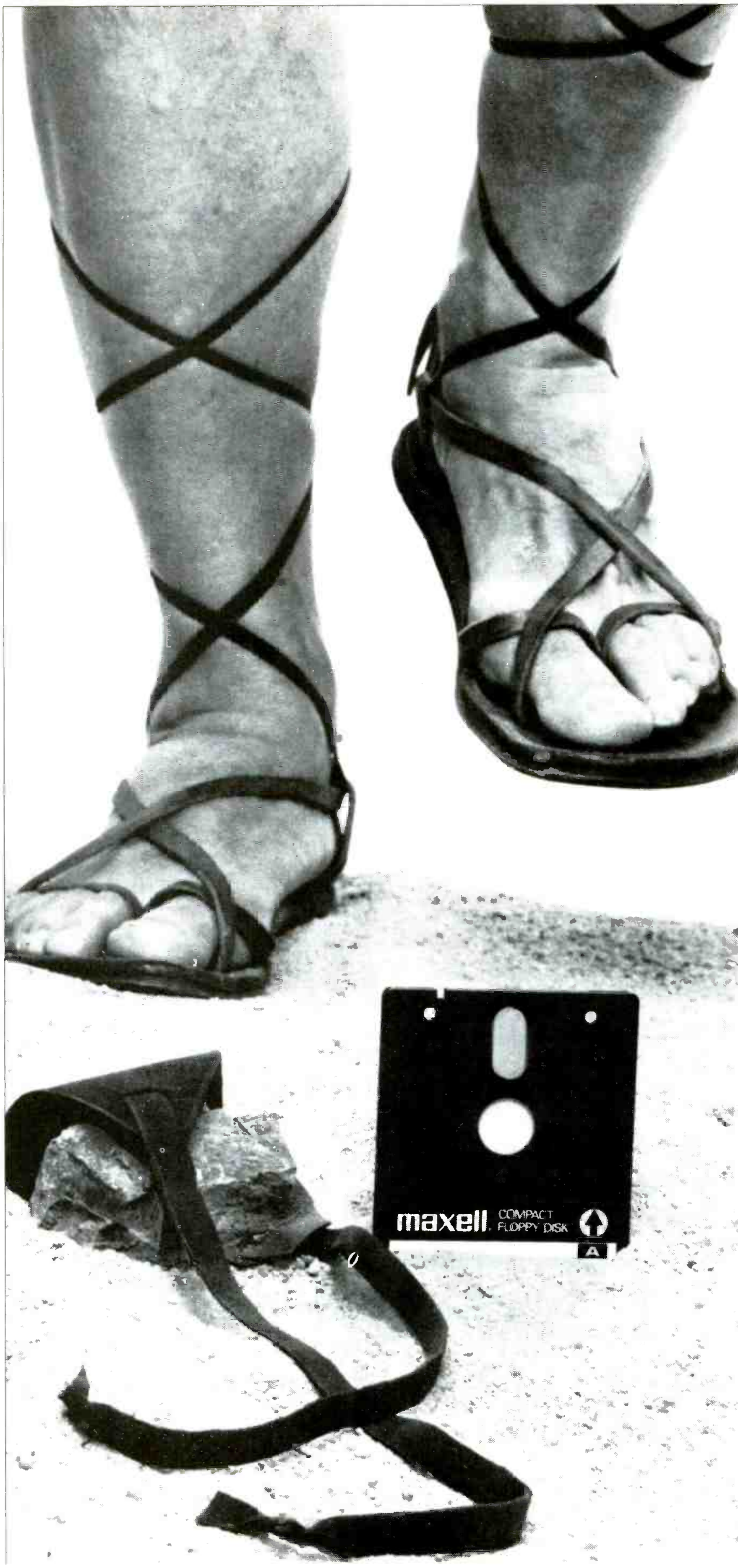
Another typical 16-bit CPU is the Mostek MK68200 optimized for control applications. It contains 4K bytes of ROM, 256 bytes of RAM, and three 16-bit timers. It can be slaved to a 68000. The MC68010 supports virtual memory and virtual machine, terms formerly associated only with mainframes.

The next few years should see a considerable number of 68000-compatible chips coming into wide usage.

In the software arena, the 68000 has over 40 independent software vendors working on 68000 packages. In high-level languages, everything from FORTH to ADA is available. In operating systems, Motorola is announcing UNIDOS, a UNIX version 7 compatible operating system. Digital Research is also to produce a CP/M-68K to take advantage of the 8-bit standard CP/M. ◇

TABLE IV—EXECUTION TIMES FOR SAMPLE INSTRUCTIONS

Time (μs)	Instruction	Explanation
0.8	ADD.L D0,D1	Add the 32-bit register D0 to D1 and put the sum in D1
1.2	MOVE.W (A0),(A1)	Move the word pointed to by A0 to the location pointed to by A1
7.0	MULS D0,D1	Multiply the signed 32-bit integer in D0 by D1 and put product in D1



The 3" vs. 3½" Minifloppy Battle

By Leslie Solomon
Technical Director

The latest trend in miniaturization has produced two new types of disks battling it out between themselves and perhaps the established larger floppies

A MAJOR trend in computer technology today is toward size reduction. Digital computers were once behemoths that occupied large rooms. They gave way, however, to minis that could be rack-mounted or placed on a large desktop. Then came the microcomputer, producing another order of size reduction. The past couple of years has seen still another size reduction with the introduction of the battery-powered "pocket" or "handheld" computer that can be carried in an ordinary briefcase or

even stored in one's jacket pocket.

In line with computer size reduction, data storage devices have also undergone great dimensional changes. Large magnetic drums were once used to store data, but the introduction of the low-cost microcomputer led to the development of reasonably priced, relatively small 5¼" and 8" floppy-disk systems so common today.

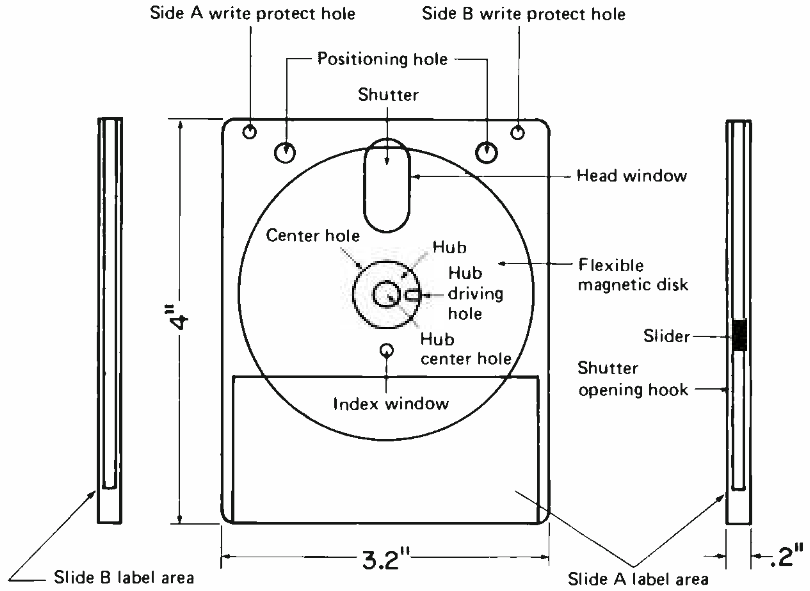
Of course, data expands to fill the available storage media, so new approaches were found to increase the amount of data that could be stored on popular disks. From the original single-density modulation technique that allowed about 90K bytes on a diskette, came double-density that allowed twice the amount of data to be stored. Some manufacturers have even started to produce quad-density diskettes. There is still no standard for these techniques, however. Today, one can get about 300K bytes on a 5¼" and approach one megabyte on an 8" diskette.

Since physical size is important to the creation of small computers, drive manufacturers started to deliver slender mechanisms (still using the 5¼" and 8" diskettes), giving birth to low-profile packages that are coordinated with the sleek look of a modern computer enclosure.

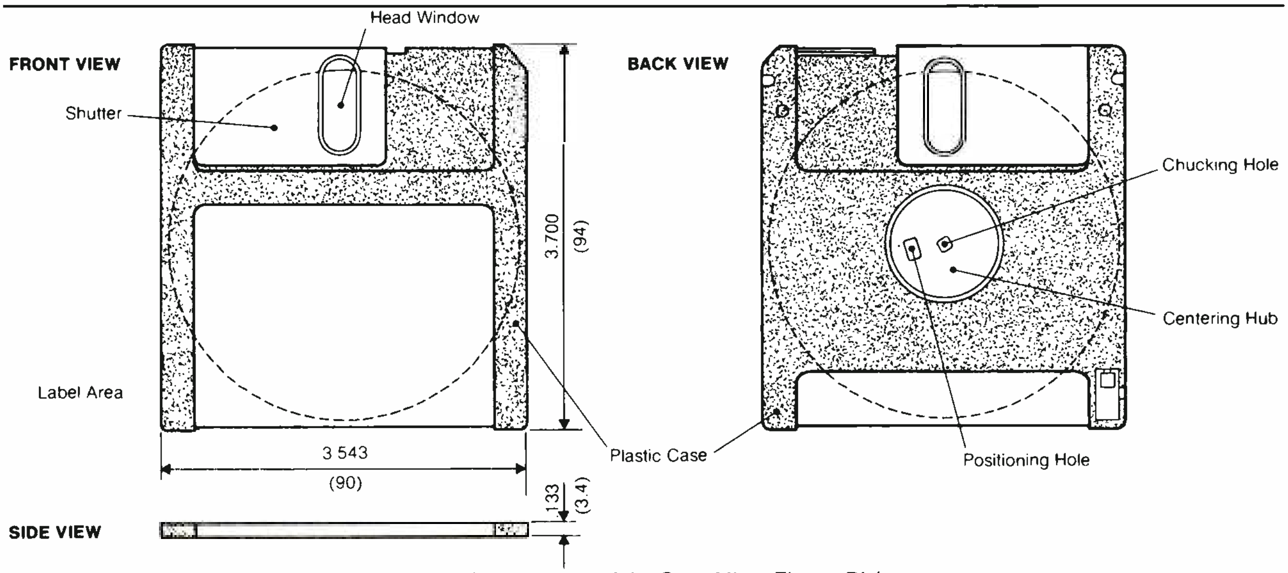
Now we are on the verge of a new generation—the "3-inch" floppy diskette system that not only offers a great size reduction, but an even greater storage density. Although designated a floppy diskette, only the internal media is floppy since the diskette is housed in a rigid enclosure. Currently, there are two major small-disk competitors: the 3-inch Compact Floppy Disk (CFD) developed jointly by Hitachi Ltd., Matsushita Electric Industrial, Hitachi Maxell, Ltd., and TDK Electronics Corp. versus the Sony 3.5-inch Micro Floppydisk.

Although many manufacturers, including Dysan, Shugart, Verbatim, Tabor, Xidex, Olivetti, Brown Disc Mfg., Micro Peripherals Inc., and BASF are having meetings to determine the specifications for the new small diskette, no standards have been set as of this writing. The standards group will first concentrate on the packaging—soft or hard jacket—then will cover the media's magnetic characteristics. It will present its findings at an upcoming fall meeting of the American National Standards Institute (ANSI).

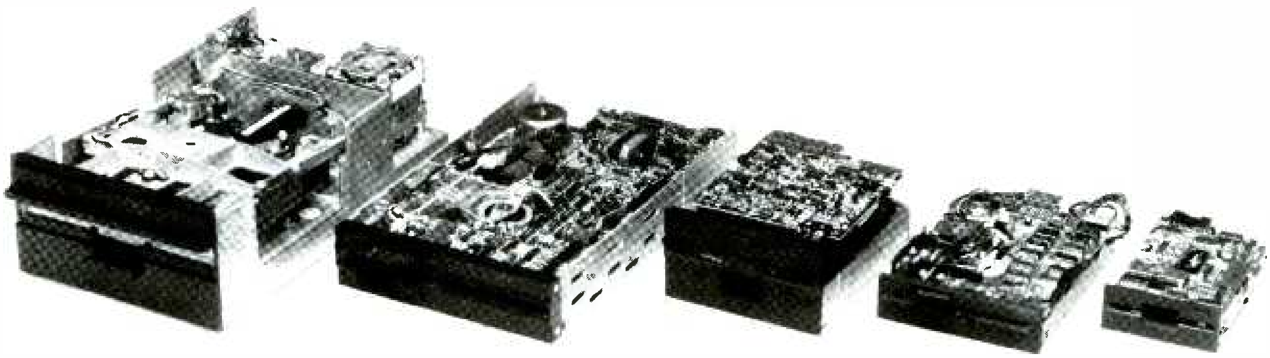
However, several computer manufacturers are jumping on one bandwagon or the other. Amdek, Brown Disk, and Otrona, for example, are leaning toward the Hitachi approach, while Jonos Ltd. and



Construction of the Hitachi 3" Compact Floppy Disk



Physical parameters of the Sony Micro Floppy Disk.



The shrinking world of disk drives is shown by a conventional 8" at left, followed by a half-size 8", conventional and half-size 5¼", and 3½" drive at far right.

Hewlett-Packard, among others, have elected to go the Sony route. The parameters of both types of diskette are shown in the diagrams on the preceding page.

Physically, the approaches are very similar, although the diskettes are not interchangable. Each is about half the size of a conventional 8" diskette and about 60% the size of a 5¼" unit. In both cases, the recording media has a rigid case that provides mechanical protection, and each has a sliding shield that automatically covers the head hole when the diskette is removed from the drive. Each is also provided with a solid rim that surrounds the drive hub hole to prevent diskette warping when the drive is engaged to the soft recording media.

The major difference shows up in track density and rotational speed. Sony's new head allows 135 tracks per inch with a data track width of 125 microns and a guard band of 63 microns. The gap length of the read/write head is 2 microns while rotational speed is 600 rpm. The Hitachi approach uses 100 tracks per inch. To allow its microdisk to gain acceptance, the rotational speed (300 rpm), data transfer rate, recording capacity per track, and other specifications are essentially the same as conventional 5¼" systems. The diskette magnetic coating has the same recording capacity as a double-density 5¼", making it possible to transmit data from a 5¼" disk to the 3" microdisk using a similar controller. Specifications for both approaches are shown in the Table.

There is no question that the small diskette will be improved to give higher densities and capacities. The development of perpendicular recording, where the magnetic domains run *through* the magnetic media, rather than *along* the media as conventionally used, could produce a considerable increase in data storage. It is quite possible at this time to produce microdiskettes having one-megabyte storage using the double-sided version, increasing the storage density to possibly 100 megabytes.

DISK SPECIFICATIONS

	SONY		HITACHI					
	Single density	Double density		Single density			Double density	
Capacity								
Unformatted (K bytes)	218.8	437.5		250			500	
Formatted (K bytes)								
Sectors/track	9	9	16	9	5	16	9	5
Per disk	161.2	322.5	164	184	205	328	369	410
Per track	2.3	4.6	2.048	2.304	2.56	4.096	4.608	5.12
Per sector	256	512	128	256	512	256	512	1024
Transfer Rate (K bits/s)	250	500		125			250	
Latency (avg in ms)	50	50		100			100	
Access time (ms)								
Track to track	15	15		3			3	
Average	365	365		55			55	
Settling time	15	15		15			15	
Head load time	50	50		NA			NA	
Rotational Speed (rpm)	600	600		300			300	
Recording Density (bpi)	3805	7610		4473			8946	
Track Density (tpi)	135	135		100			100	
Encoding Method	FM	MFM		FM			MFM	
Tracks per side	70	70		40			80	

Drives. As the diskette size dropped, so did the physical dimensions of the drives. However, the apparent size drop in this area is greater than the difference between the diskettes themselves. Although the microfloppy diskette is about 60% of the size of a conventional 5¼" diskette, the floppy disk drive volume appears to be about 75% smaller than the 5¼" drives. This is important when designing systems for small computers since more data storage can be packed into the same valuable space.

