

Computers & Electronics

NOVEMBER 1982

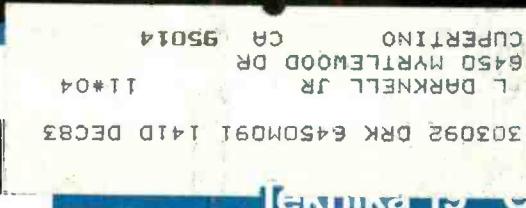
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formerly Popular Electronics

- Computer Clones
- Automatic Video Game/TV Antenna Switching
- How To Print Computer Graphics

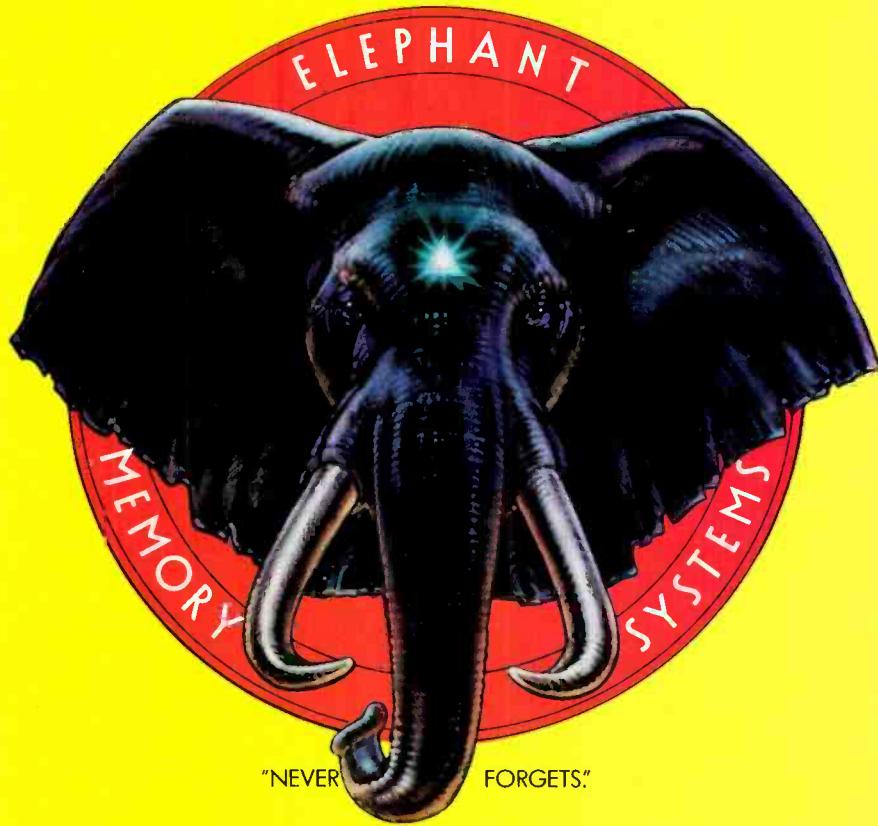


Polish Your
Apple with a
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This Issue:
Car-Tracking Turntable
Integrated Stereo Amplifier
Color TV Monitor

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Says who? Says ANSI.

Specifically, subcommittee X3B8 of the American National Standards Institute (ANSI) says so. The fact is all Elephant™ floppies meet or exceed the specs required to meet or exceed all their standards.

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PHM 2300	P.C. Color Graphics Adapter	699.95	500.00
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PHM 2010	Monitor Cable	14.95	11.00
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PHM 2310	Panasonic VCR Controller Cables	99.95	84.00
PHM 2320	Sony Video Controller Cables	99.95	85.00
PHM 2330	Pioneer Video Controller Cables	99.95	85.00
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PHM 3006	Home Financial Decisions	29.95	21.00
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PHM 3012	Securities Analysis	54.95	44.00
PHM 3013	Personal Record Keeping (Data storage system is recommended)	49.95	44.00
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)	99.95	75.00
PHM 3111	Microsoft® Multiplan®	99.95	75.00
PHM 3113	DOSS® Memory Expansion required)	99.95	75.00
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PHM 5002	Personal Financial Aids	19.95	14.00
PHM 5021	Checkbook Register	19.95	14.00
PHM 5022	Business Aids Library—Finance Management (Extended BASIC Command Module is required)	39.95	32.00
PHM 5024	Business Aids Library—Inventory Management (Personal Record Keeping or Statistics Command Module is required)	69.95	56.00
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PHM 5029	Business Aids Library—Management (Personal Record Keeping or Statistics Command Module is required)	69.95	56.00
PHM 5030	Business Aids Library—Marketing (Personal Record Keeping or Statistics Command Module is required)	39.95	32.00
PHM 5032	Business Aids Library—Purchase Decisions	69.95	56.00
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PHM 6003	Personal Financial Aids	14.95	12.00
PHM 6036	Business Aids Library—Lease/Purchase Decisions	59.95	45.00
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PHM 3043	Reading Fun (Solid State Speech™ Synthesizer is recommended)	54.95	44.00
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PHM 3049	Division I (Solid State Speech™ Synthesizer is recommended)	39.95	32.00
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PHM 3062	Scholastic Spelling—Level 6 (Solid State Speech™ Synthesizer is required)	59.95	48.00
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PHM 3088	Computer Math Games VI	39.95	32.00
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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
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PHM 5001	Teach Yourself BASIC	34.95	28.00
PHM 5009	Music Skills Trainer	29.95	24.00
PHM 5011	Computer Music Box	19.95	16.00
PHM 5018	Computer Music Box II	19.95	16.00
PHM 5019	Teach Yourself Extended BASIC (Extended BASIC Command Module is required)	24.95	20.00
PHM 5020	Music Master (Extended BASIC Command Module is required)	24.95	20.00
PHM 5023	Basketball Statistics Extended BASIC Command Module is required)	24.95	20.00
PHM 5026	Bridge Bidding II	29.95	24.00
PHM 5030	Speak & Spell™ Program (Solid State Speech™ Synthesizer and Terminal Emulator II are required)	29.95	24.00
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PHM 5067	Math Practice™ (Extended BASIC Command Module is required)	29.95	24.00
PHM 5084	Math Practice™ (Extended BASIC Command Module is required)	29.95	24.00
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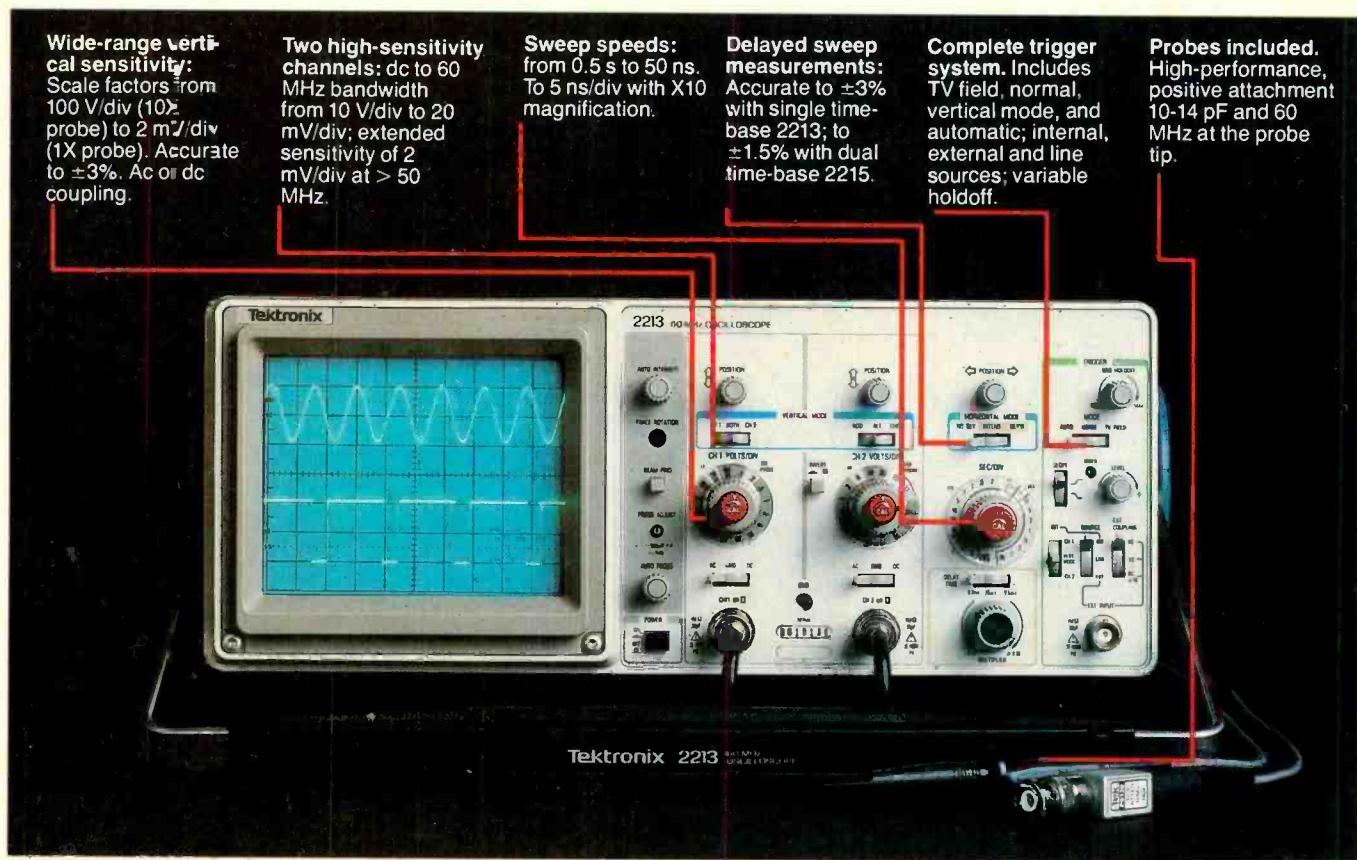
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PHM 5086	Extended BASIC Command Module is required)	29.95	24.00
PHM 5087	Social Science™ (Extended BASIC Command Module is required)	29.95	24.00
PHM 5088	Teacher's Tool Box (Extended BASIC Command Module and printer are required)	29.95	24.00
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PHM 6007	Superior BASIC	29.95	24.00
PHM 6009	Muscle Trainer	24.95	20.00
PHM 6011	Computer Music Box	14.95	12.00
PHM 6013	Music Box	14.95	12.00
PHM 6019	Teach Yourself Extended BASIC Command Module is required)	19.95	16.00
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PHM 6042	Bridge Bidding II	24.95	20.00
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PHM 3058	Alpen II	39.95	32.00
PHM 3059	Blastoff!	24.95	20.00
PHM 3060	Blaze and Power II	24.95	20.00
PHM 3061	Blackout	24.95	20.00
PHM 3062	ZeroZap II	24.95	20.00
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PHM 3064	Hangman II	19.95	16.00
PHM 3065	Yankee II	24.95	20.00
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PHM 3032	Blastoff!	24.95	20.00
PHM 3033	Blackout	24.95	20.00
PHM 3034	Hangman II	24.95	20.00
PHM 3035	ZeroZap II	24.95	20.00
PHM 3036	Hangman II	24.95	20.00
PHM 3037	Hangman II	19.95	16.00
PHM 3038	Yankee II	24.95	20.00
Adventure International Packages (Developed by Scott Adams)			
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PHM 3042	Adventureland	19.95	16.00
PHM 3043	Adventureland	19.95	16.00
PHM 3044	Adventureland	19.95	16.00
PHM 3045	Adventureland	19.95	16.00
PHM 3046	Adventureland	19.95	16.00
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PHM 3048	Adventureland	19.95	16.00
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PHM 3057	Adventureland	19.95	16.00
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PHM 5010	Oldies But Goodies—Games I	14.95	12.00
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PHM 5072	Adventureland	24.95	20.00
PHM 5073	Adventureland	24.95	20.00
PHM 5074	Adventureland	24.95	20.00
PHM 5075	Adventureland	24.95	20.00
PHM 5076	Adventureland	24.95	20.00
PHM 5077	Adventureland	24.95	20.00
PHM 5078	Adventureland	24.95	20.00
PHM 5079	Adventureland	24.95	20.00
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PHM 5082	World Geography (Extended BASIC Command Module is required)	29.95	24.00
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NOVEMBER 1982
VOLUME 20, NUMBER 11