The Sony OA-D30V drive is 4"W × 2"H × 5"D. The Hitachi

HFD 305S is 3½" W × 1½" H × 6" D. Both of these are single drives. Amdek Corp., is producing a dual-drive package called the Micro-Floppydisk for the 3" diskette whose dimensions are a mere 7" W × 4" H × 8" D. TDK is currently talking to Shugart about the 3" (Hitachi) and say that they will talk to any drive manufacturer that displays an interest in the new small disk.

Tandon who is looking into the Sony approach, uses a double-sided diskette that can support 875K bytes, and a drive that is only 1⅝" H × 4" W × 6½" D.

Winchester Drives. Not only are floppy diskettes and their drives getting smaller, hard disks are also on the way down. Sony is soon to introduce its 3½" hard disk that will offer 3 to 10 megabytes using conventional recording, increasing to 10 to 100 megabytes using perpendicular recording. They also claim to have removable media under consideration.

The SyQuest SQ306 is a 3.9-inch Winchester disk drive with removable cartridge media. Unformatted, this disk has a 6.38-megabyte capacity, with 5-megabytes formatted. Its half-height form factor, just 1.625 inches high, allows two of these drives to be located in the same physical space as a single 5¼" drive. It is fully compatible with the Seagate ST506/406 5¼" fixed Winchester drive, and uses the controllers designed for the ST506/406 such as the DTC, 510A, XEBEX 1410, and the Western Digital WD 1000. The removable cartridge media requires no purge cycle upon power up and is engineered for 10,000 insert/removal operations. Price of a disk pack is less than $30 in OEM quantities.

The SyQuest features a fully digital closed-loop embedded servo that extends the accuracy of the metal-band positioner to 100 microinches. The embedded burst servo, where the control data resides within a single wedge per track, allows full definition control of sector formats. An on-board microprocessor verifies track position after each seek and adjusts for any positioning errors. ◊

the output stages become overheated (as when the outputs are shorted). A second system, the Sentry Monitoring Circuit, responds instantly to excessive drive or load current that could damage the output devices, and restricts the drive signal to keep their heat dissipation at safe levels. A third protection circuit monitors the speaker outputs for any dc component (which could signal an internal failure). Within milliseconds of detecting any dc, this circuit disconnects the speaker outputs.

The McIntosh Power Guard is a unique protection against waveform clipping, which is audibly irritating and can damage speakers. It compares the input and output waveforms and if the disparity between them correspond to about 0.5% distortion, a red LIMIT warning light appears on the panel. A further increase in signal level does not increase the output level, yet the limiting action creates no audibly significant distortion, no matter how great the overload.

Laboratory Measurements. Driving 8-ohm loads at 1000 Hz, the McIntosh MA6200 delivered 98 watts per channel at the point where the LIMIT light came on. (This criterion was used in lieu of "clipping," which could not be induced.) The maximum 4-ohm output was 151 watts per channel. These corresponded to Clipping Headroom ratings of 1.16 dB and 1.8 dB, respectively. With 2-ohm loads, the maximum output was about 66 watts per channel, but the thermal protection shut down the amplifier rapidly at levels greater than 50 watts.

When we used the 20-millisecond tone bursts of the IHF Dynamic Headroom measurement, the maximum output readings were 111 and 178 watts respectively for 8- and 4-ohm loads, corresponding to Dynamic Headroom ratings of 1.71 dB and 2.51 dB. The dynamic output into 2 ohms was roughly the same as the maximum continuous.

Harmonic distortion at 1000 Hz with 8-ohm loads was under 0.002% up to 30 watts, reaching 0.0034% at the rated 75 W and 0.17% at 100 W, well into the Power Guard limiting range. With 4-ohm loads, the distortion rose from 0.0018% at 1 W to 0.014% at the rated 100 W, and 0.022% at 150 W. The 2-ohm distortion rose from 0.0034% at 1 W to 0.025% at 50 W.

At the rated 75-W output into 8 ohms, the distortion was 0.004% to 0.005% from 20 to 7000 Hz, rising to 0.011% at 20,000 Hz. Distortion decreased as power was reduced. The high-frequency linearity was measured with the two-tone IHF-IM test signal. Equal amplitude inputs at 18 and 19 kHz drove the amplifier to the same peak level as a 75-watt sine-wave signal. The second-order difference product at 1000 Hz, and the third order distortion products at 17 and 20 kHz, were measured on a spectrum analyzer. All were in the range of 75 to 77 dB below 75 W, a negligible value. The slew factor of the amplifier exceeded our measurement limit of 25, and it was stable when driving reactive-simulated speaker loads.

Through the high-level inputs (TUNER or AUX) the amplifier required a 30-mV signal for a 1-W reference output, and the A-weighted noise in the output was 86 dB below 1 W. Through the phono input, the sensitivity was 0.21 mV, and the noise was −82 dB. The phono input overloaded at 95 to 100 mV, depending on frequency. The phono input had a resistance of 48 kilohms, shunted by about 25 pF. The RIAA equalization was accurate within 0.5 dB overall, from 30 to 20,000 Hz, and down about 1 dB at 20 Hz.

The loudness compensation worked as specified. As the control was advanced, the midrange level (500 to 1500 Hz) decreased by about 1 dB, while the bass response reached a maximum of about +19 dB at 33 Hz (or 20 dB above the depressed midrange level). Above 2000 Hz, the entire response was elevated to a maximum of +3 dB relative to the midrange level.

User Comment. It should hardly be necessary to point out that the McIntoch MA6200 has no sound quality of its own. Its freedom from distortion and noise, complete lack of switching transients or crosstalk between inputs, immunity to overload or other distortions, and extensive protection circuitry combine with excellent overall electrical performance to make this one of the most satisfying and elegant audio products we have had the pleasure of using.

The unusual loudness-compensation characteristic proved to be one of the most listenable we have encountered. It was easy to supply a feeling of full deep bass at low listening levels, without the artificial heaviness that mars most so-called "loudness controls." Similarly, flexibility of the 5-band tone control was as great as we can imagine anyone needing in a home music installation. Each knob had its distinctive, easily recognizable effect on the sound, leaving little doubt as to the optimum setting of the controls for any particular situation. We also found the rotary knobs easier to use than the more commonly employed slider controls. At their center (detented) positions, they gave a response flat within ±0.25 dB from 20 to 20,000 Hz.

Not only is it impossible to make this amplifier distort by overdriving it, we also found that its protective systems make it practically immune to damage. For example, an inadvertent reversal of output leads during one test effectively shorted both outputs, which were driven at high levels for some time. The LIMIT lights signalled that something was amiss, but our wiring error was not detected until after the amplifier's thermal protection shut off its outputs. After a cooling period, it returned to service, none the worse for treatment that would have destroyed most amplifiers.

The McIntosh MA6200 is an expensive amplifier, if judged only on the basis of price. However, when one considers the manufacturer's well-deserved reputation for reliability and long-term support of its products, the MA6200 would be a most reasonable choice for someone who is looking for perhaps the finest possible, nondeteriorating performance over many years of use. —*Julian D. Hirsch*

THE MASTER HANDBOOK OF IC CIRCUITS

By Thomas R. Powers

Here's a useful encyclopedia of 932 different circuits, using more than 212 popular ICs. Six sections (Linear Integrated Circuits, Voltage Regulators, CMOS Integrated Circuits, TTL/LS Integrated Circuits, Radio and Television Integrated Circuits, and Special Purpose Devices) provide information on build-it-yourself projects like high speed op amps, RC active filters, audio bass boosters, NOR gates, and clock pulse generators.

Published by TAB Books, Inc., Blue Ridge Summit, PA 17214. Soft cover. 532 pages. $14.95.

FIBER OPTICS

By Edward A. Lacy

The use of fiber optics is becoming increasingly widespread. This book focuses on their operating principles, e.g., internal reflection, bandwidth capacity, resistance to interference, etc. The author gives a very thorough overview of why and how fiber optics can be used in various applications. The devices associated with fiber optics are discussed, with attention to splicers, connectors, couplers, and photodiodes. Typical systems that use fiber optics are dealt with briefly.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632. Hard cover. 222 pages.

PRACTICAL BASIC PROGRAMS

Edited by Lon Poole

This is a book of actual programs in BASIC. It is intended for those who have already mastered one or more microcomputer versions of that language, e.g., Applesoft BASIC, Atari BASIC, TRS-80 BASIC, etc. Each program begins with a general description of a common problem in financial analysis or business management, together with a specific example of the task to be accomplished. Then the actual program listing is written out step-by-step.

Published by Osborne/McGraw Hill, Berkeley, CA. Soft cover. 171 pages. $12.50.

COMPUTER HOTLINE

A monthly column devoted to answering your questions on computers

By Stan Veit

IN THIS new column, we will select questions from readers that we feel will be most useful and answer them as best we can. We cannot, of course, answer all of the questions we receive on an individual basis, but here are some recent queries we have received regarding computers and applications.

DISK STORAGE SPACE

Q. *I have been learning to use UCSD Pascal on my Apple II and I think I understand it. But when I complete a program, in the Editor and Quit, and try to either write it to the disk or compile it, I get an error message that tells me I do not have enough room on the disk to store the program either as a TEXT file or as a CODE file. I end up losing all my work; and then, when I look at the directory listing, it tells me I have enough blocks left to store the program! Why does this happen?—Robert Sales, Anaheim, CA.*

A. When you go into the FILER, do an extended directory listing by using the E command. You will notice the amount of storage space in blocks that you have left in the largest remaining space. That is really the amount of usable space you have left—no more. The rest of the space is scattered throughout the disk in noncontiguous space. The systems can only save in contiguous blocks of storage space. So when your edited text or compiled code is larger than this amount, you get the error message.

When there is not enough room to save your work, you end up losing it unless you can substitute a formatted diskette with a system on it and enough room to save your text file. USCD Pascal needs at least a 56K system to run at all. The 64K in an Apple II does not leave much room for long programs. You must watch your disk storage space and crunch them to avoid wasting space. It is a good idea before you write a program to go into the FILER and do an extended directory listing to observe how much contiguous space remains on the disk. If there is not enough space, you can delete unneeded code or text files and then use the Krunch command to crunch diskette storage. As an alternative, you can make a diskette with only the system elements you need and no other files on it. This will maximize space. Refer to the UCSD System Manual for names of files you must have in a minimum system.

USING A PRINTER

Q. *I have a Centronics-type parallel printer that I want to use with Wordstar on my computer. The trouble is that the version I bought is set to use a serial printer. I've tried to use the Install program supplied with Wordstar to make a version that will work with a parallel interface and it still won't print. Can you help?—Bernard Green, NY*

A. Although the Install program has a provision for a Centronics-type parallel interface, the driver software may not exist, or there may be small differences between the requirements of your printer and the characteristics in the driver routine provided. There is a much surer way to make your printer work with Wordstar (or any other word processor with an Install program). This method depends on the fact that CP/M is device-independent. It normally outputs to a device that has been declared to be "The List Device" or LST. This is a serial device accessed from a serial port. The normal CP/M printer device is referred to as the Line Printer or LPT. This is normally a parallel device accessed from the parallel printer port. Now the STAT program in CP/M provides the method of making any normal CP/M device the List Device by declaring it to be so. For example STAT LST: LPT: makes the line printer the List device. Now we can use the Wordstar Install program to create a version that outputs to a Teletype printer and the CP/M List Device. We give it a name to identify it and it becomes our usual version of Wordstar.

Prior to loading our new version of Wordstar, when the CP/M prompt appears, you say STAT LST: (cr). Then, CTRL "P" should cause whatever you type to be sent to the printer where it will be printed. Now load the new version of Wordstar and compose your text. When you issue the PRINT command, it will be sent to the printer.

COMPUTER FOR BUSINESS

Q. *We are about to buy a personal computer to use in our business, the principle use of which will be applications using electronic spreadsheets. Can you help in selecting a maching for this purpose?—I. Fila, Racine, WI.*

A. Electronic spreadsheets such as Visicalc, Supercale, Calcstar, and others have one characteristic in common. They use larger amounts of memory. While they all display the same size empty matrix on the screen, when you enter a template or data, they need considerable memory to store your applications. Be sure that the computer you select permits you to add memory that is usable by the spreadsheet program you want to use. Some computers restrict you to a maximum of, say, 48K for the complete system. This is very restrictive for spreadsheet program work. ◇

A Universal Active Filter Breakthrough

By Forrest M. Mims

ANYONE working with or designing active filters would probably welcome a simple approach to their implementation. An ideal solution would be a single integrated circuit providing low-pass, band-pass, high-pass, and notch filtering *without* requiring external components. The ideal active filter would be tunable, consume little current, and be compatible with CPUs and other digital circuits.

Several years ago Datel (now Datel-Intersil, Inc., 11 Cabot Blvd., Mansfield, MA 02048) introduced the FLT-U2 Universal Active Filter. Manufactured with thick-film, hybrid technology, it employs three operational amplifiers to implement second-order low-pass, band-pass, high-pass, and notch transfer functions. The FLT-U2 includes a fourth, uncommitted op amp that can be used as a gain stage, buffer, or summing amplifier, or for additional filtering (such as implementation of a notch filter).

The FLT-U2 can operate over a frequency range of from 0.001 Hz to 200 kHz. Its block diagram (Fig. 1), reveals that many of the passive components necessary to implement the various filter functions are already present. This means, for example, that a band pass filter can be made by adding only four external resistors.

More recently, National Semiconductor (2900 Semiconductor Drive, Santa Clara, CA 95051) introduced the MF10 Universal Monolithic Dual Switched Capacitor Filter. Unlike the FLT-U2, this filter is a monolithic CMOS chip and is therefore easier to fabricate. Its current consumption is 10 mA, about the same as the FLT-U2.

The MF10 is a *switched-capacitor filter*, a standard analog filter in which fixed resistors are replaced by a network of switched capacitors under the control of an external clock. The clock frequency determines the center or corner frequency of the filter.

The MF10 contains *two* independent active-filter building-block stages. Each block requires an external clock and from three to four external resistors to implement any of the various filter functions.

A major breakthrough in active filter technology has been achieved by EG&G Reticon (345 Potrero Ave., Sunnyvale, CA 94086). It is the R5620, the first *fully integrated* universal active filter. Like National's MF10, the R5620 is a switched-capacitor filter that requires an external clock. Filter parameters, however, are selected digitally and *no* external resistors or capacitors are required.

The corner or center frequency for the R5620's particular operating mode is selected from any of 32 frequencies for a specific clock frequency. The frequencies are spaced logarithmically over two decades. The overall frequency range for the filter is 0.05 Hz to 25 kHz. The Q of the filter can be set to one of 32 logarithmically spaced values ranging from 0.57 to 150.

Figure 2 shows the various connections to the R5620. Note that the filter has separate inputs for each of its modes. The Q and frequency-control inputs can be hardwired or selected by BCD mechanical switches, logic circuits, or a microprocessor. The chip consumes only about 3 mA and operates from a power supply of from ±4 to ±10 V. Small quantity pricing for this sophisticated chip is around $8.00.

Although the R5620 represents a major breakthrough in active filter technology, it doesn't necessarily solve all application problems. As you can see in the accompanying table, the more traditional design of the FLT-U2 provides a considerably wider operating range. While the R5620 has a more limited range, it's ideally suited for applications in which digital control and tuning are required.

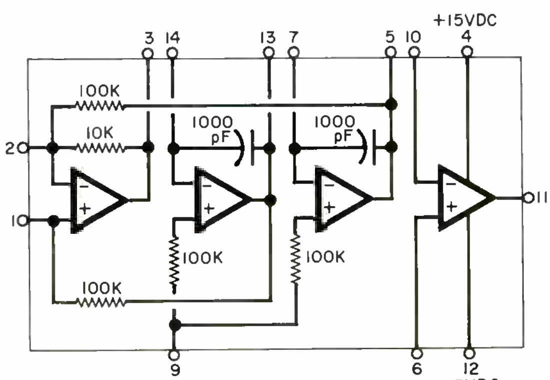


Fig. 1. Internal block diagram of the FLT-U2.

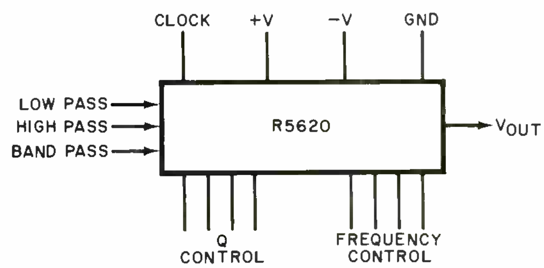
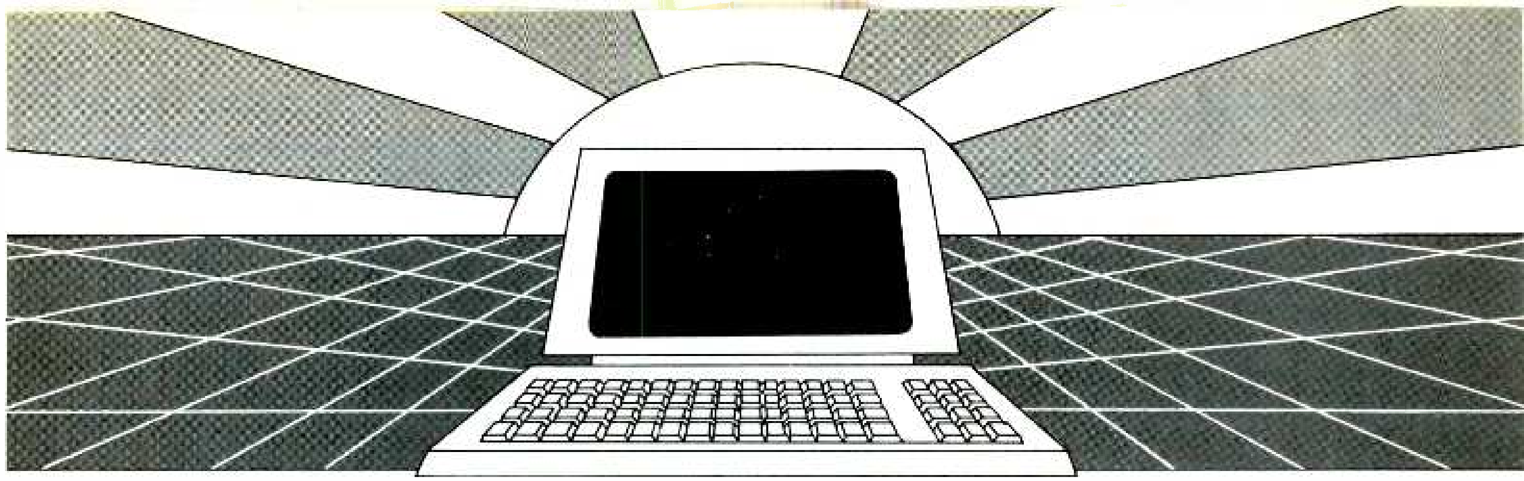


Fig. 2. External connections to R5620 Universal Active Filter.



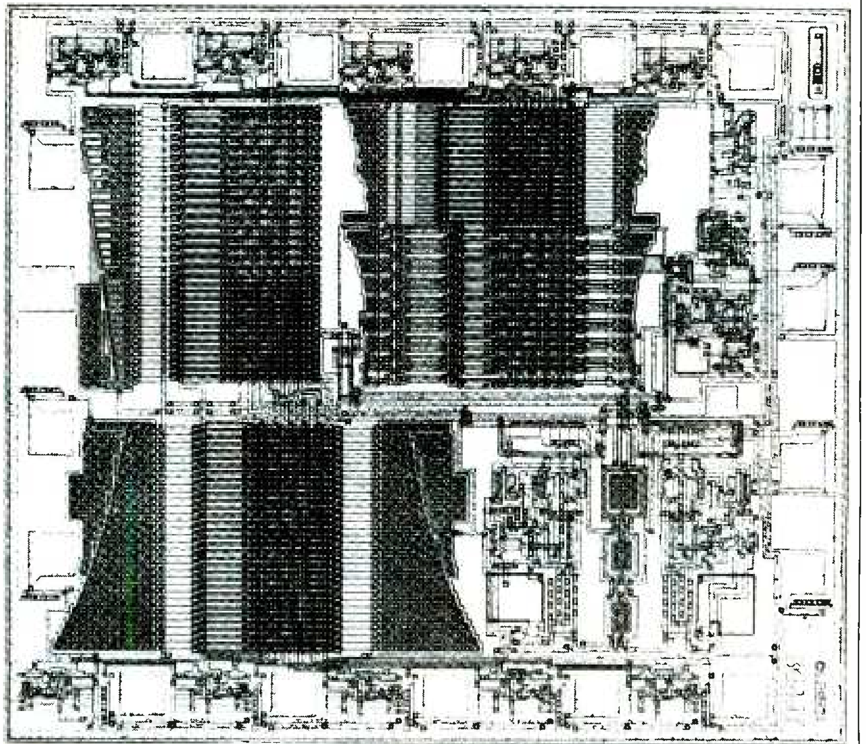
A New CMOS Microcontroller. Four-bit dedicated microcontrollers are widely used in a host of consumer applications. Recently, there's been a major swing from NMOS to CMOS microcontrollers, and now the number of CMOS units is nearing the NMOS total.

One of the latest CMOS microcontrollers is an addition to National Semiconductor's COPS family of 4-bit controllers. The new controller is available in six versions that provide various temperature ranges and I/O capacities.

The first two chips in this new line are the COP410C and COP411C. The COP410C is housed in a 24-pin DIP and has 20 I/O lines. The COP411C has 16 I/O lines and is packaged in a 20-pin DIP.

Power consumption of the new chips is substantially less than their NMOS counterparts. The NMOS COP410L, for example, consumes 15 mW while the CMOS COP410C consumes only 40 μW. Furthermore, the CMOS part is much faster. When operated from a 5-V supply, its minimum instruction cycle time is only 4 μs, 11μs faster than the NMOS version.

These new CMOS microcontrollers retain the internal architecture and features of the NMOS versions including 41 instructions, a two-level subroutine stack, and I/O lines that can be designed for specific requirements (CMOS, TTL and 3-state interfacing). The new microcontrollers include 32 nibbles of RAM and 512 $\times$ 8 bit user-specified masked ROM. Custom-programmed versions of the new chips will be available in volume for about $3.00 each.



Microphotograph of EG&G Reticon's R5620 Universal Active Filter.

A Videotex Graphics Chip. At last summer's Videotex '82 Conference and Exhibition in New York, Jean Guillermin, chairman of Antiope, announced a new graphics generator chip that provides high-resolution graphics and text for Videotex terminals. The new chip is a video-display processor used in conjunction with a microprocessor, memory, and possibly a modem. It can operate with either the 525- or 625-line television standards, and can provide a resolution of 80 dots per character space.

Several operating modes for the new chip are available. In its text mode, the chip can display 20 to 25 rows having up to 40 characters per row. In its captioning mode, the chip will insert text onto a graphics background. The combined graphics and text mode provides full bit-mapping capability, 320 points by the number of the monitor's scan lines, all NABTS graphics primitives, and eight colors (expandable to sixteen).

Jean Guillerman is also the president and chief executive officer of Telediffusion de France, the French public common carrier and research laboratories for all radio and television in France. The announcement of the new chip was accompanied by a statement pointing out the advantages of high-resolution graphics for Videotex and emphasizing that "France is fully prepared to support such activities in the United States." For additional information, contact Herbert L. Corbin, an Antiope media representative (99 Park Avenue, New York, NY 10016).

COMPARISON OF FILTER PARAMETERS

	FLT-U2	MF10	R5620
Minimum Frequency (Hz)	0.001	*	0.05
Maximum Frequency (Hz)	200	30	25
Minimum Q	0.1	*	0.57
Maximum Q	1000	*	150
Operating Voltage Range	±5 to ±18	±5	±4 to ±10
Current Consumption (mA)	10	8	3

**Not directly specified in data brochure.*

High-Power Semiconductor Lasers. A research team from Xerox Research Center in Palo Alto, CA has developed a new kind of semiconductor injection laser capable of continuously emitting up to 400 mW at room temperature. This represents a major advance over previous high-power semiconductor lasers.

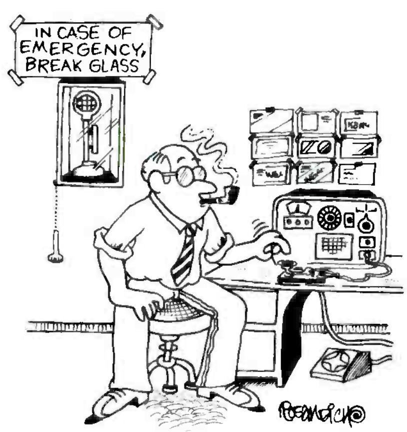
The new laser incorporates ten parallel stripes that provide an array of active regions. Each stripe is 3 micrometers wide and extends the length of the laser. The radiation from adjacent stripes is optically coupled to provide phase locking and transverse mode stability.

When operated in a pulsed mode (1 kHz @ 75 nanoseconds), one of the new lasers exhibited a lasing threshold of about 300 mA. It emitted 2.1 W from its front facet before irreversible catastrophic damage occurred. The peak wavelength of the GaAlAs device was 832 nanometers.

In a continuous mode study, the average onset of catastrophic damage to the new lasers was about 370 mW per facet. The *total* power conversion efficiency was a remarkable 17%.

In a fiber-optic communications role, these new lasers can inject more optical radiation into a fiber than any previous LED or diode laser. In a preliminary test, a 5-meter length of large core (100-micrometer diameter) fiber was coupled to one of the new lasers with an insertion loss of −3 dB. The optical power emerging from the free end of the fiber measured 150 mW, approximately seven times greater than the results of previous such demonstrations reported in the literature.

While Xerox may have an interest in the communications potential of these new lasers, their very high output power makes them prime candidates for such applications as printing and video disk writing. ◇



COMPUTER BITS

Notes on Using Your System as a Secretary

By Carl Warren

OCCASIONALLY, when I'm on the road at article deadline time, I have sent material directly to the office via computer link. I use an Otrona Attache portable computer with Metalogic's Whizlink communication package and a Hayes Microcomputer Smartmodem for this purpose.

At the home end, I've implemented the Hayes 1200-baud Smartmodem with Ward Christenson's computer bulletin board system (CBBS™), as well as his public domain BYE program.

Although the CBBS can be used by anyone, I've modified it for private use and added a mailbox function in concert with the Hayes modem. With Ward's help (and a very large phone bill), I've been able to implement several functions. I can call in to either upload or download items, leave a message to my secretary coupled to an alarm function (the system beeps until she answers it or I command it off), or leave a special system message.

This last function, the system message, currently relies on the system clock (which, unfortunately, is thrown off by disk accesses) to perform date/time tasks. (Eventually I plan to add the Hayes Stack Chronometer). This unique system message permits the entering of a date, time, and phone number to call. At the specified time, the number is dialed and sign-in is established. After the transfer is completed, the system signs off.

Even though this mailbox function may seem trivial in concept, we found that we had to take into account a number of things that might go wrong. Besides power outages and glitches, you need to know that you do, in fact, have a valid carrier and have connected. The Hayes modem handles this. Next, you must be able to determine that you have achieved a valid sign-on and have proper communication. The modem can't perform this function, so we had to look further.

In designing the mailbox, we found that Ward had provided all the CP/M system level handlers to move messages. What was missing, however, was the handling mechanism for the mailbox functions. Since we needed reasonable speed and ease of programming, we turned to the command language in Ashton Tate's dBase II management system.

Essentially we had to perform string comparisons to make sure the functions were valid. We also had to manipulate files that could be text, data, or command structures. Since CBBS allows the creation of message files that are handled by the structure in a way similar to that of dBase II all we needed to add in CBBS code was a call to dBase II letting it manipulate all the message files.

Rather than allow CBBS to create the file—which it can do—we always default to dBase II. The message files are defined as:

```
CODE 3,C (3 ASCII characters long)
PHONE 15,C (Up to 15 ASCII characters)
CONTENTS 200,C (Up to 200 characters)

System displays this as:

CODE:            PHONE:              :

Total message is 200 characters
```

To further simplify the message system, a Control-Q displays a list of codes and phone numbers (we allow up to ten). In this mode, all we do is enter the desired code (I'll explain this shortly) and the phone number. The system automatically fills in the correct information. An enhancement I plan later is a switch that calls a file for the message. This will permit messages of greater than 200 characters.

The code that I mentioned is a

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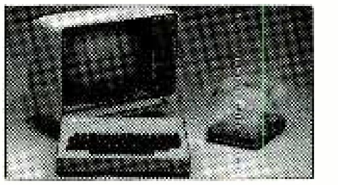

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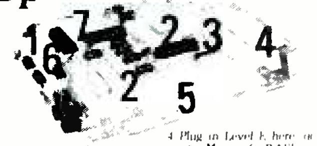

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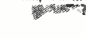

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unique indicator directly related to what I want to do. The code is made up of three characters.

The first (leftmost) character is either a D or an F. D is for dial from the date and time in the first line of the message. An F uses a special call file for the date and time. The second and third characters set up the attributes of the transfer:

CS—call and send only;
CD—call and send then delete;
CM—call, send, and look for messages.

The latter function only works with similar systems that are expecting a message query.

One of the features of the Whizlink communication program is its ability to reduce the size of a file by 40% using a compression system, which speeds communications. We found that we could use the compression file from Whizlink in concert with our modified CBBS. (Currently, we have only tested this in a local loop and not on the operating CBBS so we aren't sure we have all the links properly implemented.)

Unfortunately, we don't have room in the magazine to publish the code we created; but we can make it available via the COMPUTER & ELECTRONICS Bulletin Board found on CompuServe. When on CompuServe, type GO PEM-450 and look in the access file (function XA).

If you want to duplicate the procedures described here, you'll need to contact Ward Christenson (via CompuServe's bulletin board) for the CBBS package and purchase a Hayes Smartmodem. There are other intelligent modems available, but the Hayes system is the only one we have used. In addition, we have our system on a Zenith Z89 with a Magnolia disk controller and a combination of 8″ and 5¼″ drives.