FEATURE ARTICLES

COMPUTER CLONES/ <i>Stan Veit</i>	64
A comparison of computer variations to their originals.	
PRINTING COMPUTER GRAPHICS/ <i>Stan Veit</i>	79
How to use high-resolution graphics software plus a review of packages available.	
THE 68000/ <i>Hunter Scales</i>	96
A powerful 16-bit microprocessor chip with many applications.	
THE 3" VS. 3½" MINIFLOPPY BATTLE/ <i>Les Solomon</i>	94
Sony's 3½" and Amdek's 3" disks against the standard floppies.	

CONSTRUCTION ARTICLES

POLISH YOUR APPLE WITH A LUMINANCE BOARD/ <i>Ray Dahlby</i>	42
Add-on board generates 16 shades of color or black/gray on video screen.	
STILL USING A "MODEL T" TV/GAME ANTENNA SWITCH?/ <i>Gary Kloesz</i>	53
An electronic circuit switches from a TV antenna input to video game or computer and back.	
BUILD THE MAIL-BOX SENTRY/ <i>Les Svoboda</i>	76
LED and tone indicators announce mail arrival.	

EQUIPMENT REVIEWS

TEKNIKA ATV-M19 19" COLOR TV MONITOR	14
TECHNICS MODEL SL-5 LINEAR TRACKING TURNTABLE	26
MCINTOSH MODEL MA6200 INTEGRATED STEREO AMPLIFIER	40

COLUMNS

LES SOLOMON ON COMPUTER HARDWARE	22
STAN VEIT ON COMPUTER SOFTWARE	24
COMPUTER HOTLINE/ <i>Stan Veit</i>	102
SOLID-STATE DEVELOPMENTS/ <i>Forrest M. Mims</i>	104
A Universal Active Filter Breakthrough.	
COMPUTER BITS/ <i>Carl Warren</i>	108
Notes on Using Your System as a Secretary.	
EXPERIMENTER'S CORNER/ <i>Forrest M. Mims</i>	111
Experimenting with Kodak's Disc Camera.	
Part 1. Modifying the Camera for Electronic Triggering.	
PROJECT OF THE MONTH/ <i>Forrest M. Mims</i>	124
Homemade pressure Sensitive Resistor.	
DX LISTENING/ <i>Glenn Hauser</i>	120

DEPARTMENTS

EDITORIAL/ <i>Art Salsberg</i>	4
NumberOne!	
LETTERS	6
NEW PRODUCTS	10
ELECTRONICS LIBRARY	101
OPERATION ASSIST	116
ADVERTISER'S INDEX	117

COVER ART BY JAMES HEGEDUS

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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 doubtless 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.

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formerly Popular Electronics

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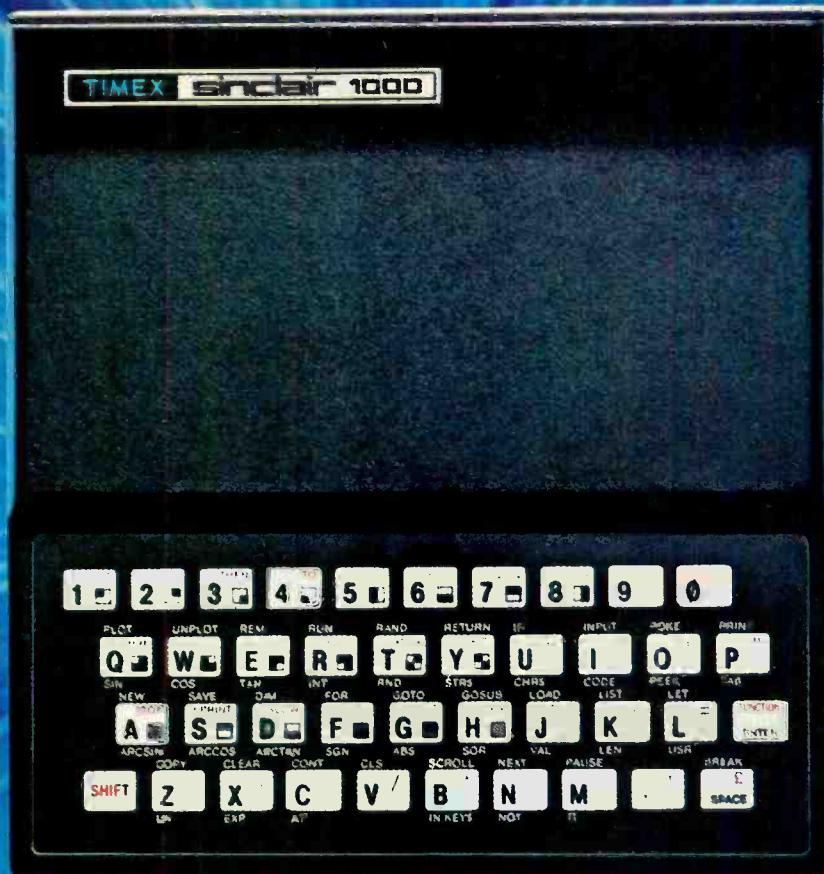
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LETTERS

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.

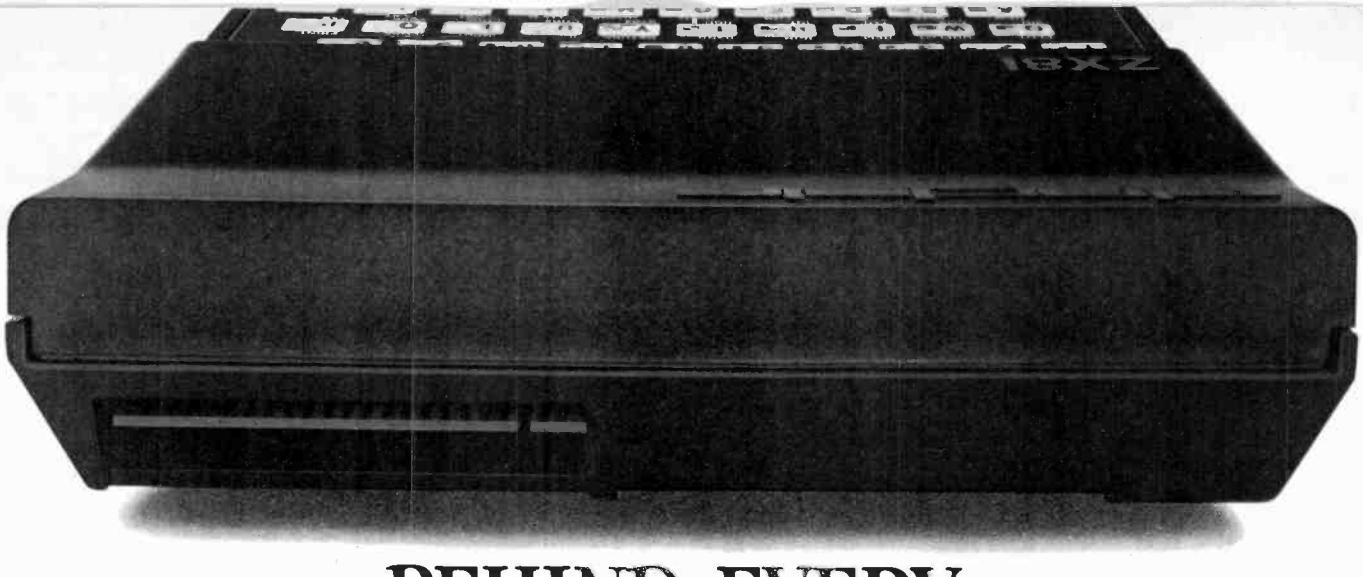
Its legality in the hands of the user is being challenged, so we can't publish the information.—Ed

OUT OF TUNE

In "Digital Auto Tune-Up Meter" (May 1982), R_3 should be 56 ohms and should be connected to $DIS2$ instead of $DIS1$. R_{13} should be 300 kilohms, R_{16} should be 1.33 megohms and R_{17} should be 665 kilohms.

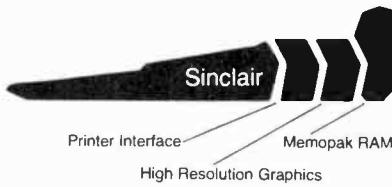
In "Triac Motor Control for Warm-Air Systems" (August 1982), the diacs should be listed as type 1N5759 in Parts List.

In "Simple Audio Gate Expands Dynamic Range" (July 1982), potentiometer R_{16} should be omitted from Parts List.



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If you own a Timex-Sinclair 1000 or ZX81 computer, you should have a Memopak behind it. From increased memory to high resolution graphics, Memotech has a Memopak to boost your system's capabilities. Every Memopak peripheral comes in a black anodised aluminum case and is designed to fit together in "piggy back" fashion to enable you to continue to add on and still keep an integrated system look.



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Memopak 16K RAM The Memopak 16K RAM provides an economical way to increase the capabilities of your Sinclair. And at the same time, it enables you to continue to add on other features with its "piggy back" connectors. It is compatible with the Sinclair 16K or a second Memopak 16K or Memopak 32K to give 32K or 48K of RAM respectively.

Memopak High Resolution Graphics The Memopak HRG contains a 2K EPROM monitor and is fully programmable for high resolution graphics. The HRG provides for up to 192 by 248 pixel resolution.