Unfortunately, the BIOS (basic input/output system) implemented by Magnolia differs enough from the Zenith version to require a redefinition of the location of the TPA (transient program area) in CBBS. ◇

Experimenting with Kodak's Disc Camera
Part 1. Modifying the Camera for Electronic Triggering

By Forrest M. Mims

KODAK's new system of disc photography has been widely acclaimed as an important development in snapshot photography. The disc camera system opens up a wide range of applications for experimenters who wish to add electronic accessories to the basic camera.

Each of the four cameras in the disc family combines a motorized film advance, built-in strobe, batteries, and totally electronic triggering in a rugged package that weighs only six ounces and is sold for as little as $45. These features make the disc cameras ideally suited for many fascinating assignments that otherwise require hard-to-find, costly equipment and accessories.

Many electronic accessories for the disc camera family can be designed. Some of the more obvious include a variable-speed sequence controller and circuits that remotely trigger the camera in response to light, sound, or radio signals. Applications for a disc camera and one or more accessories such as these are wide ranging. A sound-activated disc can photograph wildlife or an unwanted intruder. A light-triggered disc can record lightning or serve as a combination slave flash *and* camera. A sequentially triggered disc camera can take elapsed-time photos of flowers opening, cloud movements, and traffic patterns. It can also be used to provide a timed photographic record of an instrument panel or a sequence of zones through which a vehicle or aircraft has passed. A radio- or infrared-triggered disc has numerous applications in remotely controlled photography.

However, until Kodak introduces a disc camera with an external socket or jack suitable for connecting various triggering devices, it is necessary to modify one of their existing units for special control purposes. I'll describe how that is accomplished later. First, let's find out more about the design and operation of the cameras in the Kodak disc family.

Fig. 1. Kodak's disc 4000 can be purchased for less than $45 in many discount stores.

The Disc Camera Family. Thus far, Kodak has announced four disc cameras: Models 2000, 4000, 6000 and 8000. The four have many features in common. Each is about the size of a pocket calculator (1" × 3" × 4.5") and includes motorized film advance and a built-in strobe. All four accept a 15-exposure flat film cartridge that contains a unique rotating disc of Kodacolor HR film. All the cameras also include a fixed-focus, 4-element, all-glass lens system with a focal length of 12.5 mm and a fully open aperture of f/2.8.

The Kodak disc 2000 is a low priced version of the camera which, though made in the United States, is currently sold only in countries other than the U.S. and Mexico. It is powered by a replaceable 9-volt alkaline battery and lacks the fully automatic features of the three other disc cameras.

The Kodak disc 4000, Fig. 1, includes a built-in light sensing integrated circuit with a threshold of 125 footlamberts. Above that value, the camera provides an exposure speed of 1/200 second at a lens aperture of f/6. Below it, exposure speed is automatically reduced to 1/100 second and the lens aperture is opened fully to f/2.8. Furthermore, the electronic strobe always flashes when the light level is below 125 foot-lamberts.

A second 16,000 square mil integrated-injection logic chip housed in a miniature 18-pin DIP makes the timing and control decisions necessary to charge the flash capacitor, fire the strobe, select the lens aperture and exposure speed and advance the film disc. The chip drives the camera's 6-volt slot-car-type motor at an average power of 2 watts and a peak current of 2 amperes.

The flash capacitor is fully charged in less than a second. Combined with the automatic film advance feature, which rotates the film disc to the next frame in 0.4 second, the camera can therefore take flash photographs at intervals of only 1⅓ seconds!

The Kodak disc 4000 is powered by a pair of 3-volt lithium polycarbon monofluoride batteries made by Panasonic, making it one of the first consumer products to be powered by this exceptional energy source. These batteries are reported to have a shelf life in excess of five years and a capacity of 1200 milliampere hours.

The Kodak disc 4000 is housed in a robust plastic and silver anodized aluminum case. A sliding lens and viewfinder cover automatically actuates the strobe capacitor charging circuit when the camera is made ready for use.

The Model 6000 is identical to the Disc 4000 with two exceptions. The first is a folding cover that protects the entire front of the camera when it is not in use. When opened, the cover serves as a handle. It also automatically actuates the strobe capacitor charging circuit. The second addition to the disc 6000 is a close-up lens that can be quickly slid into action by moving a small protrusion under the lens opening. The close-up lens reduces the minimum picture taking distance from 4 feet to 18 inches.

The disc 8000 is the most sophisticated of the family. It incorporates the close-up lens and cover of the disc 6000 plus a self-timer, a rapid sequence film advance and a digital alarm clock. The self-timer provides a 10-second delay before the camera automatically takes a picture, thus allowing the user to be included in a photograph. The timer activates a blinking red LED on the front of the camera and an audible, pulsating tone. The tone sequence speeds up during the final two seconds before the exposure is made to notify the user the camera is about to be triggered.

The rapid sequence feature of the disc 8000 permits the camera's user to take photos at a rate of three per second in daylight simply by holding down the shutter button. If the flash is needed, the camera will take a picture once every 1⅓ second when the shutter button is held down. The digital alarm clock has its own power supply.

The Film Disc. Figure 2 shows a processed 15-exposure disc color negative. The Kodacolor film has an ISO speed of 200 and the film has twice the speed and a finer grain than Kodacolor II film.

The disc in Fig. 2 includes frame numbers and both alphanumeric and bar-coded identification codes. These data as well as the individual frame numbers are preflashed on the film when it is manufactured and made visible during development.

Modifying a Disc Camera. To modify a disc camera, you have at least two options. One is to employ a servo or solenoid to electromechanically trip the existing shutter button. The other is to gain access to the camera's circuitry and attach a set of external connection leads.

The advantage of the electromechanical approach is that there is no need to open the camera, thus protecting its warranty. On the other hand, the electromechanical approach requires more space, is heavier, consumes more power, and is less reliable than purely electronic triggering.

I've modified two disc 4000 cameras by removing the front panel and soldering connection leads directly to the cameras' circuit boards. I'll describe how this is done next, but first here are a few precautions you must heed.

1. Kodak's warranty is voided "... if the camera is damaged by misuse or other circumstances beyond Kodak's control..." Since the manual provided with the disc cameras specifically states that the camera should not be disassembled, opening and modifying the camera might be grounds for voiding the warranty. On the other hand, if a malfunction is not associated with a modification, the warranty might stand. But you should be aware of the risks.

2. Unless you are careful and follow the instructions given below, you might damage the camera. You must avoid touching or manipulating the complex and fragile mechanical parts of the camera. You must also avoid bridging solder across adjacent terminals on its circuit board.

3. The camera's built-in strobe circuitry constitutes a potential shock hazard.

The primary shock hazard is a 160-microfarad photoflash capacitor which is almost always charged to about 180 volts. Even *weeks* after the camera is last used, this capacitor retains a hefty charge! The discharge from this capacitor across a finger or hand can cause an involuntary jerk that may dump a soldering iron in your lap or jam your elbow into a wall. A discharge through your body (as from one hand to the other) may cause a more severe reaction. Therefore, you should open the camera *only* if you know what you are doing *and* if you plan to use the proper precautions.

For example, when the camera is open, *never* touch any part of the circuit board or any electronic parts or components with your fingers or an uninsulated tool. There's no need to touch anything inside the camera to make the modifications to be described. Furthermore, you should always keep one hand *away* from the camera to avoid a possible shock through your body. Of course, you should not open the camera at all if you have had no prior electronics experience.

Opening A Disc Camera. Opening a disc camera requires a *clean* work area and a steel implement about half-a-millimeter thick and a centimeter or so wide. It should be at least 10 centimeters long. A 15-centimeter stainless steel pocket rule like those available at hardware stores works reasonably well. Avoid the temptation to use a screwdriver! It will damage the case and may slide up inside the camera.

You want to remove the aluminum front cover with its attached black plastic lens and viewfinder door assemblies. Along the bottom of the camera there is a narrow gap between the aluminum front cover and the

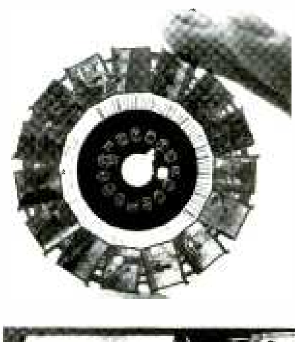

Fig. 2. A processed 15-exposure disc negative showing frame numbers and identification codes.

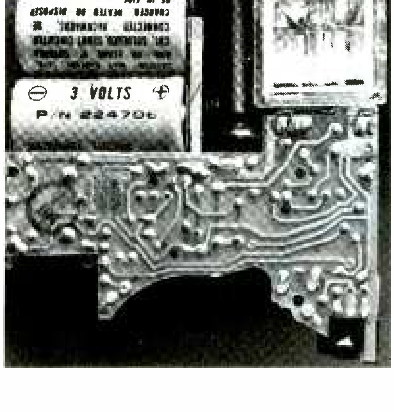

Fig. 3. One version of the circuit board in a disc camera.

camera's plastic body. Look closely and you'll see two slots in the gap on either side of the camera. With the lens facing away from you, the widest of the two slots is to your left.

Make sure the camera's lens door is fully *closed*. Then insert the steel tool into the widest of the two slots and twist the tool from side to side until the aluminum cover begins to give. Repeat this procedure with the slot on the right side of the camera's bottom. Be patient. Several cycles of twisting and prying may be necessary to remove the cover. Above all, don't force the tool or push it up inside the camera's body where it might damage the circuit board or delicate moving parts, or even cause a shock.

Eventually you will be able to lift the cover from the camera. Figure 3 shows what you will see. Avoid getting dust on the lens and do not touch any of the camera's internal parts.

Connecting External Shutter Lead. When the camera is opened, make a 1-millimeter hole in the bottom of the camera at the location shown in Fig. 4. Use a small drill or simply twirl a sharp hobby knife into the plastic. Remove any protrusions or cuttings from inside the case. Incidentally, if you select a different location for the shutter leads' access hole, make sure it does not interfere with the protruding lips of the camera front panel.

Next, notice the square opening in the yellow plastic circuit board protective cover. The three rectangular pads visible through the opening are the shutter contacts. You may solder external connection leads directly to them, but to avoid complications you may then have to remove the flexible contacts from the shutter switch on the back side of the camera's cover panel. Of course, this will permanently disable the camera's manual shutter switch.

Alternatively, you can do as I have done and temporarily remove the yellow circuit-board cover in order to solder the leads to the terminal points of the lands leading away from each of the three shutter switch pads. CAUTION: To avoid being shocked by the strobe capacitor, do *not* touch the exposed circuit board! See the safety remarks previously given.

Since the early versions of the disc camera used at least two entirely different circuit-board layouts, I've not included a photograph of my modified cameras, each of which employed a different circuit board. But all you have to do is follow the land leading away from each shutter switch pad to its end point and carefully solder an 8" length of wrapping wire to each terminal. See Fig. 5 for the color-coding arrangement you should use.

Only a few millimeters of insulation need be removed from one end of each wire. Do *not* remove any insulation from the opposite end of each wire. Use a low-wattage soldering pencil to make the connections

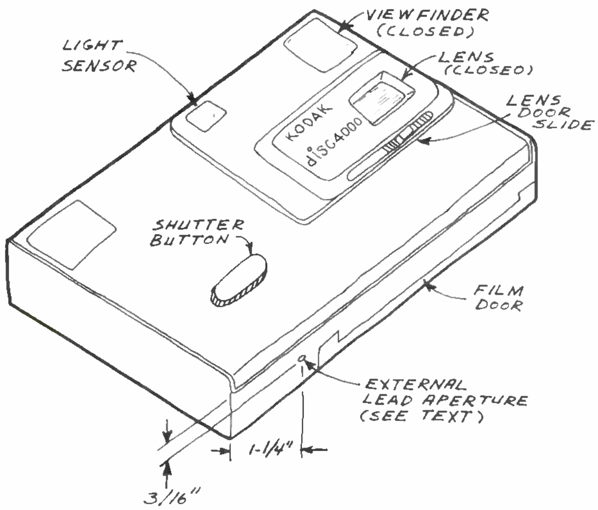

Fig. 4. Location of external leads aperture.

and be careful to avoid bridging solder between the closely spaced terminals on the board. A rubber-bulb solder slurper will remove solder bridges.

After leads are in place, inspect the board to find and remove any solder balls or bits of wire. Make sure the soldered ends of each wire do not extend away from the terminals and contact any nearby terminals or lands.

Next, clip off any exposed wire from the end of each lead. Then thread the three leads through the hole in the bottom of the case. Pointed electronic tweezers will be very helpful. Again, do not touch the circuit board! If necessary, insulate the tweezers with vinyl tape. Pull the wires so they extend in a gentle curve over the two batteries and then carefully replace the adhesive yellow cover over the circuit board. There's no need to touch the board. Just allow the cover to fall into position on the board and press it in position with the eraser end of a wood pencil.

Finally, replace the camera's cover. First, make sure

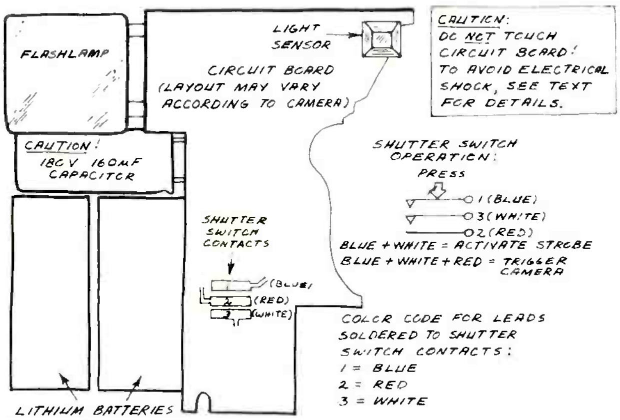

Fig. 5. Connecting leads to the shutter switch terminals.

the lens door is fully *closed*. Then insert the upper edge of the cover into the top side of the camera's body. When it is aligned, press the bottom edge of the cover down into position. Press along all four corners to snap the cover in place. The modification of the camera is now complete.

Triggering the Camera Externally. Figure 5 shows the arrangement of the shutter contacts in the disc camera. When the shutter is lightly pressed or merely touched, the upper two contacts close to activate the strobe capacitor charging circuit. Opening the lens door has the same effect.

You can hear a brief, high-pitched hum from inside the camera when this occurs. For more volume, place the camera near an AM radio and touch the shutter button. The speaker will emit a brief but noisy hum (or a few clicks if the capacitor is already charged).

To trip the shutter, the upper two contacts must make contact with the lower contact. The exposure is then made and the film disc is automatically advanced to the next frame. You can accomplish this with your modified camera by removing some insulation from the end of each lead, twisting the blue and white strobe charging leads together and touching them to the red lead. Disconnect the blue and white leads to save a few mils of current drain. You can use a pair of miniature switches to manually trigger your modified camera. Add longer connection leads, and you can take pictures from across the room.

To Be Continued. In Part 2 I'll describe a variety of straightforward but very versatile accessories for your modified disc camera. In a subsequent column we'll fly a radio-controlled disc camera from kites and balloons. ◇

OPERATION ASSIST

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist. Computers & Electronics, *1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)*

Midland Model 15-520 video camera. Need schematic and service manual. Ed Herbert, 410 N. Third St., Minersville, PA 17954.

Lafayette Model HE-40 receiver. Need operating manual and schematic. Ned Black, N1BQI, Rt. 1, Box 487, Casco, ME 04015.

Heathkit Model 0-8 oscilloscope. Need schematic and service manual. Mike Profitt, 6855 St. Rt. 722, Arcanum, OH 45304.

AN/US-24C oscilloscope. Need power supply transformer. Joseph B. Fontan, Rt. 5, Box 496, Covington, WA 70433.

Tektronix Model 422 oscilloscope. Need CRT V859. Clyde Warner 3901 Coventry Road, Fayetteville, NC 28304.

Eico Model HFT90 FM tuner. Need owner's manual, and schematic. **Hewlett-Packard** Model 712B power supply. Need parts list and schematic. Willis L. Roberts, 5717 Woodlawn, Little Rock, AR 72205.

Precision Series ES-500A oscilloscope and **Accurate Instruments Co.**, Model 156 genometer. Need schematics, manuals and service information. Rob Leonard, Len's Avenue, Dayville, CT 06241.

Panasonic Model VTR # NV-3020 tape recorder. Need schematic and service manual. D. Test, Box 9064, Newark, NJ 07104.

Hewlett Packard Model 212A pulse generator and model 650A test oscillator. Owner's manual, service manual, and schematics needed. B. Pilkinton, 109 Wellwood, Corpus Christi, TX 78410.

Tektronix Model S54U oscilloscope. Need data on transistor U14064/2 npn. P.E.A. Hertz, 40 Baden Powell Road, Northend, Bulawayo, Zimbabwe.

Polytronics Lab Inc., Model PC-73 23-channel CB. Need schematic and operating manual. Steve Alva, P.O. Box 1804, Paso Robles, CA 93446.

EMC Model 215 tube tester. Need updated operating manual. Thomas L. Marotz, Rt. I, Box 1AAA, Sibley, MO 64088.

Microswitch Model 113SD5 keyboard. Need schematic, operating manual or any information available. Doug Chase, 7915 Pala St., San Diego, CA 92114.

E.H. Scott Radio Labs Model RBO CZC46139 Navy receiver. Need schematic and manual. D. E. Lyon, 922 Gardendle, Bellflower, CA 90706.

Webcor Model 2356 tape recorder. Need schematic and service manual. William Mims, 611 Bell Avenue, Inverness, FL 32650.

Knight Kit Model 223102XW star roamer. Need schematics, assembly manual and any other pertinent information. Richard Barton, 325 Sago Avenue, Jacksonville, FL 32218.

Panorama Model RDP 1CPN55161 oscilloscope. Need operating instructions and schematic. G. Sterni, 23-80 28th Street, Long Island City, NY 11105.

Precision Apparatus Corp., Series 600 electronometer tube analyzer. Need schematic and operating manual. Bob Nicholson, 3423 Long St. Topeka, KS 66605.

Eico Model 751 ac power supply. Need schematics or owner's manuals. Richard Benoit, 533 Ridgecrest Road, N.E., Atlanta, GA 30307.

ADVERTISERS INDEX

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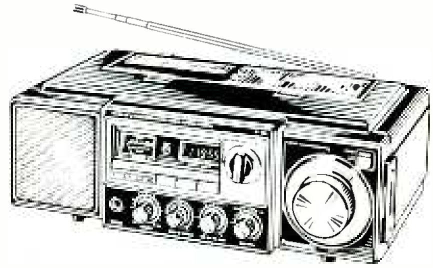

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Recommended Shortwave Programs by Time and Station

By Glenn Hauser

OUR previous compilation under this title drew such enthusiastic response that readers have persuaded us to present a new, updated, listing drawn from a much more extensive schedule that appears periodically in *Review of International Broadcasting*. Keep in mind that all times and days are GMT. Thus, at the beginning of the listing, the first few hours of "Saturday" are actually during Friday evening in North America. Times shown take into account those stations shifting programs due to the annual departure of DST Oct. 31. However, some frequency changes will be made Nov. 7.

GMT	Station	Program & Frequencies
		SATURDAY
0010-0030	Kol Yisrael	T.G.I.F.; 11640, 9815 (also 0210)
0010-0035	R. Japan	Science & Industry Journal; Editorial Roundup; 21610, 17825 (also 0155)
0015-0045	R. Peking	Profile; The Land & the People; 17855, 17680, 15120 (also, 0115, 0215, 0315, 0415)
0030-0100	R. Canada Int'l	Nightfall; 5960, 11850 or 9755
0110-0125	Kol Yisrael	Shabbat Shalom; 11640, 9815
0130-0140	HCJB	Week in Ecuador; 17890, 15155, 9745
0130-0158	R. Budapest	Hungarian History; 11910, 9835, 9585
0144-0159	BBC	South Asia Survey; 9410
0210-0228	R. Budapest	Various Features; 11910, 9835, 9585 (also 0310)
0212-0225	R. Australia	Editorial Opinion; 21740, 17795 (also 0412)
0230-0245	UN Radio	UN-Africa; 15240, 6035
0330-0355	R. Tirana	Answering Listeners' Questions; 7300, 6200
0330-0359	BBC	Fiesta; 9410, 6175, 5975
0335-0359	BBC	Week & Africa; 11860, 7105
0339-0355	R. Australia	This Australia; 17795
0400-0412	R. Budapest	Calling DXers & Radio Amateurs; 11910, 9835, 9585
0530-0539	BBC	New Ideas; 9510, 9410, 6175, 5975
0535-0559	AFRTS	World of Religion; 6030 (also 1035)
0700-0800	Xandir Malta	Malta Calling; 9670
0715-0729	BBC	From the Weeklies; 9510, 9410, 6175
0830-0859	BBC	Comedy Series; 11955, 9510
0840-0855	R. Australia	This Australia; 11775, 9570
0912-1100	R. Australia	International Top Hits; 11775, 5995
0945-1014	BBC	Science in Action; 21660, 15070, 11750
1005-1025	V. of Vietnam	Vietnamese Music; 10080
1040-1050	R. Korea	Folk Tales & Proverbs; 9570
1100-1115	HCJB	Musica Nacional; 11960, 9765, 6050
1110-1125	R. Australia	Editorial Opinion; 9580, 5995
1130-1145	4VEH, Haiti	Hobby of Kings; 11835, 9770
1130-1159	BBC	Meridian; 21710, 21660, 11775, 11750, 9510, 6195
1135-1159	AFRTS	Agronsky & Co.; 15430, 15330, 11805, 9700 (also 1435)
1210-1230	R. Finland	Compass North; 21475, 15400 (also 1310 and 1410)
1211-1226	R. Moscow	Roundabout the Soviet Union; 9600
1215-1244	BBC	Anything Goes; 21710, 21660, 11775, 11750, 9510
1215-1255	R. Peking	Chinese Sayings, Stories, Music; 9820
1230-1259	VOA	New York, New York; 9565, 9545
1235-1259	AFRTS	Portfolio; 15430, 15330, 11805, 9700 (also 1735)
1240-1255	R. Australia	Australian Inventor; 9580, 5995
1321-1343	Swiss R. Int'l	Shortwave Merry-go-round, or Grapevine; 25780, 21570 (also 1536)
1330-1359	BBC	30-Minute Theatre; 25650, 21660, 11750
1400-1427	R. Sweden	Saturday from Stockholm; 17790
1400-1415	HCJB	Nature Trail; 17890, 15115, 11740
1430-1459	BBC	Fiesta; 25650, 21710, 21660, 15400, 11750
1459-1529	BBC	Week & Africa; 21590
1535-1545	R. RSA	DX Corner; 25790, 21535
1535-1559	CBC No. Service	Royal Canadian Air Farce; 11720, 9625
1649-1659	AFRTS	Science Editor; 15430, 15330, 11805 (also 1949)
1714-1743	BBC	Week & Africa; 21470
1807-1859	R. Canada Int'l	Canada Week; Canada a la Carte; 17820, 15260
2030-2114	BBC	Features; 15260, 15070, 12095
2130-2159	R. Canada Int'l	Shortwave Listeners' Digest; 17875, 17820, 15325, 15150, 11945
2209-2229	BBC	From Our Own Correspondent; 15260, 15070, 12095, 9410
2230-2239	BBC	New Ideas; (as above)
2315-2329	BBC	Letterbox; 15260, 15070, 9590, 9410, 7325, 6175, 6120, 5975
2330-2359	BBC	Meridian; (as above)
		SUNDAY
0015-0055	R. Peking	Chinese Sayings, Stories, Music; 17680, 17855, 15120, (also 0115, 0215, 0315, 0415)
0015-0030	R. Moscow	Moscow Mailbag; 9600 (also 0215)
0030-0159	BBC	Play of the Week; 15260, 9410, 7325, 6175, 6120, 5975
0035-0050	HCJB	Música del Ecuador; 17890, 15155, 9745
0112-0125	R. Australia	Report from Asia; 21740
0140-0155	R. Moscow	Roundabout the Soviet Union; 9600 (also 0340)
0150-0213	Swiss R. Int'l	Shortwave Merry-go-round or Grapevine; 15305, 11715, 9725, 6135, (also 0435)
0212-0220	R. Australia	Letters to the Editor; 21740, 17795
0215-0255	R. RSA	P.O. Box 4559; Touring RSA; DX Corner; 15325, 11900, 9615, 5980
0230-0300	WRNO	World of Radio; 6155
0230-0300	HCJB	DX Party Line; 15155, 9745 (also 0630)
0230-0300	VOA	New York, New York; 17640, 15205, 9650, 6130, 5995
0245-0300	R. Cairo	Passport to Afroasian Music; 12000, 9475
0249-0321	R. Nederland	Shortwave Feedback; 9590, 6165 (also 0549)
0315-0329	BBC	From Our Own Correspondent; 9410, 7325, 6175, 6120, 5975
0330-0355	R. Tirana	Week in Review; Revolutionary Art & Culture; 7300, 6200
0330-0359	BBC	My Music; 9410, 6175, 5975
0330-0359	AFRTS	Communiqué; 15330, 6030
0410-0430	WRNO	Ukranian religious music; 6155
0412-0425	R. Australia	Report from Asia; 17795, 15320
0515-0529	BBC	Letterbox; 9510, 9410, 6175, 5975
0540-0555	R. Australia	The Body Program; 21650, 15160
0545-0559	BBC	Letter from America; 9510, 9410, 6175, 5975
0612-0628	R. Australia	Spectrum; 21650, 17795 (first, third, fifth Sundays)
0630-0659	BBC	Jazz for the Asking; 9510, 9410, 6175, 5975
0705-0730	VOA	African pop music; 6125
0712-0725	R. Australia	Report from Asia; 11775, 9570
0715-0729	BBC	From Our Own Correspondent; 9510, 9410, 6175, 5975

0810-0825	R. Australia	Spectrum (first, third, fifth Sundays); 11775, 9570
0815-0859	BBC	The Pleasure's Yours; 15070, 11955, 9640, 9510
1000-1015	R. Korea	Week in Review; 9570
1100-1115	HCJB	Música Nacional; 11960, 9765, 6050
1100-1130	Sri Lanka B.C.	Radio Monitors International; 17850, 15120, 11835
1115-1129	BBC	Letter from America; 21710, 21660, 11775, 11750, 9510, 6195
1130-1159	AFRTS	The Source Report; 15430, 15330, 11805, 9700 (also 1430)
1130-1259	BBC	Play of the Week; 21710, 21660, 11775, 11750, 9510
1140-1155	R. Australia	The Body Program; 9580, 5995
1212-1225	R. Australia	Report from Asia; 9580, 5995
1215-1255	R. Peking	Music Album; China Anthology; Letterbox; 9820
1231-1249	Austrian R.	Letter from Austria; Shortwave Panorama; 21535
1235-1259	AFRTS	Perspective #1; 15430, 15330, 11805, 9700 (also 1735)
1307-1328	VOA	New Products; Critic's Choice; 9565; 9545
1310-1320	CBC No. Service	Voice of the Pioneer; 9625, 6065
1320-1343	Swiss R. Int'l	Various monthly features; 25780, 21570 (also 1535)
1330-1359	CBC No. Service	The Food Show; 9625, 6065
1330-1400	VOA	Studio One; 9565; 9545
1300-1525	R. Finland	Sunday Best; 15400, 21475
1335-1359	AFRTS	Perspective #2; 15430, 15330, 11805, 9700 (also 1835)
1400-1428	R. Sweden	Mailbag; 21615
1405-1659	R. Canada Int'l	Sunday Morning; 17820, 15240, 11955, 9625
1430-1458	BBC	Comedy series; 21710, 21660, 15070, 11750
1435-1459	AFRTS	Speaking of Everything; 15430, 15330, 11805, 9700 (also 1935)
1459-1529	BBC	African Perspective or Theatre; 21590
1515-1559	BBC	Concert Hall; 21710, 21660, 17830, 15260, 11750
1535-1559	AFRTS	World News This Week; 15430, 15330, 11805, 9700 (also 2035)
1611-1630	VOA	Voices of Africa; 26040, 15410
1615-1634	BBC	From Our Own Correspondent; 21710, 21660, 17830, 15260, 11750
1630-1700	HCJB	Selecciones Interamericanas; 15160
1635-1659	AFRTS	Listen Closely; 15430, 15330, 11805, 9700 (also 2135)
1645-1659	BBC	Letter from America; 21710, 21660, 17830, 15260, 11750
1709-1738	BBC	Meridian; (as above)
1715-1730	R. France Int'l	P.O. Box 9516; 21580, 21515, 17860
1715-1744	BBC	African Perspective or Theatre; 21470
1807-1859	R. Canada Int'l	Bonsoir Africa; 17820, 15260
1830-1900	VOA	Music Time in Africa; 26040, 15600
1830-1959	CBC No. Service	The Entertainers; 11720, 9625
1915-2000	BRT, Belgium	Music Box; Radio World; 17595
2010-2028	Kol Yisrael	Calling All Listeners; DX Corner; 15585, 11640, 15475, 13745
2015-2029	BBC	Letterbox; 15260, 15070, 12095
2030-2120	R. Nederland	The Happy Station; 21685, 17695, 17605, 15220, 9715
2105-2159	CBC No. Service	Drama; 11720, 9625
2113-2128	VOA	Critic's Choice; 26040, 15410, 9760
2115-2159	BBC	The Pleasure's Yours; 15260, 15070, 12095
2115-2159	BBC	Calling the Falklands; 15400, 11820
2200-2230	WINB	Latin Mass; 15185
2209-2238	BBC	Science in Action; 15260, 15070, 12095, 9410
2230-2250	SPLAJOBS	Focus on the Jamahariyah; 11815
2315-2329	BBC	Letter from America; 15260, 9590, 9410, 7325, 6175, 6120, 5975
2330-2400	WRNO	World of Radio; 11855
2330-2400	AFRTS	Hear & Now; 25615, 21570, 15330 (also 0430 Mon.)