Memopak Printer Interface The Memopak Centronics Parallel or RS232 Interface paks enable your Sinclair to use a wide range of compatible printers (major manufacturers' printers available through Memotech at significant savings). The resident software in the units gives the ASCII set of characters. Both Memopak printer interfaces provide lower case character capabilities. The RS232 Interface is also compatible with modems.

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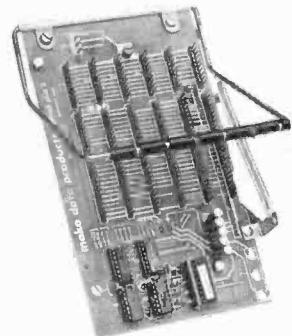
The VC-X2 from Akai has an "intervalometer" that serves as a time-lapse device capable of recording periods from 8 hours to 11 days. The camera uses the new Saticon tube, said to be superior to a vidicon tube in resistance to burning (after-images when a camera is moved from a bright scene to a dim one) and effective-ness 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, audio 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.

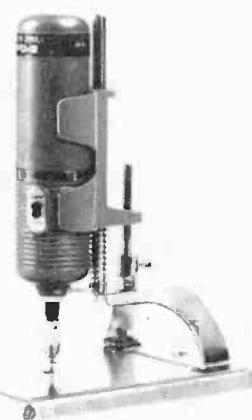
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Information Card*



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.

Circle No. 97 on Free Information Card

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.

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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 CrO₂ 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.

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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.

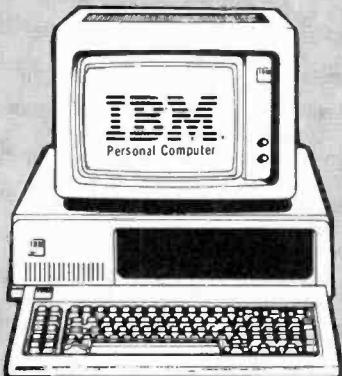
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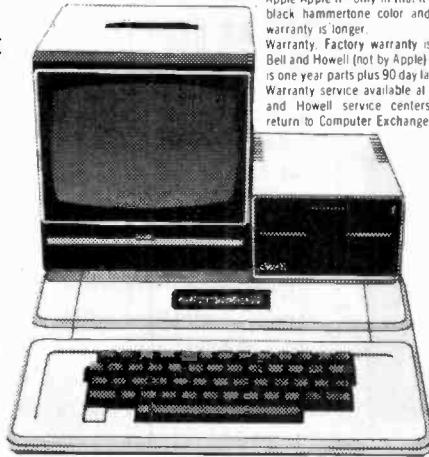
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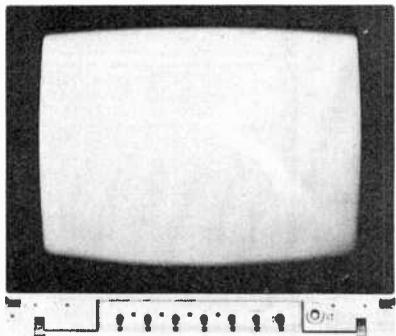
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Teknika ATV-M19 19" Color TV Monitor



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" vid-

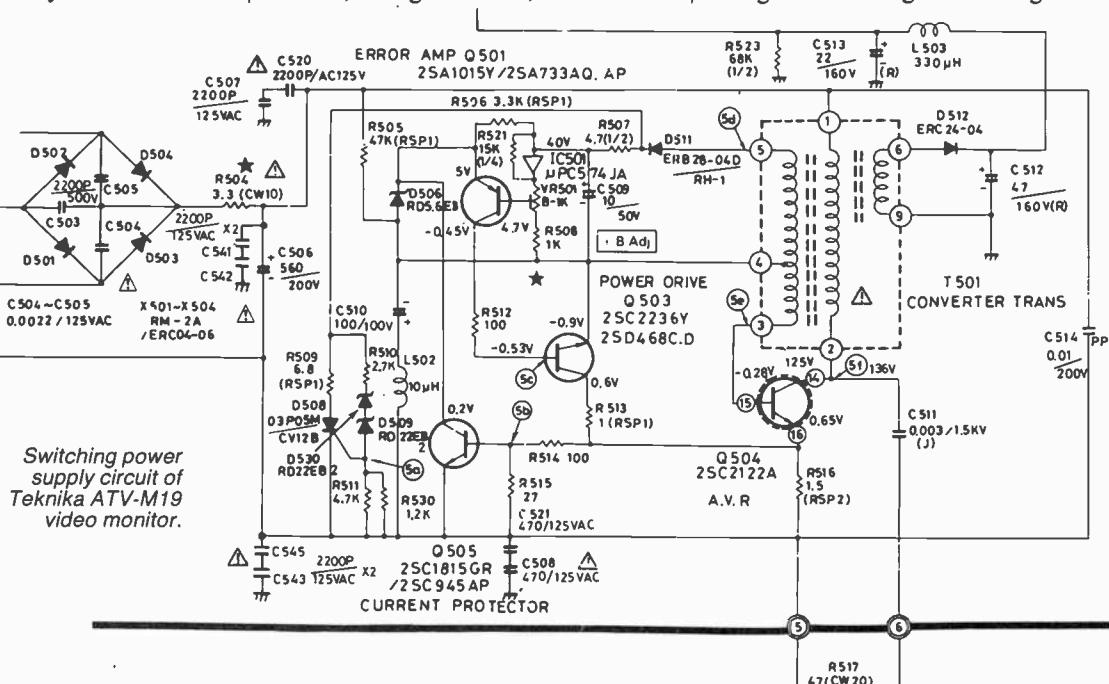
eo monitor examined in our September 1982 issue has a built-in stereo amplifier, the Teknika Model ATV-M19 that's the subject of this review does not incorporate audio amplifiers. There is a significant difference in the price of this 19" model and the highly rated Sony 19" model, though. While the Teknika 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" × 18½" × 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 transis-

tors, 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



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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 performance 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 occurring 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%

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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.

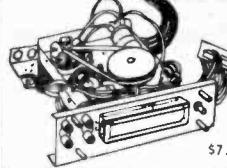
Conclusion. the Teknika ATV-M19 color video certainly provides good color pictures, probably better than the majority of commercial color TV receivers. As part of an integrated TV/FM/stereo component system, this monitor has the simplicity of interconnection and a high-quality picture to recommend it. 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 amplifier, 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

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CIRCLE NO. 24 ON FREE INFORMATION CARD

LES SOLOMON ON COMPUTER HARDWARE



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 CON-

TROLS: 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.

...HARDWARE

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, count timer 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). ◇

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CIRCLE NO. 54 ON FREE INFORMATION CARD

STAN VEIT ON COMPUTER SOFTWARE



VALDOCS and the Mind Amp

WELOCOME 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 between 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 select 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 VALDQCS 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 VisiTrend/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.

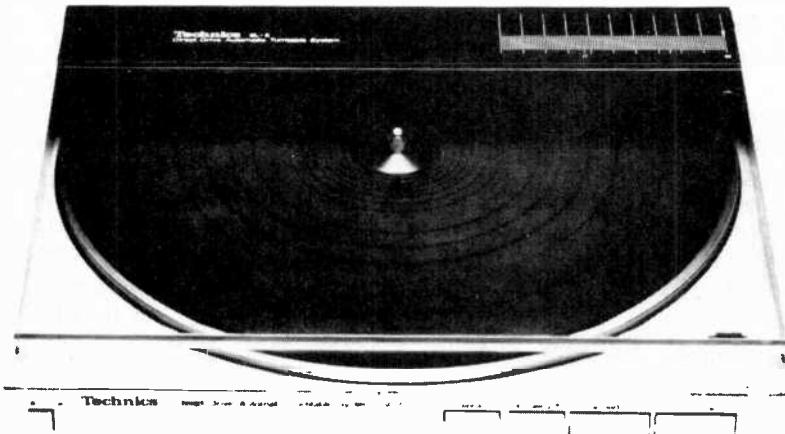
Invaders for Osborne 1. A disk version of the popular Invaders game has been released for the Osborne 1 Computer. Features a variable parameter file that can be changed by the user to increase the challenge of the game. \$19.95. Address: Toolworks, 14478 Sherman Oaks, CA 91423. (Tel: 213-986-4885).

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 conven-

tional 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 its 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 measures $17^{\prime\prime} W \times 4\frac{3}{8}^{\prime\prime} H \times 14\frac{3}{4}^{\prime\prime} D$ 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 $\pm 0.07\%$, and the SL-D30 reading was $\pm 0.08\%$. (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.

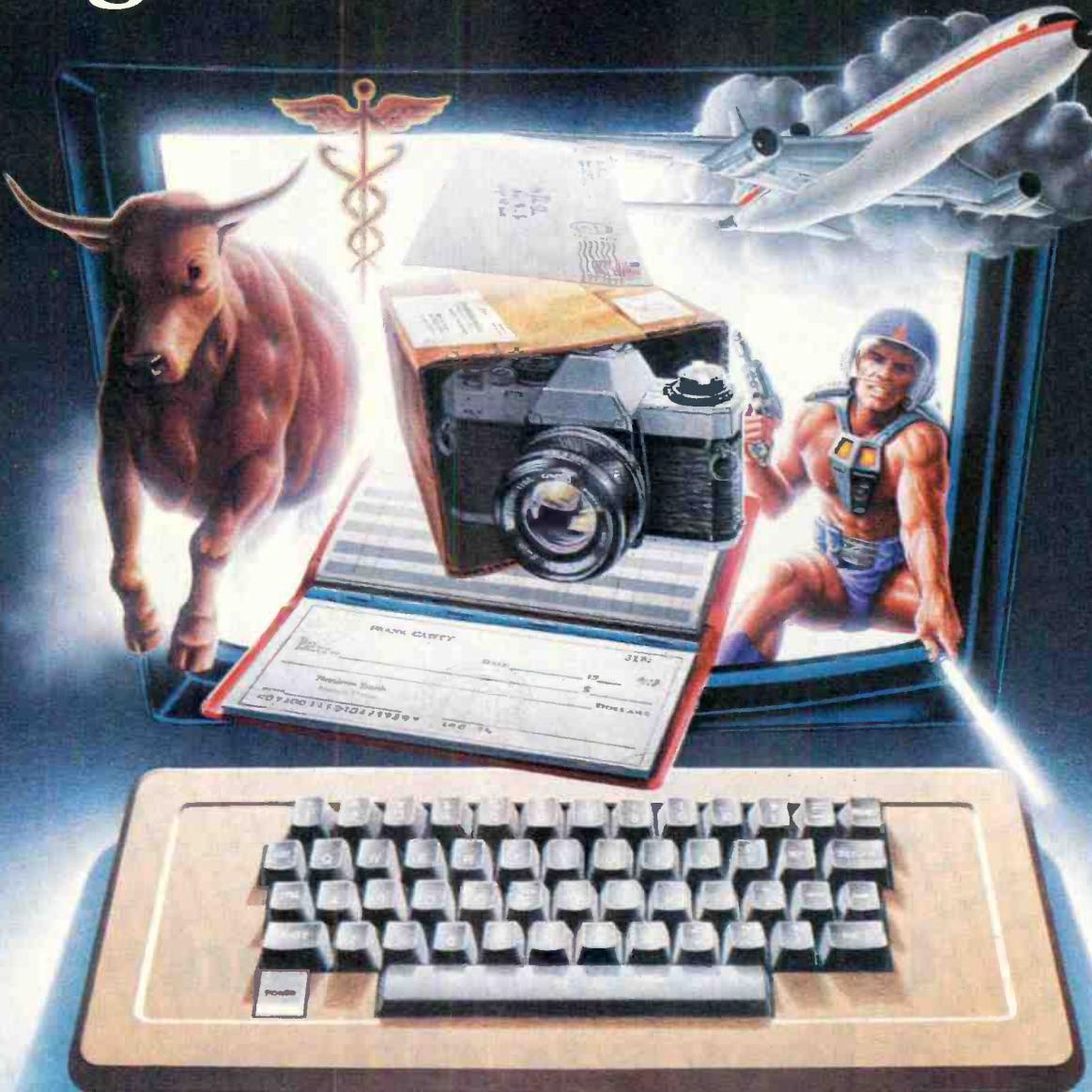
This does not in any way imply that these two record players are equally suitable for every user. The linear tracking SL-5 is, in most respects, a uniquely simple and functional instrument whose features are unavailable in any other unit we know of selling for anywhere close to its price.

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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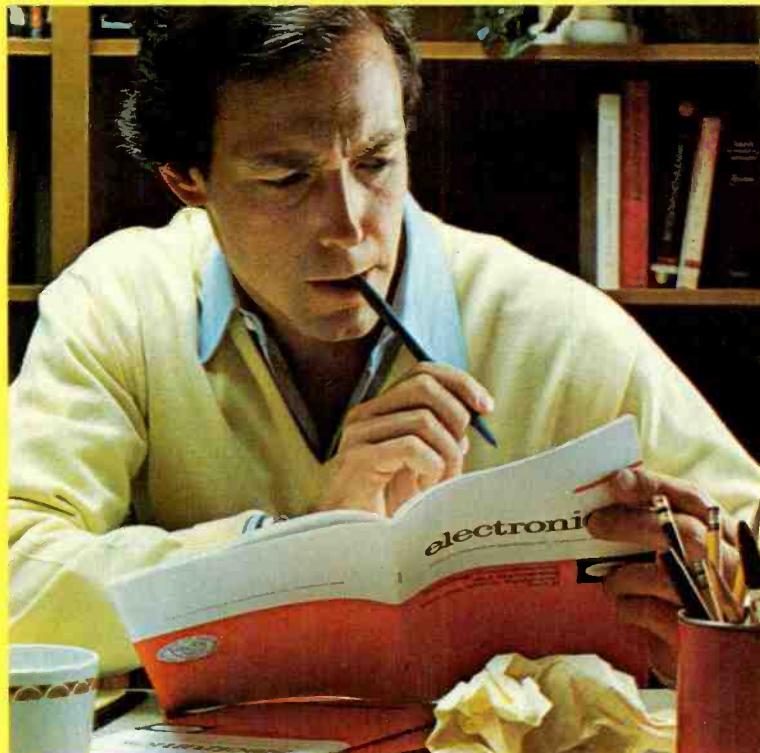
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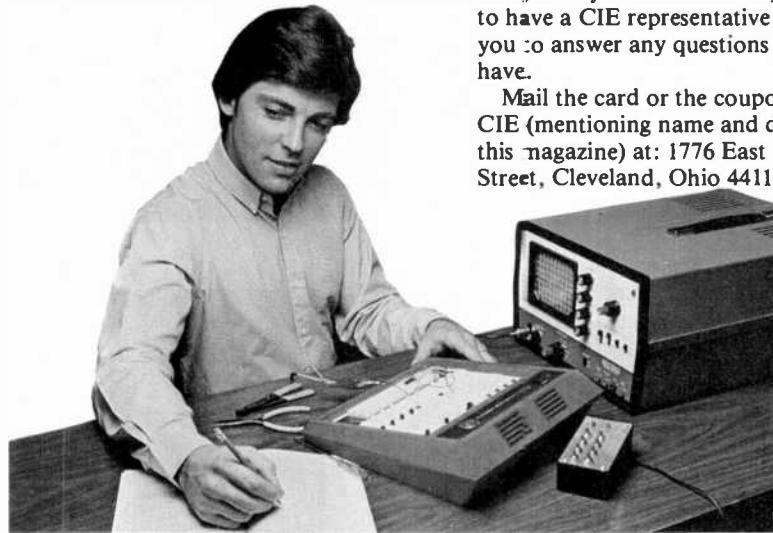
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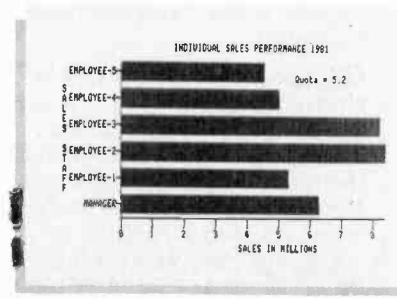
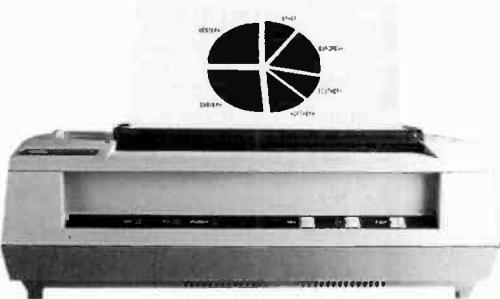
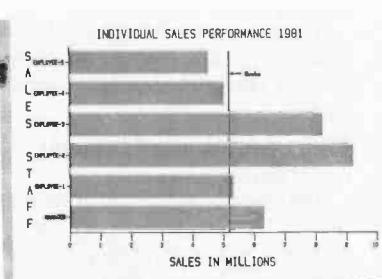
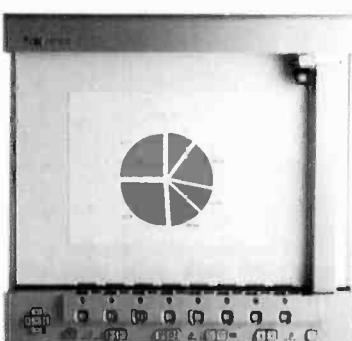
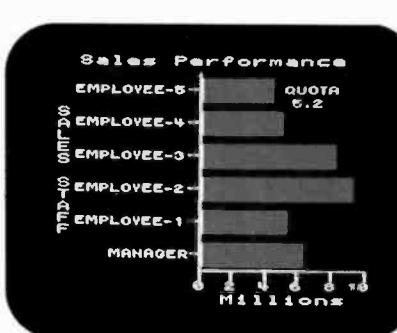
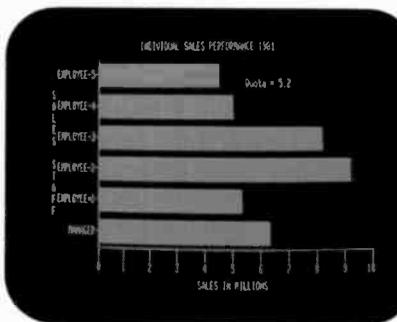
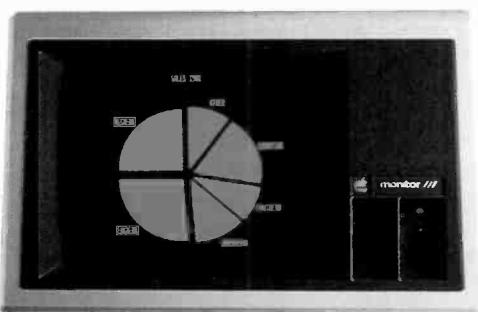
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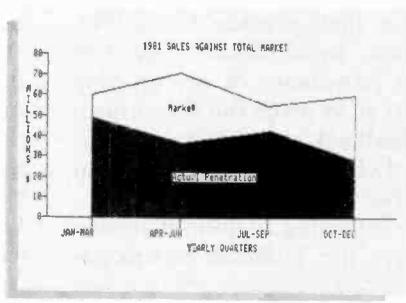
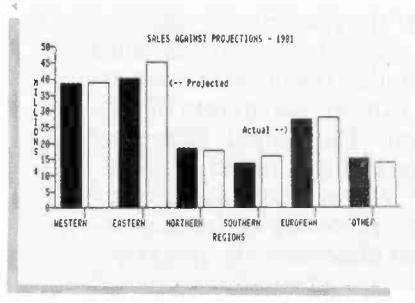
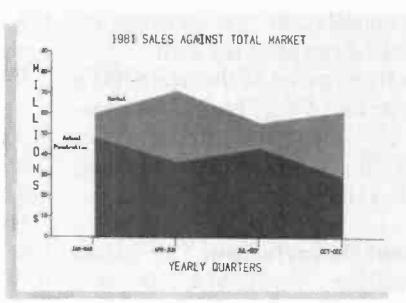
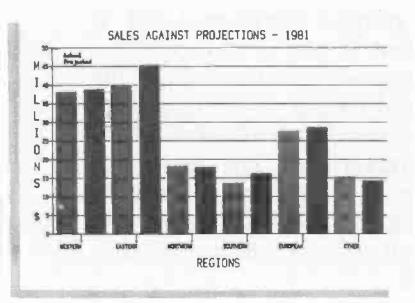
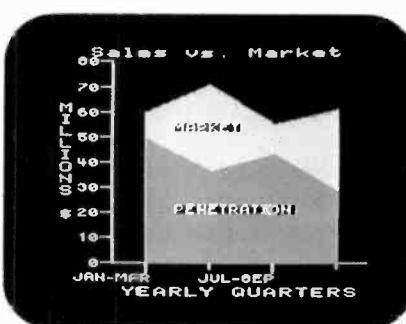
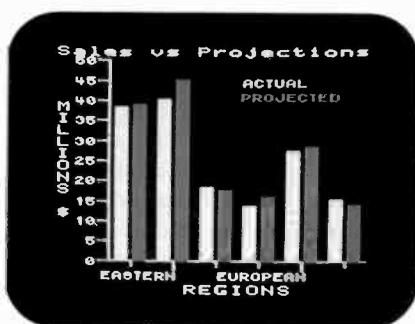
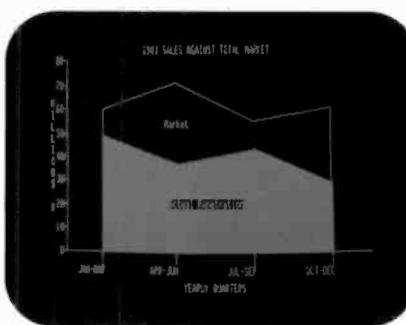
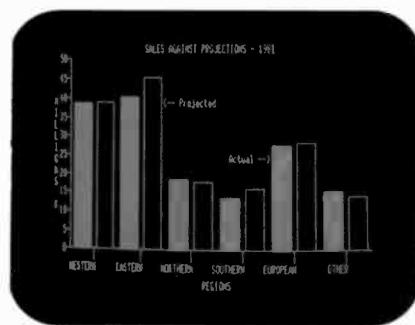
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Horizontal Bar	Yes	No	No
Side-by-side Bar	Up to 4	2	4
Pie	Yes	Yes	Yes
Partial Pie	Yes	No	No
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Curve Fitting	5 Kinds	1	None
Data Points (Max.)	3500+	645	36
Plotter Compatible	Virtually Any	None	H-P7470A Only
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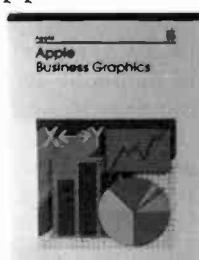
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Apart from operating convenience and protection features, there is one salient advantage to both these units (especially the SL-5). Namely, the low mass of the arm/cartridge combination provides an outstanding ability to play warped records. The SL-D30, 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*

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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 compensa-

tion, 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.