MONDAY

0005-0035	R. Japan	Hullo America; 21610, 17825 (also 0150)
0010-0028	Kol Yisrael	Calling All Listeners; DX Corner; 15585, 11640, 9815 (also 0210)
0015-0030	R. Moscow	Moscow Mailbag; 9600 (also 0215)
0015-0030	VOA	Critic's Choice; 17730, 17640, 15205, 9650, 6130, 5995
0015-0055	R. Peking	Music Album; China Anthology; Letterbox; 17855, 17680, 15120 (also 0115, 0215, 0315, 0415)
0030-0115	BRT, Belgium	Music Box; Radio World; 11695
0045-0055	Spanish Foreign R.	DX Program; 11880, 9630 (also 0145 and 0615)
0100-0145	BBC	Features; 15260, 15070, 11335, 9410, 7325, 6175, 6120, 5975
0106-0128	R. Canada Int'l	Shortwave Listeners' Digest; 5960, 11850 (also 0406)
0130-0150	R. Australia	Concert Hall; 21740
0131-0156	Austrian R.	Letter from Austria; Profile; Postbox; 9770, 5945
0135-0159	AFRTS	Face the Nation; 21570; 6030 (also 0635)
0150-0213	Swiss R. Int'l	Various monthly features; 15305, 11715, 9725, 6135 (also 0435)
0200-0257	R. Nacional, Brazil	Sunday Special; 17830, 15290
0210-0228	R. Canada Int'l	Mailbag 5960 (also 0310)
0230-0300	VOA	Studio One; 17730, 15205, 9650, 6130, 5995
0230-0320	R. Nederland	The Happy Station; 9590, 6165 (also 0530)
0239-0244	R. Australia	Australian Perspective; 21740, 17795
0300-0330	Austrian R.	Lieder von Heute; 9770, 5945
0308-0328	R. Budapest	Various features; 11910, 9835, 9585
0330-0345	R. Australia	Spectrum; 17795 (first, third, fifth Sundays)
0330-0359	BBC	Anything Goes; 9410, 6175, 5975
0331-0356	Austrian R.	Letter from Austria; Profile; Postbox; 9770, 5945
0335-0359	AFRTS	Meet the Press; 21570, 6030
0400-0428	R. Budapest	Hungarian History; 11910, 9835, 9585
0431-0449	Austrian R.	Letter from Austria; Shortwave Panorama; 12015
0535-0559	AFRTS	This Week with David Brinkley 6030 (also 1035)
0630-0659	BBC	Man, Myth and Music; 15070, 11955, 9510, 6175
0730-0750	R. Australia	Concert Hall; 11775, 9570
0830-0859	BBC	Anything Goes; 15070, 11955, 9640, 9510
1000-1015	HCJB	Música del Ecuador; 11925, 9745, 6130
1040-1050	R. Korea	Inside North Korea; 9570
1130-1159	BBC	Pageant of the Past; 25650, 21710, 21660, 11750, 9510
1210-1229	R. Finland	Voices of Finland; 15400, 21475 (also 1310, 1410)
1211-1226	R. Moscow	Science & Engineering: 9600
1215-1244	BBC	Quiz program; 21710, 21660, 11775, 11750, 9510
1234-1256	Austrian R.	Profile of Austria; Post Box; 21535
1240-1250	R. Australia	Australian Perspective; 9580, 5995
1315-1340	R. Japan	DX Corner; Crossroads; 9505, 11815
1345-1414	BBC	Documentaries; 21710, 21660, 15070, 11750
1415-1427	CBC No. Service	Steven Freygood's Shortwave Report; 11720, 9625
2130-2159	BBC	London Sinfonietta; 15260, 15070, 12095, 9410
2130-2200	HCJB	DX Party Line; 21477.5, 17860, 15340
2330-2359	BBC	Quiz Program; 15260, 9590, 9410, 7325, 6175, 6120, 5975

(To be continued next month.)

PROJECT OF THE MONTH

Making Your Own Pressure-Sensitive Resistors

By Forrest M. Mims

THE conductive plastic foam that provides anti-static protection for MOS transistors and integrated circuits can be used to make pressure-sensitive resistors. The resistance of these do-it-yourself components can range from several tens of kilohms (no pressure) to a few hundred ohms or less (maximum pressure.)

Figure 1 shows just one of many possible ways to assemble a conductive-foam, pressure-sensitive resistor. The basic resistor is simply a sandwich made by placing copper foil conductors on either end of a conductive-foam cylinder or block. If you prefer, you can add embellishments (such as a plunger and return spring) to enhance the utility of the basic pressure-sensitive resistor.

The resistor can have a diameter ranging from that of a pencil eraser to a silver dollar. Copper foil for making the end contacts is available from hobby and craft shops. If you cannot find the foil, an acceptable substitute is unetched, copper-clad circuit board. In both cases, the copper should be buffed with a pencil eraser to prepare it for soldering. When the surface is shiny (*both* sides if you use foil), solder a length of wrapping or small-diameter hookup wire to each end terminal.

Conductive plastic foam is available from many sources. If you don't happen to have any, try requesting a small piece from an electronics supplier or a firm or university that purchases integrated circuits in volume. Conductive foam and copper foil can be cut with scissors or a hobby knife.

You can make a miniature pressure-sensitive resistor by using a 1/4" mechanical paper punch to cut identical circles of foil and a cylinder of conductive foam. After soldering leads to the foil disks, insert a copper-foam-copper sandwich into a short section of miniature plastic tube like those in which points for lettering pens are sold. Two tiny apertures should be drilled in the side of the tube to provide exit ports for the leads. If you prefer a larger pressure-sensitive resistor, use a sawed off section of a plastic pill bottle and proportionally larger sections of copper and plastic.

Applications for Pressure-Sensitive Resistors. Many applications exist for pressure-sensitive resistors. One possibility is a pressure-sensitive control that functions as a single-axis joystick. Another is a programmable sensor for a weight-sensitive scale. Still another is a simple accelerometer. In this role, a small weight such as a steel nut or lead fishing sinker attached to the upper, moving contact of the pressure-sensitive resistor would provide the necessary mass.

I've devised two simple circuits that illustrate how to use pressure-sensitive resistors in these and other applications. In Fig. 2, the pressure sensitive resistor is connected as the variable time-contant component in a 555-astable-oscillator audio-tone generator. As the pressure on the resistor is increased, its resistance is decreased. This increases the circuit's frequency of oscillation. While this circuit was devised merely to illustrate the use of a pressure-sensitive resistor in a straightforward analog or linear mode, it suggests possible applications in electronic music.

Figure 3 shows how a comparator can be connected to a pressure-sensitive resistor to provide a programmable two-state output. In operation, the switching threshold of the comparator is set by threshold-adjust potentiometer *R3*. Pressure applied to *R1* lowers its resistance, thus increasing the voltage applied to the comparator's noninverting input. When this voltage exceeds the reference voltage determined by *R3*, the comparator output swings to near the positive supply voltage. This turns on *Q1* and illuminates *LED1*.

The circuit in Fig. 3 has practical applications as an input stage to a pressure-sensing logic circuit or microcomputer. Resistor *R3* permits the circuit to be adjusted over a range of sensitivities.

Going Further. Conductive-foam, pressure-sensitive resistors are not as sophisticated as commercial pressure-sensing devices, but they are remarkably cheap and very easy to make. If you would like more information on the subject, Thomas Henry of Transonic Laboratories wrote a brief article entitled "Conductive Foam Forms Reliable Pressure Sensor" In *Electronics* magazine (May 19, 1982, p. 161). ◇

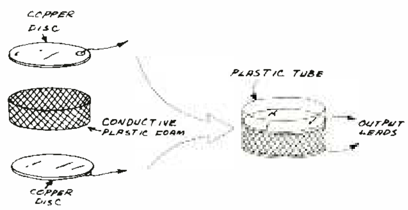

Fig. 1. Pressure-sensitive resistor.

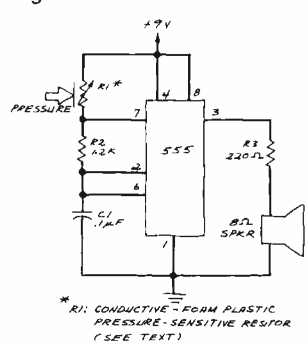

Fig. 2. Tone generator.

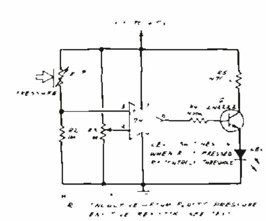

Fig. 3. Pressure-controlled comparator.

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SN7409N	14	.25	SN7485N	16	.59	SN74167N	16	2.79
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SN7413N	14	.35	SN7491N	14	.59	SN74174N	16	.69
SN7414N	14	.49	SN7492N	14	.39	SN74175N	16	.69
SN7416N	14	.25	SN7493N	14	.39	SN74176N	14	.69
SN7417N	14	.25	SN7494N	14	.69	SN74177N	14	.69
SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
SN7421N	14	.35	SN7496N	16	.49	SN74180N	14	.69
SN7422N	14	.45	SN7497N	16	2.75	SN74181N	24	1.95
SN7423N	16	.59	SN74100N	24	1.49	SN74182N	16	.89
SN7425N	14	.29	SN74104N	14	.89	SN74184N	16	1.95
SN7426N	14	.29	SN74105N	14	.89	SN74185N	16	1.95
SN7427N	14	.25	SN74107N	14	.29	SN74190N	16	.69
SN7428N	14	.49	SN74109N	16	.39	SN74191N	16	.69
SN7430N	14	.25	SN74116N	24	1.49	SN74192N	16	.69
SN7432N	14	.29	SN74121N	14	.39	SN74193N	16	.69
SN7437N	14	.25	SN74122N	14	.55	SN74194N	16	.69
SN7438N	14	.29	SN74123N	16	.49	SN74195N	16	.69
SN7439N	14	.59	SN74125N	14	.45	SN74196N	14	.89
SN7440N	14	.19	SN74126N	14	.45	SN74197N	14	.89
SN7441N	16	.89	SN74132N	14	.49	SN74198N	24	1.19
SN7442N	16	.45	SN74136N	14	.49	SN74199N	24	1.19
SN7443N	16	.99	SN74141N	16	.69	SN74221N	16	1.19
SN7444N	16	.99	SN74142N	16	2.95	SN74251N	16	.79
SN7445N	16	.69	SN74143N	24	2.95	SN74276N	20	1.95
SN7446N	16	.69	SN74144N	24	2.95	SN74279N	16	.79
SN7447N	16	.69	SN74145N	16	.59	SN74283N	16	1.49
SN7448N	16	.69	SN74147N	16	1.49	SN74284N	16	2.95
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SN7453N	14	.19	SN74151N	16	.59	SN74366N	16	.55
SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459A	14	.25	SN74153N	16	.59	SN74368N	16	.55
SN7460N	14	.19	SN74154N	24	1.25	SN74390N	16	1.49
SN7470N	14	.29	SN74155N	16	.59	SN74393N	14	1.49

74LS

74LS00	14	.25	74LS92	14	.55	74LS192	16	.79
74LS01	14	.25	74LS93	14	.55	74LS193	16	.79
74LS02	14	.25	74LS95	14	.79	74LS194	16	.69
74LS03	14	.25	74LS96	16	.89	74LS195	16	.69
74LS04	14	.29	74LS107	14	.39	74LS197	14	.79
74LS05	14	.29	74LS109	16	.39	74LS221	16	.89
74LS08	14	.29	74LS112	16	.39	74LS240	20	1.09
74LS09	14	.29	74LS113	14	.39	74LS241	20	1.09
74LS10	14	.29	74LS114	14	.39	74LS242	14	1.09
74LS11	14	.35	74LS122	14	.45	74LS243	14	1.09
74LS12	14	.35	74LS123	16	.79	74LS244	20	1.09
74LS13	14	.39	74LS125	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS126	14	.49	74LS247	16	1.09
74LS15	14	.35	74LS132	14	.59	74LS248	16	1.09
74LS20	14	.29	74LS133	16	.59	74LS249	16	1.09
74LS21	14	.29	74LS136	14	.39	74LS251	16	.59
74LS22	14	.29	74LS138	16	.59	74LS253	16	.59
74LS26	14	.29	74LS139	16	.59	74LS257	16	.59
74LS27	14	.29	74LS151	16	.59	74LS258	16	.59
74LS28	14	.35	74LS153	16	.59	74LS260	14	.59
74LS30	14	.29	74LS154	24	.99	74LS266	14	.59
74LS32	14	.35	74LS155	16	.69	74LS273	20	1.49
74LS33	14	.55	74LS156	16	.69	74LS279	16	.49
74LS37	14	.35	74LS157	16	.69	74LS283	16	.69
74LS38	14	.35	74LS158	16	.59	74LS290	14	.89
74LS40	14	.29	74LS160	16	.69	74LS293	14	.79
74LS42	16	.55	74LS161	16	.69	74LS298	16	.89
74LS47	16	.75	74LS162	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS163	16	.69	74LS353	16	1.29
74LS49	14	.75	74LS164	14	.69	74LS365	16	.49
74LS51	14	.25	74LS165	16	1.19	74LS366	16	.49
74LS54	14	.29	74LS168	16	1.19	74LS367	16	.49
74LS55	14	.29	74LS169	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS170	16	1.49	74LS373	20	1.29
74LS74	14	.39	74LS173	16	.69	74LS374	20	1.29
74LS75	16	.39	74LS174	16	.59	74LS375	16	.69
74LS76	16	.39	74LS175	16	.59	74LS386	14	.45
74LS78	16	.39	74LS181	24	2.49	74LS393	14	1.19
74LS83	16	.65	74LS190	16	.89	74LS399	16	1.49
74LS85	16	.69	74LS191	16	.89	74LS670	16	1.49
74LS86	14	.39				81LS95	20	1.49
74LS90	14	.55				81LS97	20	1.49

74S/PROMS*

74S00	14	.35	74S124	16	2.95	74S243	14	2.49
74S02	14	.35	74S133	16	.45	74S244	20	2.49
74S03	14	.35	74S134	16	.50	74S251	16	1.19
74S04	14	.45	74S135	16	.69	74S253	16	1.19
74S05	14	.45	74S136	14	1.39	74S257	16	1.19
74S08	14	.39	74S138	16	.89	74S258	16	1.19
74S09	14	.39	74S139	16	.89	74S260	14	.79
74S10	14	.35	74S140	14	.55	74S280	14	1.95
74S11	14	.35	74S151	16	.99	74S287*	16	1.95
74S15	14	.35	74S153	16	.99	74S288*	16	1.95
74S20	14	.35	74S157	16	.99	74S373	20	2.49
74S22	14	.35	74S158	16	.99	74S374	20	2.49
74S30	14	.35	74S160	16	2.49	74S387*	16	1.95
74S32	14	.45	74S174	16	.99	74S471*	20	5.95
74S38	14	.89	74S175	16	.99	74S472*	20	4.95
74S40	14	.39	74S188*	16	1.49	74S473*	20	4.95
74S51	14	.35	74S194	16	1.49	74S474*	24	4.95
74S64	14	.39	74S195	16	1.49	74S475*	24	4.95
74S65	14	.39	74S196	14	1.49	74S570*	16	2.95
74S74	14	.55	74S240	20	2.25	74S571*	16	2.95
74S86	14	.55	74S241	20	2.25	74S572*	18	4.95
74S112	16	.55	74S242	14	2.49	74S573*	18	4.95
74S113	16	.55				74S940	20	2.49
74S114	16	.55				74S941	20	2.49

CA—LINEAR

CA3010H		.99	CA3060N	16	3.25	CA3089N	16	1.69
CA3013H		2.15	CA3080E	8	.89	CA3096N	16	1.19
CA3023H		3.25	CA3081N	16	1.49	CA3130E	8	1.49
CA3035H		5.95	CA3082N	16	1.49	CA3140E	8	.99
CA3039H		1.35	CA3083N	16	1.49	CA3160H		1.95
CA3046H	14	.89	CA3086N	14	.89	CA3401N	14	.59
CA3059N	14	3.25				CA3600N	14	3.95