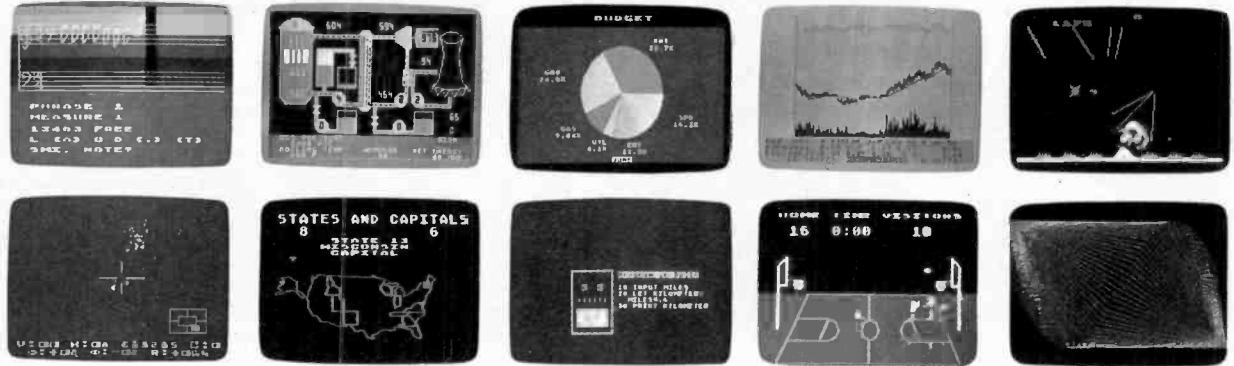
Instead of the usual bass and treble tone controls (or a third mid-range control), McIntosh has chosen to use a 5-band equalizer in the MA6200. Controlled by conventional rotary knobs, it is not actually a "graphic equalizer," but is equivalent to one in its operation. Each channel uses an op amp at 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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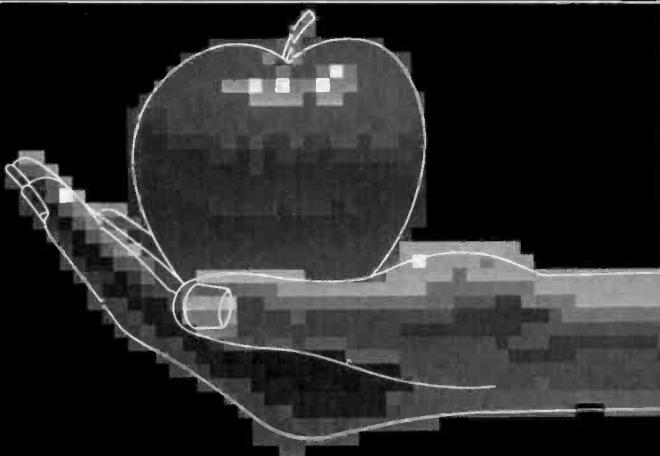
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POLISH YOUR APPLE WITH A LUMINANCE BOARD



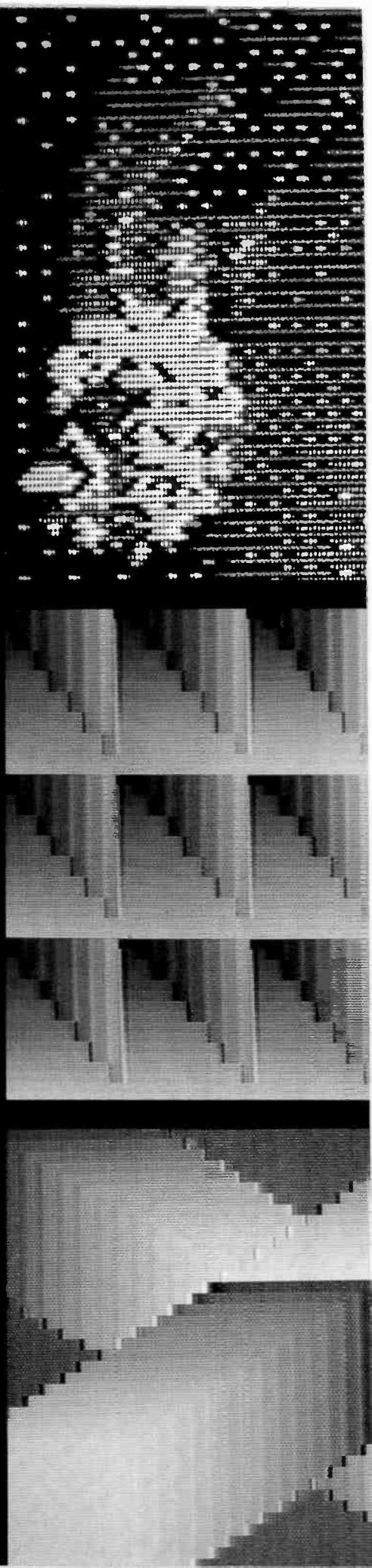
A low-cost plug-in board turns an Apple II computer into a graphics giant with 240 color choices

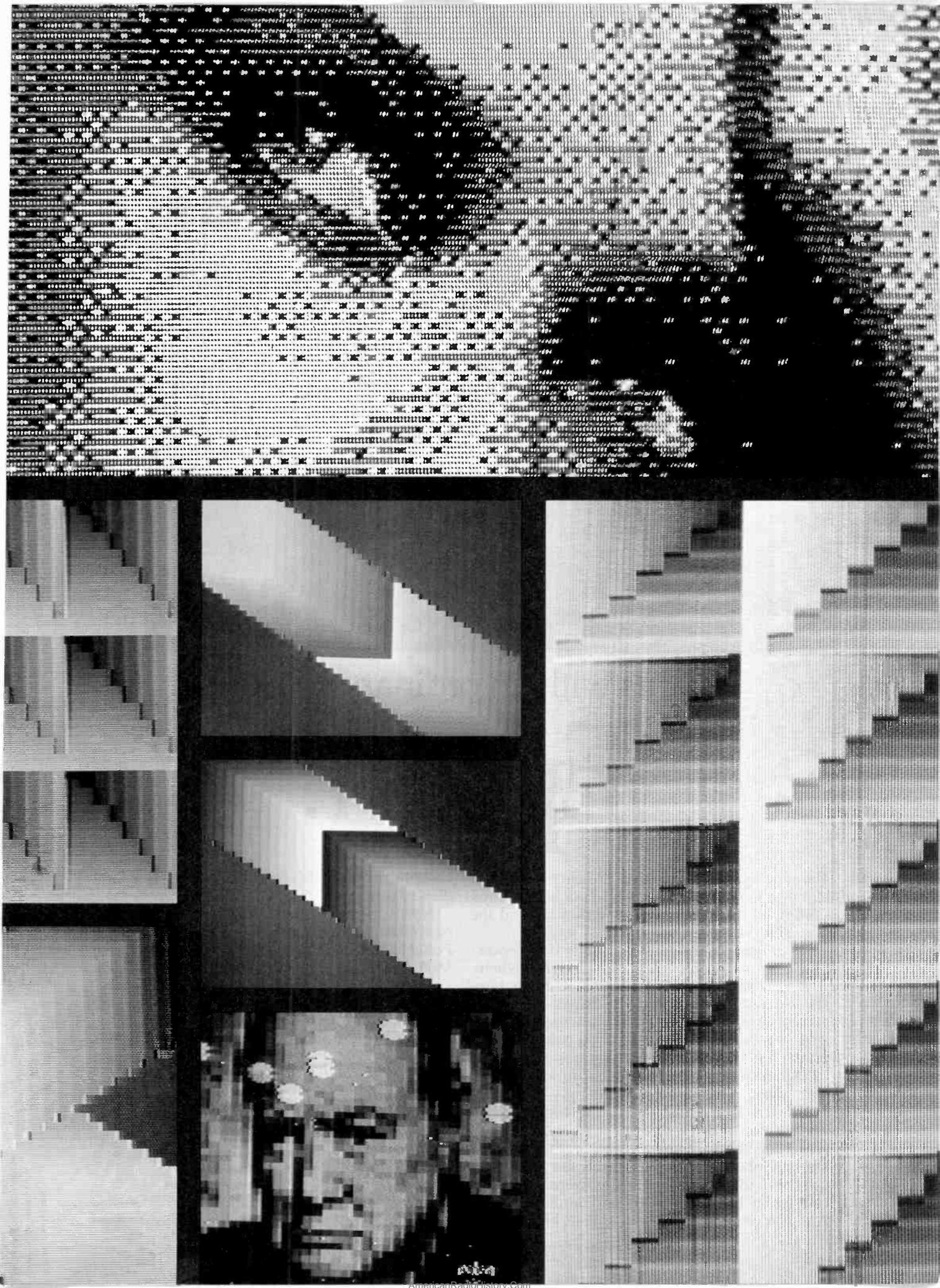
By Ray Dahlby

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 hires graphics with part of the graphics on page 2, or you







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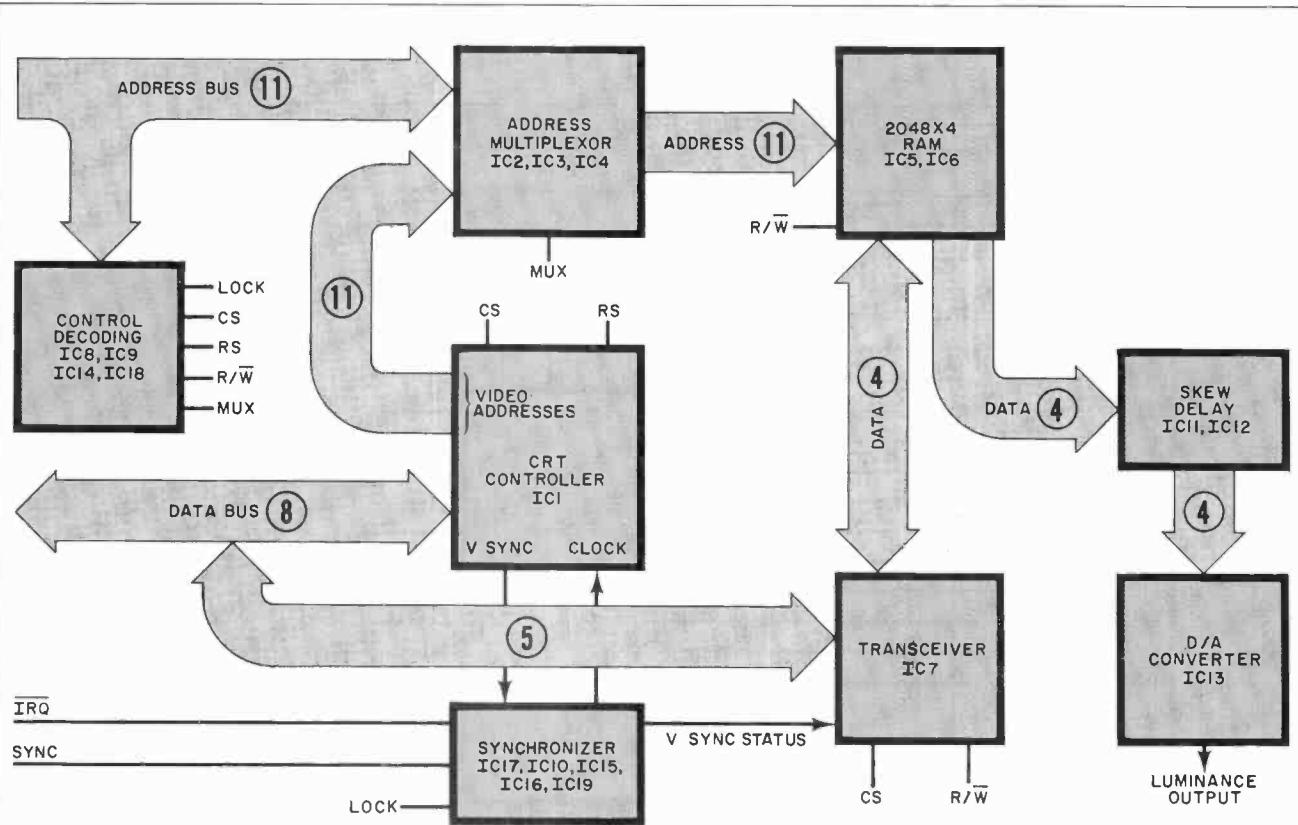


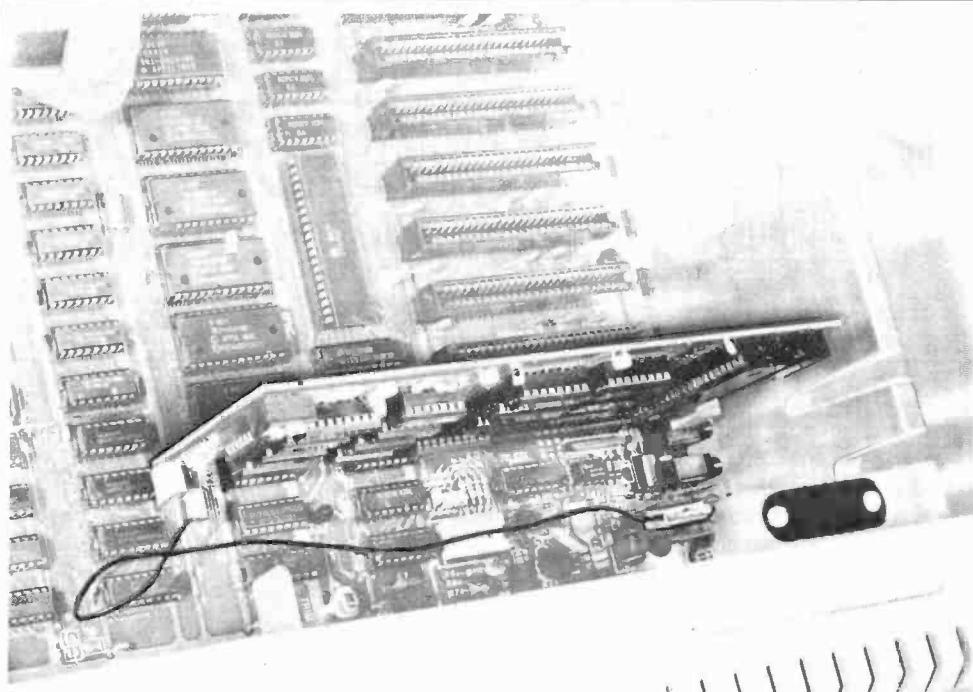
Fig. 1. The most important element of the system is the 6845 CRT controller.

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 x 4-bit RAM memory. Data is mapped to overlay the Apple's screen in a 40 x 48 array of pixels. Data written to each



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

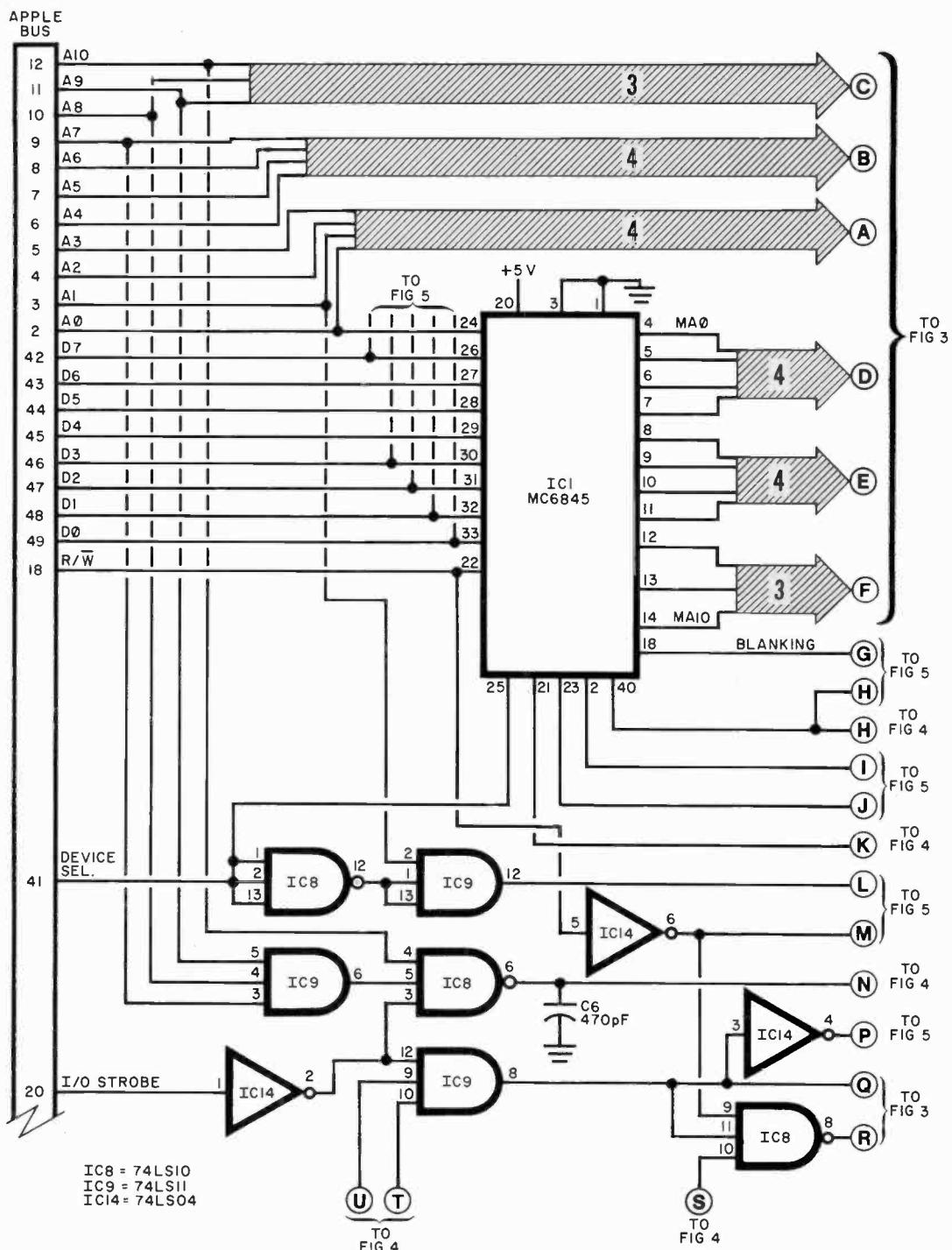


Fig. 2. The 6845 synchronously regenerates the video RAM addressing.

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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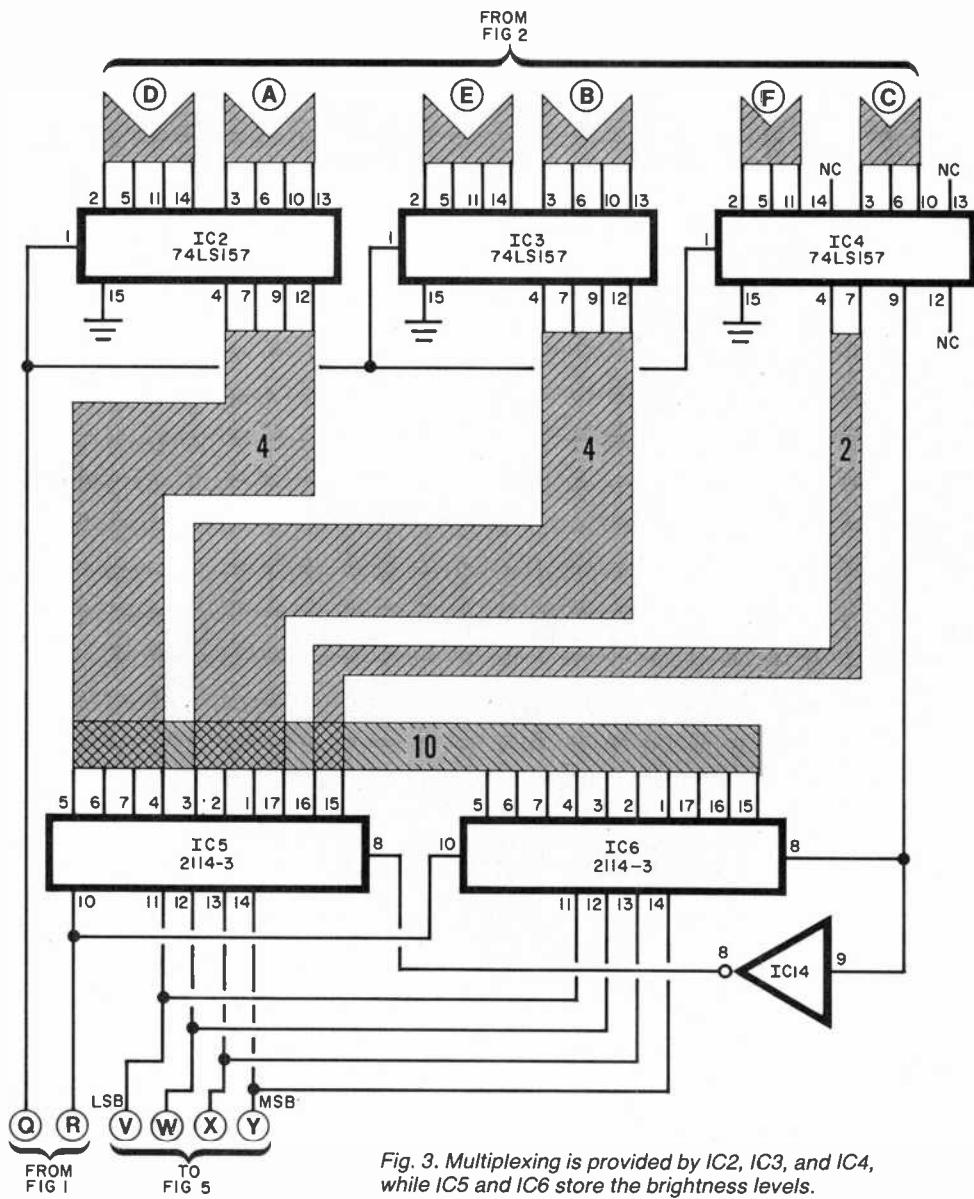