CD—CMOS

CD4000	14	.29	CD4040	16	.79	CD4098	16	1.95
CD4001	14	.29	CD4041	14	.79	CD4506	16	1.19
CD4002	14	.29	CD4042	16	.69	CD4507	14	.39
CD4006	14	.89	CD4043	16	.79	CD4508	24	3.95
CD4007	14	.29	CD4044	16	.79	CD4510	16	.89
CD4009	16	.39	CD4046	16	.89	CD4511	16	.89
CD4010	16	.39	CD4047	14	.89	CD4512	16	.89
CD4011	14	.29	CD4048	16	.39	CD4514	24	1.79
CD4012	14	.25	CD4049	16	.39	CD4515	24	1.79
CD4013	14	.39	CD4050	16	.39	CD4516	16	.99
CD4014	16	.79	CD4051	16	.79	CD4518	16	.99
CD4015	16	.39	CD4052	16	.79	CD4519	16	.39
CD4016	14	.39	CD4053	16	.79	CD4520	16	.79
CD4017	16	.75	CD4056	16	2.95	CD4526	16	1.19
CD4018	16	.79	CD4059	24	7.95	CD4528	16	1.19
CD4019	16	.39	CD4060	16	.89	CD4529	16	1.19
CD4020	16	.75	CD4066	14	.39	CD4543	16	1.19
CD4021	16	.79	CD4068	14	.39	CD4562	14	6.95
CD4022	16	.79	CD4069	14	.29	CD4566	16	1.39
CD4023	14	.29	CD4070	14	.39	CD4583	16	2.49
CD4024	14	.69	CD4071	14	.29	CD4584	14	.59
CD4025	14	.23	CD4072	14	.29	CD4723	16	1.19
CD4026	16	2.49	CD4073	14	.29	CD4724	16	1.19
CD4027	16	.45	CD4075	14	.29	MC14409	16	13.95
CD4028	16	.69	CD4076	16	.79	MC14410	16	13.95
CD4029	16	.79	CD4078	14	.49	MC14411	24	11.95
CD4030	14	.39	CD4081	14	.29	MC14412	16	13.95
CD4034	24	1.95	CD4082	14	.29	MC14419	16	7.95
CD4035	16	.89	CD4093	14	.49	MC14433	24	13.95
						MC14538	16	1.19
						MC14541	14	1.19

(More in Catalog)

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock (65K bytes mem.)	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bits Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-PIO	40	Parallel I/O Interface Controller	5.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-S10/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-PIO	40	Parallel I/O Interface Controller	5.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-S10/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-PIO	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC68308	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

8080A SERIES

INS8080A	40	CPU	3.95
INS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	6.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

MICROPROCESSOR MANUALS & DATA BOOKS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
10400	1982 Intel Data Book (1405 pg.)	14.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (640 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

DYNAMIC RAMS

Part No.	**Pins	Function	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1 (200ns)	7.49 - 8/54.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	22	2048x1 (365ns)	.49 - 8/1.95
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	2.95
2114	18	1024x4 (450ns)	1.95 - 8/13.95
2114L	18	1024x4 (450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4 (200ns)	2.25 - 8/15.95
2114L-2	18	1024x4 (200ns) L.P.	2.49 - 8/17.95
2141-3	18	4096x1 (150ns)	3.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	8.95
TMS4044	18	4096x1 (450ns)	3.95
TMS4045	18	1024x4 (450ns)	3.95
5101	22	256x4 (450ns) CMOS	4.95
MM5257	18	4096x1 (450ns) 4044	3.95
HM6116P-3	24	2048x8 (150ns) CMOS	7.95
HM6116-4	24	2048x8 (200ns) CMOS	6.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	7.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns) CMOS (6551)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

EPROMS

1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	6.95
TMS2532	24	4096x8 (450ns) NMC2532	9.95
TMS2564	28	8192x8 (450ns)	19.95
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	6.95
2732	24	4096x8 (450ns)	9.95
27580	24	1024x8 (450ns) single +5V	2.95
MM2764	28	8192x8 (450ns)	16.95
MM2764-3	28	8192x8 (300ns)	19.95

PROMS

74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S478	24	1024x8 PROM T.S. (TBP28S86)	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	4.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x8 PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	19.95

DATA ACQUISITION

DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8 Ch. Multi.)	4.49
AY-5-1013A	40	30K BAUD UART (TR1602)	4.95

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No.	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	6.95

Accessories

DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No.	Cnts.	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	.156	Solder Eyelet	2.49
22/44PC	22/44	.156	PC type (no mtg. ears)	.99
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No.	Description	Price
PL259	UHF Plug	$ .89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adapter	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-999
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

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WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-9	10-99	100-999
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
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40 pin WW	1.99	1.89	1.79

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*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD	16.95
7117CPL	40	3½ Digit A/D LED Dis. HLD	15.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7208IPI	28	Seven Decade Counter	15.95
7209IPA	8	Clock Generator	3.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95
7240IJE	16	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	8	CMOS Divide-by-256 RC Timer	2.25
7250IJE	16	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	16	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	8	CMOS 555 Timer	1.45
7556IPD	14	CMOS 556 Timer	2.20
7611BCPA	8	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	8	CMOS Op Amp Ext. Cmvr 5MV	2.95
7621BCPA	8	CMOS Dual Op Amp Comp 5MV	3.95
7631CCPE	16	CMOS Tri Op Amp Comp 10MV	5.35
7641CCPD	14	CMOS Quad Op Amp Comp 10MV	7.50
7642CCPD	14	CMOS Quad Op Amp Comp 10MV	7.50
7660CPA	8	Voltage Converter	2.95
8038CCPD	14	Waveform Generator	3.95
8048CCPE	16	Monolithic Logarithmic Amp	16.95
8069CCQ		50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	8	Volt Ref./Indicator	2.95
8212CPA	24	Volt Ref./Indicator	2.95
30009		1983 Intersil Data Book (1356 pages)	$9.95

74C—C/MOS

74C00	14	.35	74C95	14	1.39	74C221	16	1.95
74C02	14	.35	74C107	14	.89	74C240	20	1.95
74C04	14	.29	74C151	16	2.49	74C244	20	1.95
74C08	14	.35	74C154	24	3.49	74C373	20	2.49
74C10	14	.35	74C157	16	2.25	74C374	20	2.49
74C14	14	.59	74C160	16	1.19	74C901	14	.59
74C20	14	.35	74C161	16	1.19	74C903	14	.59
74C30	14	.35	74C162	16	1.19	74C906	14	.59
74C32	14	.39	74C163	16	1.19	74C911	28	8.95
74C42	16	1.39	74C164	14	1.49	74C912	28	8.95
74C48	16	1.95	74C173	16	.79	74C915	18	1.19
74C73	14	.79	74C174	16	1.19	74C917	28	8.95
74C74	14	.69	74C175	16	1.19	74C922	18	4.49
74C85	16	1.95	74C192	16	1.49	74C923	20	4.95
74C86	14	.39	74C193	16	1.69	74C925	16	5.95
74C89	16	5.95	74C195	16	1.39	74C926	18	5.95
74C90	14	1.19				80C95	16	.39
74C93	14	1.19				80C97	16	.39

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.75	74HC138	16	1.49	74HC243	14	2.79
74HC02	14	.75	74HC139	16	1.49	74HC251	16	1.19
*74HCU04	14	.75	74HC147	16	1.19	74HC266	14	.99
74HC08	14	.75	74HC151	16	1.19	74HC280	14	4.95
74HC10	14	.75	74HC157	16	1.19	74HC373	20	3.95
74HC20	14	.75	74HC160	16	1.79	74HC374	20	3.95
74HC27	14	.75	74HC161	16	1.79	74HC533	20	3.95
74HC74	14	.99	74HC164	14	1.79	74HC534	20	3.95
74HC75	16	.99	74HC174	16	1.39	74HC4075	14	.75
74HC86	14	.99	74HC175	16	1.39	74HC4538	16	2.95
74HC109	16	1.39	74HC242	14	2.79	74HC4543	16	4.95

*74HCU04 is unbuffered. All others are buffered. **Send $.30 for Data Sheet.**

Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$5.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	5.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	9.95
30012		1982 National PAL Data Book (176 pages)	$5.95

LINEAR

TL071CP	8	.79	LM340K-15		1.35	NE570N	16	3.95
TL072CP	8	1.39	LM340T-5		.79	LM703CN	8	1.19
TL074CN	14	1.95	LM340T-12		.79	LM709N	14	.49
TL081CP	8	.59	LM340T-15		.79	LM710N	14	.69
TL082CP	8	1.19	LM348N	14	.99	LM711N	14	.79
TL084CN	14	1.95	LM350K		4.95	LM723N	14	.55
LM301CN	8	.35	LF355N	8	1.10	LM733N	14	1.00
LM302H		1.95	LF356N	8	1.10	LM739N	14	1.95
LM304H		1.95	LM370N	14	4.49	LM741CN	8	.35
LM305H		.99	LM373N	14	3.95	LM747N	14	.69
LM307CN	8	.45	LM377N	14	1.95	LM748N	8	.59
LM308CN	8	.69	LM380N	14	.89	LM1310N	14	1.49
LM309K		1.25	LM381N	14	1.79	LM1458CN	8	.59
LM310CN	8	1.75	LM382N	14	1.39	LM1488N	14	.69
LM311CN	8	.69	LM384N	14	1.79	LM1489N	14	.69
LM312H		2.49	LM386N-3	8	.89	LM1496N	14	.95
LM317T		1.19	TL494CN	16	2.95	LM1800N	16	1.49
LM317K		3.95	TL496CP	8	1.49	LM1889N	18	1.95
LM318CN	8	1.95	NE510A	14	4.95	LM1896N	14	2.95
LM319N	14	1.95	NE529A	14	2.95	LM2002T		1.49
LM320K-5		1.35	NE531V	8	2.95	LM3189N	16	1.59
LM320K-12		1.35	NE536H		8.95	LM3900N	14	.59
LM320K-15		1.35	NE540H		4.95	LM3905CN	8	1.19
LM320T-5		.89	NE544N	14	2.95	LM3909N	8	.99
LM320T-12		.89	NE550A	14	1.95	LM3914N	18	3.49
LM320T-15		.89	NE555V	8	.35	LM3915N	18	3.49
LM323K		5.95	NE556N	14	.69	LM3916N	18	3.49
LM324N	14	.59	NE564N	16	2.95	RC4136N	14	1.25
LM337T		1.95	NE565N	14	1.19	RC4151NB	8	1.95
LM338K		6.95	LM566CN	8	1.49	ICL8038B	14	3.95
LM339N	14	.69	LM567V	8	.89	LM13080N	8	1.19
LM340K-5		1.35				LM13600N	16	1.19
LM340K-12		1.35				MORE AVAILABLE		

CAPACITOR CORNER

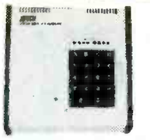
50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

JE600 Hexadecimal Encoder Kit



FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only – 3½"Hx8¼"Wx8¾"D) **$44.95**

JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) ... **$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) .... **$ 79.95**
K62 62-Key Keyboard (Keyboard only) .... **$ 34.95**
DTE-AK (case only – 3¾"Hx11"Wx8¾"D) **$ 49.95**

NEW! **JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT** Kit/ Provides -12VDC from incoming 5VDC .. **$9.95**

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply) 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) .. $24.95
(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) .. **$14.95**
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V .. **$12.95**
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp .. **$19.95**

HP-Display Sale-National

5082 Series — 0.43 Inch — 7-Segment

Part Number	Color	Description	1-3 Price	SALE PRICE
5082-7650	Hi Eff Red	CA - LHD	.99	4/$2.49
5082-7651	Hi Eff Red	CA - RHD	.99	4/$2.49
5082-7653	Hi Eff Red	CC - RHD	.99	4/$2.49
5082-7656	Hi Eff Red	Overflow ±1RHD	.99	4/$2.49
5082-7660	Yellow	CA - LHD	.99	4/$2.49
5082-7661	Yellow	CA - RHD	.99	4/$2.49
5082-7663	Yellow	CC - RHD	.99	4/$2.49
5082-7670	Green	CA - LHD	.99	4/$2.49
5082-7671	Green	CA - RHD	.99	4/$2.49
5082-7673	Green	CC - RHD	.99	4/$2.49
5082-7676	Green	Overflow ±1RHD	.99	4/$2.49
5082-7750	Red	CA - LHD	.99	4/$2.49
5082-7751	Red	CA - RHD	.99	4/$2.49
5082-7756	Red	Overflow ±1RHD	.99	4/$2.49
5082-7760	Red	CC - RHD	.99	4/$2.49

CA-Comm. Anode CC-Comm. Cathode LHD/RHD-Left/right hand dec.

UTIC
Mini Stereo AM/FM Receiver

CLOSE-OUT!

WITH HEADPHONES
For Joggers, Cyclists, Skaters & Sports Events

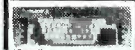
FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅞" x 4⅞" x 1". Wt. 6 oz.

Model 2830 .... $29.95

KEYBOARDS — POWER SUPPLIES

16⅜"L x 5½"W x 1⅞"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 with Pin Connection.
Part No. KB69SD12-2 (Fits into DTE-20 Enclosure) .... $19.95 each



16¼"L x 5½"W x 1⅞"H

DATANETICS 74-KEY KEYBOARD
ASCII Encoded Keyboard, Output: Even Parity ASCII, Supply voltage +5, -12 volt. Switching: Mechanical SPST — 50-pin Connection. Complete with Pin Connection.
Part No. KB354 (Fits into DTE-20 Enclosure) .... $29.95 each

23"Lx5¾"Wx1-3/8"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

18¼"L x 5¾"W x 1⅝"H

MICRO SWITCH 88-KEY KEYBOARD (PARALLEL)
Data Entry Keyboard used in a Diablo 1640 Terminal. Supply Voltage: +5V, -12V. Switching: Hall Effect — 10-pin Edge Card Connection. Schematic included. Uses 8048 Encoder Chip.
Part No. 88SD22 (Fits into DTE-20 Enclosure) .... $69.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED Transaction Tech
Output +5VDC @ 1 amp (also +30VDC) reg. Input 115VAC 60Hz. Two-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. Size: 6½"W x 7"D x 2¼"H. Wt. 3 lbs.
Part No. PS51194 .... $19.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED B Industries
Output +5VDC @ 1 amp, +36-42VDC adj. 400mA or less, 30VAC (isol.) @ 1.5 amp. Input 115VAC 60Hz. Circ. brkr. re-set button. Blk. self-encl. case w/4 rubber feet. 6 ft., 3 cond. blk. pow. cord. On/off switch. 6¾"W x 7¾"D x 3-7/8"H - wt. 7 lbs.
Part No. PS4070 .... $24.95 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.
Part No. QPS-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 @ 7.5 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.
Part No. PS94V0 .... $49.95 each

MULTI-VOLTAGE POWER SUPPLY — +5, +12, −12VDC REG.
Input: 105-125VAC, 47-63Hz/205-250VAC, 47-63Hz. Output: +5VDC @ 2 amps Adj., 5VDC @ 50mA Fixed, +12VDC @ 1 amp Adj., −12V @ 2 amp adj. Overvoltage protection. Size: 12⅛"L x 4-7/8"W x 3⅜"D.
Part No. RA0250 .... $39.95 each

SORENSEN Regulated Power Supplies

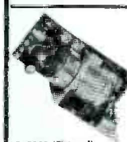
SOC 2-6 (Pictured)

Sorensen's open construction (SOC) power supplies are series-regulated solid-state systems, designed to provide reg. DC voltages at 6 levels (2-28 v/range). These units are open-framed on sturdy black anodized aluminum for excellent mounting.