Fig. 3. Multiplexing is provided by IC2, IC3, and IC4, while IC5 and IC6 store the brightness levels.

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 $2K \times 4$ 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.

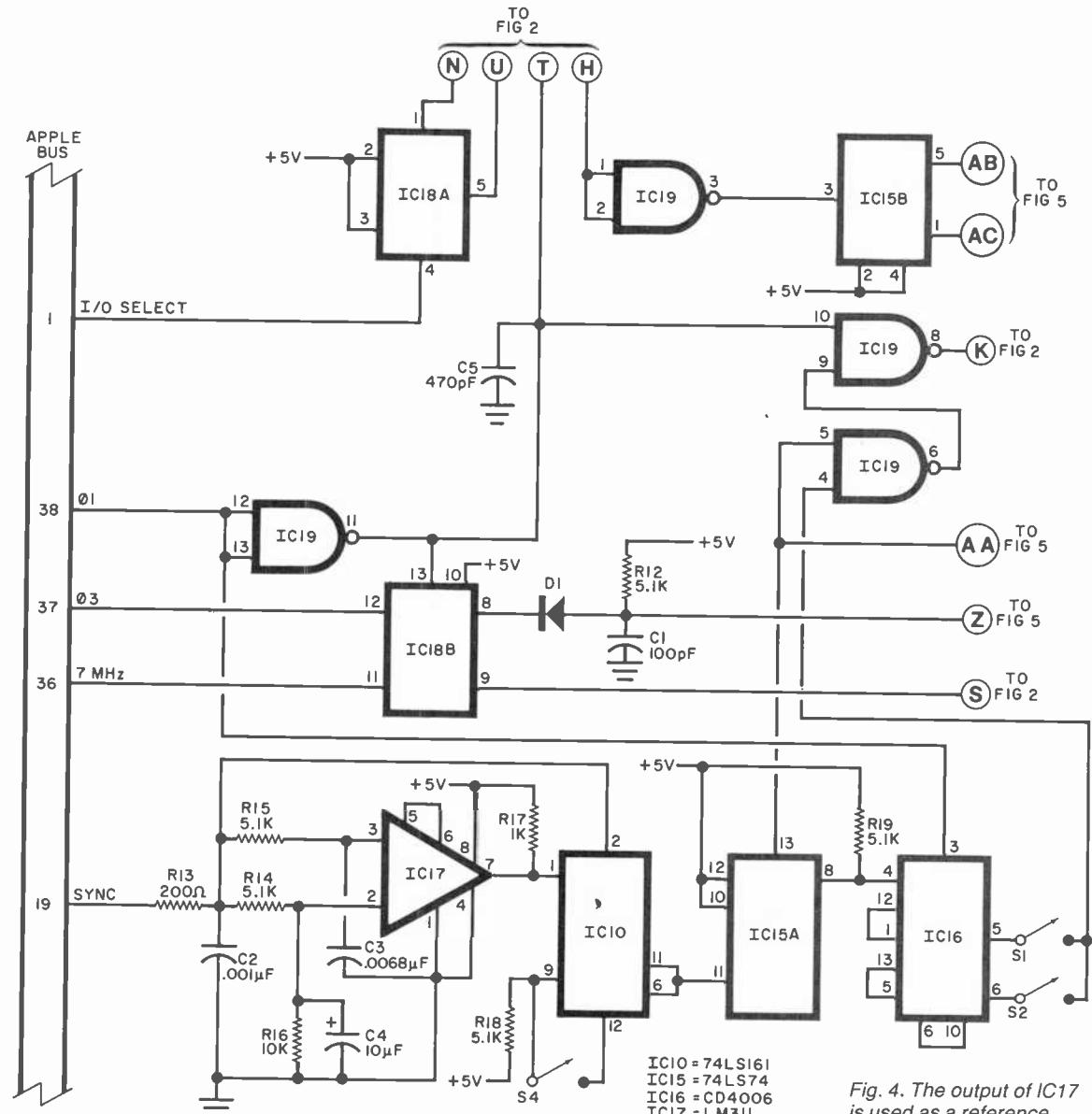


Fig. 4. The output of IC17 is used as a reference for the phase-lock loop.

PARTS LIST

C1—100-pF ceramic disc capacitor
 C2—0.001- μ F capacitor
 C3—0.0068- μ F capacitor
 C4—10- μ F, 15-V electrolytic
 C5, C6—470-pF ceramic disc capacitor
 C7 through C11—0.1- μ F 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 1/4-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

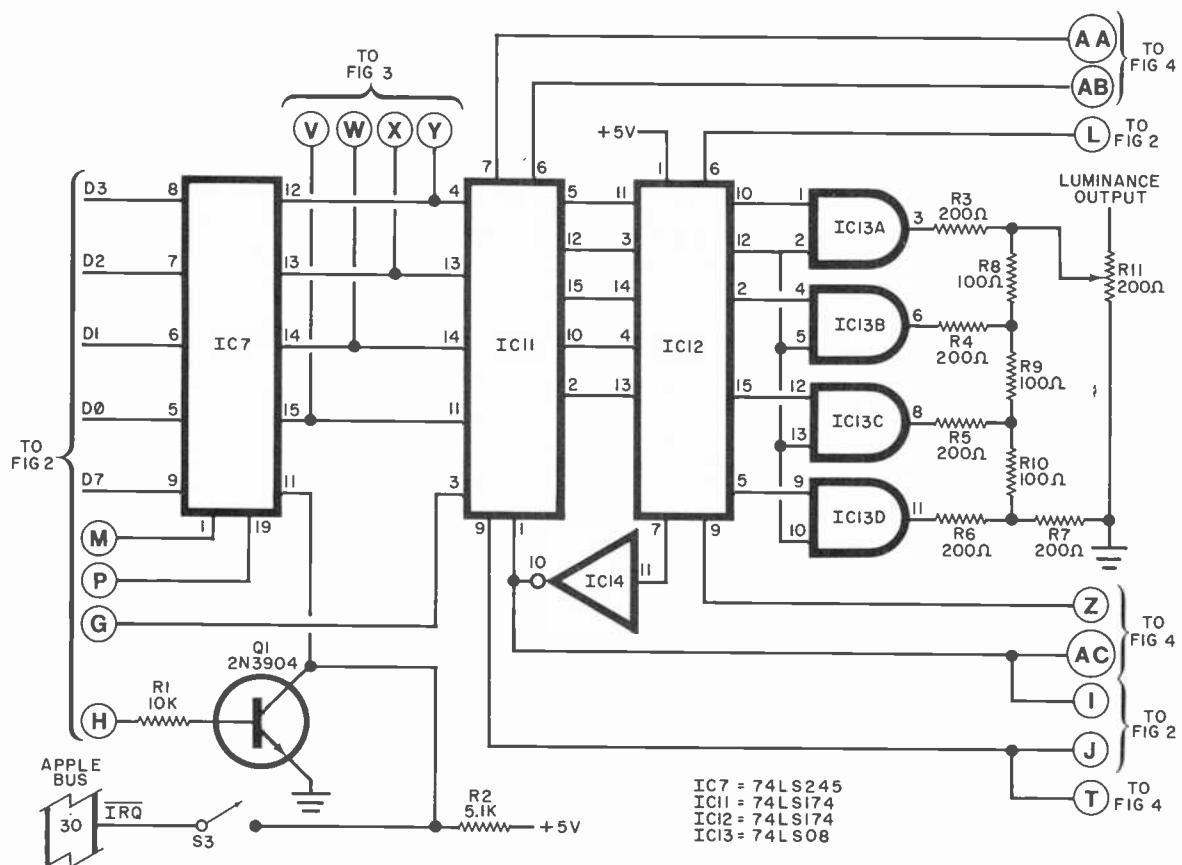


Fig. 5. Luminance output is obtained from D/A IC13.

TABLE II—INITIALIZATION (ASSEMBLY)

RS	EQU	\$C0F0
LOCK	EQU	\$C0F2
	ORG	\$0300
	SEI	
INIT	LDX	#00
	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
	D _{EY}	
	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, 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-	Luminance RAM
\$CF7F	

*See 6845 data sheet.