FEATURES: 115/208/230VAC Input @ 50-63Hz. Low Ripple: 1.5mVrms, 5mV P-P maximum. Adjustable current limit. Voltage adjustment control. All schematics and specifications supplied with unit. Series A,B,C,E have three mounting surfaces (Series F, bottom mounting only).

Part No	Series	Output Voltage Adjustment Range min.	max.	Output Current amps (Adc) @40°C	@50°C	@60°C	Size (Inches)	Weight	Price
SOC 2-6	B	1.9	2.1	6.0	4.9	3.8	5.62 x 4.88 x 2.50	4.3 lbs.	$19.95
SOC 2-25	F	1.9	2.1	26.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	28.95
SOC 5-18	E	4.25	5.25	18.0	15.0	12.0	14.00 x 4.88 x 2.75	12 lbs.	39.95
SOC 5-25	F	4.25	5.25	26.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	48.95
SOC 12-11	E	11.4	12.6	11.0	9.2	6.8	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC 12-15	F	11.4	12.6	15.0	12.75	9.5	16.00 x 4.88 x 4.88	16 lbs.	48.95
SOC15-5	C	14.25	15.75	5.0	4.2	3.5	7.00 x 4.88 x 3.37	6.6 lbs.	30.95
SOC 15-9.5	E	14.25	15.75	9.5	7.8	6.6	14.00 x 4.88 x 1.62	12. lbs.	44.95
SOC 15-13	F	14.25	15.75	13.0	10.5	8.0	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 28-0.8	A	26.6	29.4	0.8	.64	.45	4.00 x 4.88 x 1.62	2 lbs.	24.95

Powertec Sub-Modular DC Power Supplies



22D300 (Pictured)

SM Series power supplies include rectifying, filtering, regulating, overload and overvoltage protection functions. You need only connect the sub-module to the appropriate secondary transformer tap and bolt the unit to a heatsink.

REGULATION: LINE; .10% for a change from -10% to +10% input voltage. LOAD; .15% for a 0-100% load change (units below 5V output maintain 5V regulation). OUTPUT RIPPLE: 1mV RMS, 3mV P-P typical, 5mV P-P maximum. INPUT CHARACTERISTICS: Requires low-level AC input. Derate output current 15% for operations at 50Hz.

Part Number	-100 *4.75V to 7.0V	-200 *7.0V to 10.5V	-300 *10.5V to 15.75V	-500 *22.0V to 30.0V	Power Transformer Requirements (Transformers Not Included) Primary	Secondary	Size (Inches)	Wt.	Price
22AA-300			0.23A		115–120VAC	17VAC .5A no CT	2.50 x 3.00 x .98	2 oz	$14.95
22B-200		2.2A			115–120VAC	22VAC .3A w/CT	3.00 x 5.75 x 1.18	8 oz	14.95
22B-300			1.7A		115–120VAC	28VAC 2.5A w/CT	2.75 x 5.75 x 1.18	8 oz	19.95
22C-100	6.0A				115–120VAC	16VAC 8A w/CT	2.80 x 7.50 x 1.18	8 oz	24.95
22C-500				2.5A	115–120VAC	48VAC 3A w/CT	2.80 x 7.50 x 1.18	8 oz	24.95
22D-300			6.8A		115–120VAC	28VAC 10A w/CT	3.00 x 7.00 x 3.30	2 lbs	24.95
22E-100	18.00A				115–120VAC	16VAC 24A w/CT	2.90 x 7.00 x 3.30	2 lbs	29.95

*Voltage Adjustment Range — Current ratings apply over entire voltage range.

★ SHIPMENT IN 24 HOURS ★
7:00AM to 5:00PM (PST)
Call: (415) 592-8097

MONDAY THRU FRIDAY — NEW HOURS

JUMPER AND CABLE ASSEMBLIES

Custom Jumpers! *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications

JAMECO Part No	AP Cross-Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102 12	14	single end	12"	$1.79
DJ14-2	924102 24	14	single end	24"	2.05
DJ14-3	924102 36	14	single end	36"	2.35
DJ14-1-14	924106 12	14	double end	12"	3.20
DJ14-2-14	924106 24	14	double end	24"	3.49
DJ14-3-14	924106 36	14	double end	36"	3.79
DJ16-1	924112 12	16	single end	12"	1.85
DJ16-2	924112 24	16	single end	24"	2.19
DJ16-3	924112 36	16	single end	36"	2.59
DJ16-1-16	924116 12	16	double end	12"	3.35
DJ16-2-16	924116 24	16	double end	24"	3.69
DJ16-3-16	924116 36	16	double end	36"	4.05
DJ24-1	924122 12	24	single end	12"	2.69
DJ24-2	924122 24	24	single end	24"	3.39
DJ24-3	924122 36	24	single end	36"	3.95
DJ24-1-24	924126 12	24	double end	12"	4.79
DJ24-2-24	924126 24	24	double end	24"	5.29
DJ24-3-24	924126 36	24	double end	36"	5.89

JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ40-1	924132 12	40	single end	12"	5.89
DJ40-2	924132 24	40	single end	24"	6.79
DJ40-3	924132 36	40	single end	36"	7.69
DJ40-1-40	924136 12	40	double end	12"	10.95
DJ40-2-40	924136 24	40	double end	24"	11.89
DJ40-3-40	924136 36	40	double end	36"	12.79

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Part No.	Cable Length	Connectors	Price
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DB25S-4	4 feet	1-DB25S	10.95 ea.
DB25P-4-P	4 feet	2-DB25P	16.95 ea.
DB25P-4-S	4 feet	1 DB25P/1 DB25S	17.95 ea.
DB25S-4-S	4 feet	2-DB25S	18.95 ea.

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11/82

5¼" Mini-Floppy Disc Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I (Industry Standard)
Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6 amps max., +5VDC (±0.25V) 0.8 amps max. Unit as pictured at left (does not incl. case, power supply or cables). 30-page data book included. Weighs 3½ pounds. Size: 5¾"W x 8"D x 3¼"H

Limited Quantity!

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

EXPAND YOUR 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-80 16K Conversion Kit

Kit comes complete with 8 each MM5290 (UPD416/4116) 16K Dynamic RAM (*ns) and documentation for conversion.

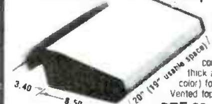
TRS-16K2 *150ns $14.95
TRS-16K3 *200ns $12.95
TRS-16K4 *250ns $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 ea. 4164-2 (200ns) 64K Dyn. RAMs & conversion documentation. Converts TRS-80 color computers from 4K-32K Memory or 16K-64K Memory.

TRS-64K2 (200ns) $54.95

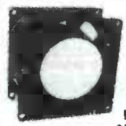
Universal Computer Keyboard Enclosure



"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.

DTE-20 Panel width 20" $39.95

Sprite-style Fan

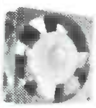


- 36cfm free air delivery
- 3.125" sq. x 1.665" depth
- 10 yrs. cont. duty at 20°C
- 115V 50/60Hz
- For Apple users

Metal Frame

PWS2107U Cleaned & tested (used) .... $ 9.95 ea.
*PWS2107F New .... $14.95 ea.

Muffin-style Fan



- 105cfm free air delivery
- 4.68" sq. x 1.50" depth.
- 10 yrs. cont. duty at 20°C
- Impedance protected, ambients to 70°C
- 115V 50/60Hz 14W Wt. 17 oz.

Metal Frame

MU2A1-U Cleaned & tested (used) .... $9.95 ea.
*MU2A-1N New .... $14.95 ea.

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

UV-EPROM Eraser

8 Chips — 51 Minutes

1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

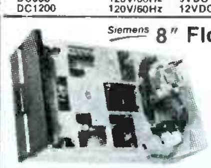
UVS-11EL Replacement Bulb $16.95
DE-4 UV-EPROM Eraser $79.95

AC250 (Pictured)

Wall Transformers AC and DC Types

Part No.	Input	Output	Price
AC 250 (above)	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
AC9004	117V/60Hz	9.2VAC 2.5 amp	$2.95 or 2/$4.95
DC 800	120V/60Hz	8VDC 400mA	$1.95 or 2/$2.95
DC6912	120V/60Hz	6,9,12VDC 300mA	$9.95
DV5490	117V/60Hz	9.5VDC 275mA	$2.49 or 2/$3.95
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95 or 2/$4.95

Siemens 8" Floppy Disk Drive



- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or equivalent disk cartridge. A hard-sectored option is available. Power: 115/230VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs.

Part No.		Price
FDD100-8	Buy 1 for	$299.95 each
FDD100-8	Buy 2 for	$279.95 each
FDD100-8	*Buy 10 for*	*$249.95 each*

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TMM2016 2KX8 STATIC 200 NS $4.15

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STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	1.29
2102L-2	1024 x 1	(250ns) (LP)	1.69
2111	256 x 4	(450ns)	2.99
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/14.95
2114L-4	1024 x 4	(450ns) (LP)	8/15.25
2114L-3	1024 x 4	(300ns) (LP)	8/15.45
2114L-2	1024 x 4	(200ns) (LP)	8/15.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.95
HM6116-3	2048 x 8	(150ns) (cmos)	5.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	6.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	8.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/11.95
4116-200	16384 x 1	(200ns)	8/13.95
4116-150	16384 x 1	(150ns)	8/15.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4816	2048 x 8	(300ns) (5v)	24.95
4164-200	65536 x 1	(200ns) (5v)	6.25
4164-150	65536 x 1	(150ns) (5v)	7.25

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	6.25
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	7.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	12.95
2732-200	4096 x 8	(200ns) (5v)	16.95
2764	8192 x 8	(450ns) (5v)	16.95
2764-250	8192 x 8	(250ns) (5v)	18.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	24.95
MC68764	8192 x 8	(450ns) (5v)(24 pin)	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

DISC CONTROLLERS

1771	16.95
1791	29.95
1793	38.95
1795	54.95
1797	54.95
6843	34.95
8272	39.95
UPD765	39.95
1691	18.95
2143	18.95

INTERFACE

8T26	1.69
8T28	2.49
8T95	.99
8T96	.99
8T97	.99
8T98	.99
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

SOUND CHIPS

76477	3.95
76489	8.95
AY3-8910	12.95
MC3340	1.49

CRT CONTROLLERS

6845	14.95
68B45	35.95
HD46505SP	15.95
6847	12.25
68047	24.95
8275	29.95
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CRT5027	39.95
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BR1941	11.95
4702	12.95
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COM8116	10.95
MM5307	10.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	14.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
74C922	See 74C00
74C923	Series Prices

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	5.95
Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	5.75
Z80-SIO/0	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	6.00
Z80A-CTC	8.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/0	22.50
Z80A-SIO/1	22.50
Z80A-SIO/2	22.50
Z80A-SIO/9	19.95

6.0 Mhz

Z80B-CPU	17.95
Z80B-CTC	15.50
Z80B-PIO	15.50

ZILOG

Z6132	34.95
Z8671	39.95

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2.0	3.95
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3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
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6.144	3.95
6.5536	3.95
8.0	3.95
10.7836	3.95
14.31818	3.95
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16.0	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
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ADC0809	4.49
ADC0817	9.95
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DAC0806	1.95
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8156	8.95
8185	29.95
8185-2	39.95
8741	39.95
8748	29.95
8755	32.00

8200

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8203	39.95
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8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8238	4.49
8243	4.45
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8251	4.49
8253	6.95
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8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
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8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
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LM566	1.49
XR2206	3.75
8038	3.95

INTERSIL

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ICL7106	9.95
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ICL8038	3.95
ICM7107A	5.59
ICM7208	15.95

6800

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6800	4.95
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6808	13.90
6809E	19.95
6809	12.95
6810	2.95
6820	4.95
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	12.25
6850	3.45
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6862	11.95
6875	6.95
6880	2.25
6883	24.95
68047	24.95
68488	19.95

6800 = 1MHZ

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68B02	22.25
68B09E	29.95
68B09	29.95
68B10	7.95
68B21	12.95
68B45	35.95
68B50	12.95

68B00 = 2 MHZ

6500

1 MHZ

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6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	8.75
6532	11.25
6545	22.50
6551	11.85

2 MHZ

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6502B	14.95

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Classified Adv'tng Cont'd from pg 138

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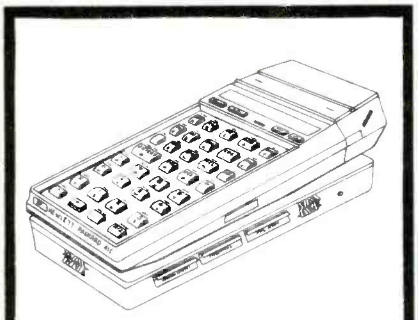

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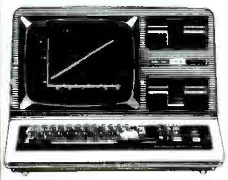

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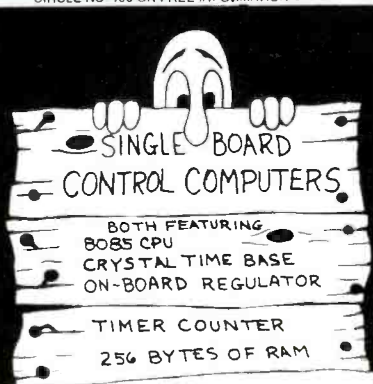

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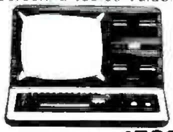

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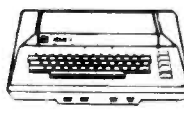

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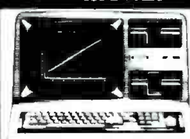

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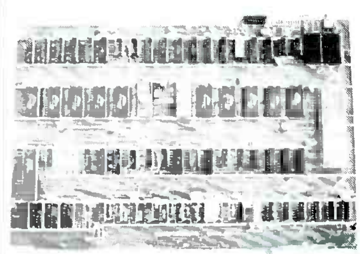

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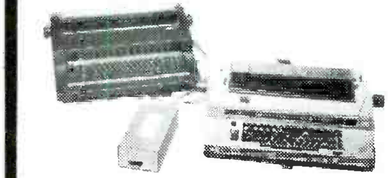

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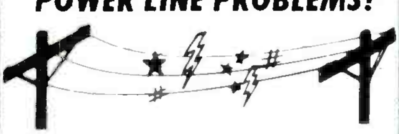

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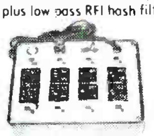

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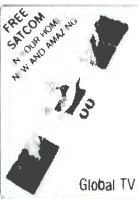

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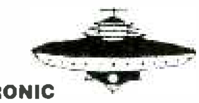

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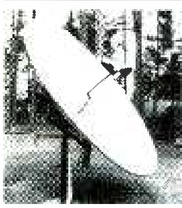

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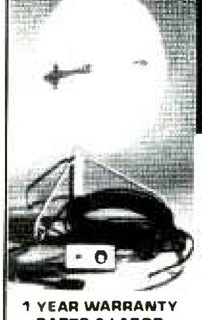

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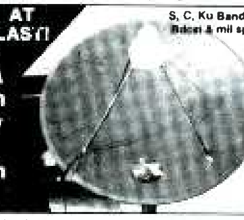

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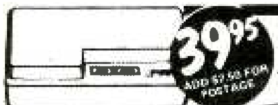

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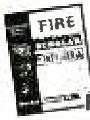

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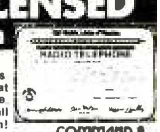

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