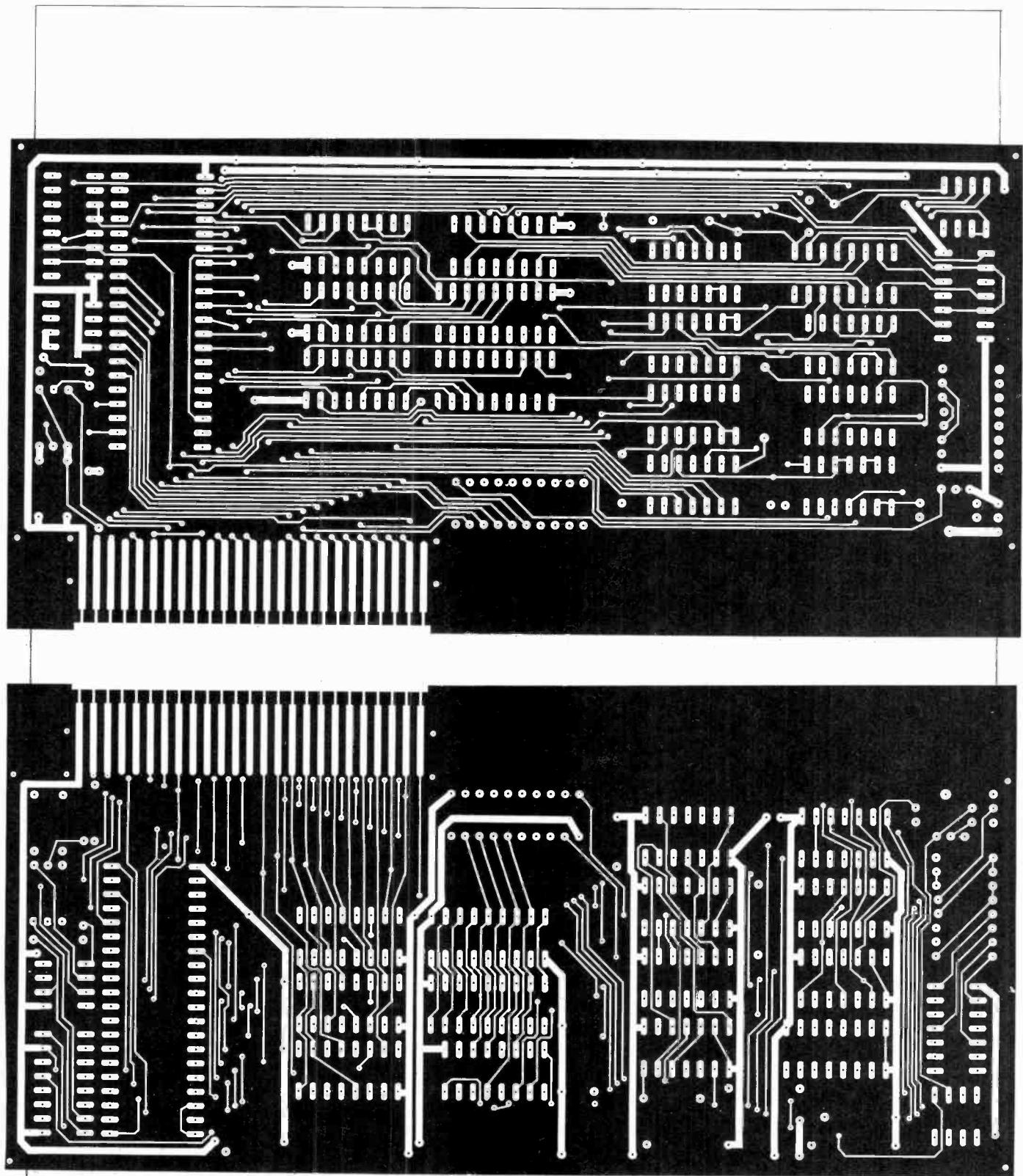


Fig. 6. Foil patterns for the double-sided printed circuit board.

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

Programming. With the luminescence 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,

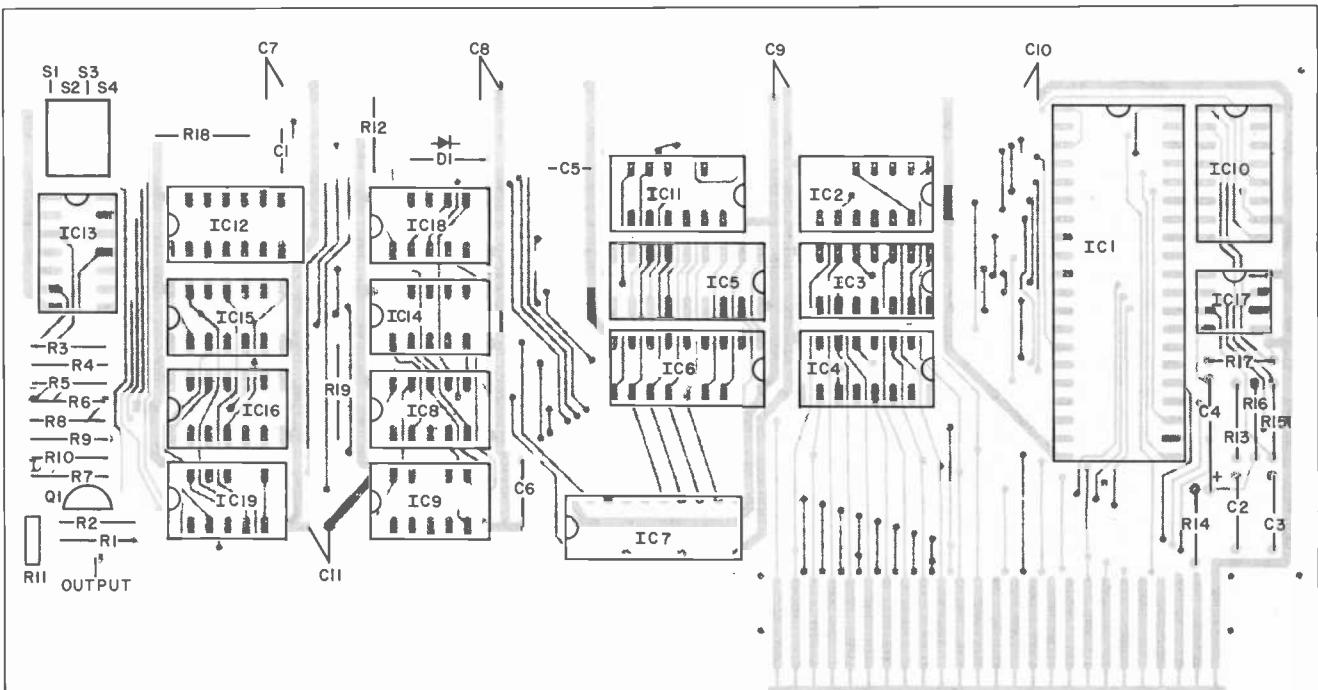


Fig. 7. Component layout for the printed circuit board.

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 luminescence screen.	&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.
&SHOW &NOSHOW	Switches the luminance display on and off. Does not alter the content of the luminance RAM.	&MOSAIC,1 &MOSAIC,2	Converts a picture on hi-res page 1 or 2 to a 40 x 48 grey scale mosaic.
&CLR,X	Clears the luminance screen to the shade indicated by the expression after the comma. (0-15)	&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.
&SHADE,X	Sets the shade for the &PLT and &FILL commands.	&I1,X	Split screen into text and hi-res 1
&PLT,X,Y	Plots a pixel of the shade specified by the last &SHADE command. Same screen coordinates as lo-res	&I2,X	Split screen into text and hi-res 2
&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)	&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.

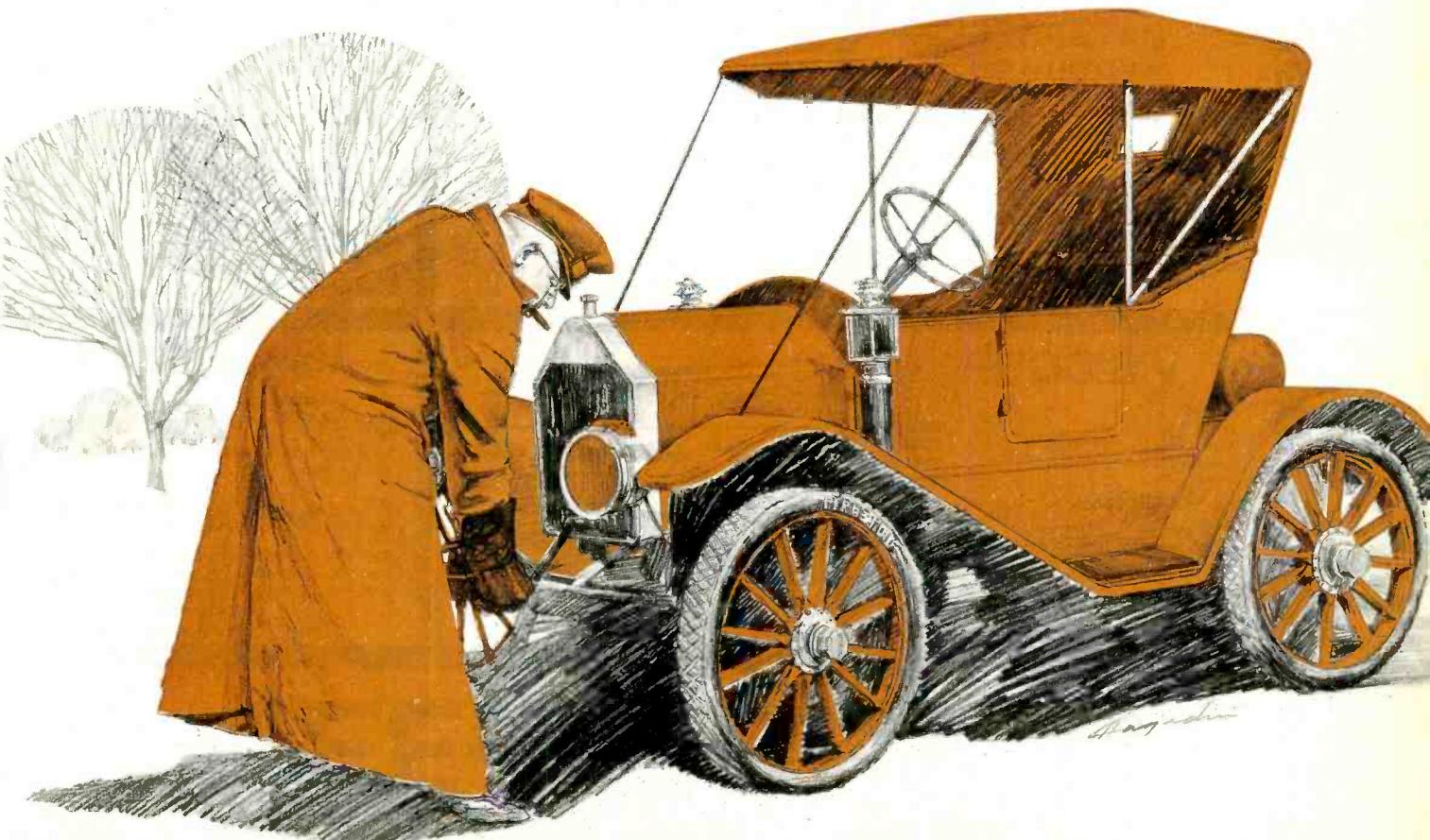
Invariably, the user forgets to switch back to the TV position after

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 MPN34Q1 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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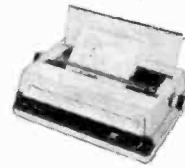
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signal from the game/computer input. To attenuate the unwanted signal further, D_6 is also turned on. This creates a low resistance to ground between D_3 and D_4 . Figure 2 illustrates the ac path when the antenna, or A, input is selected.

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-

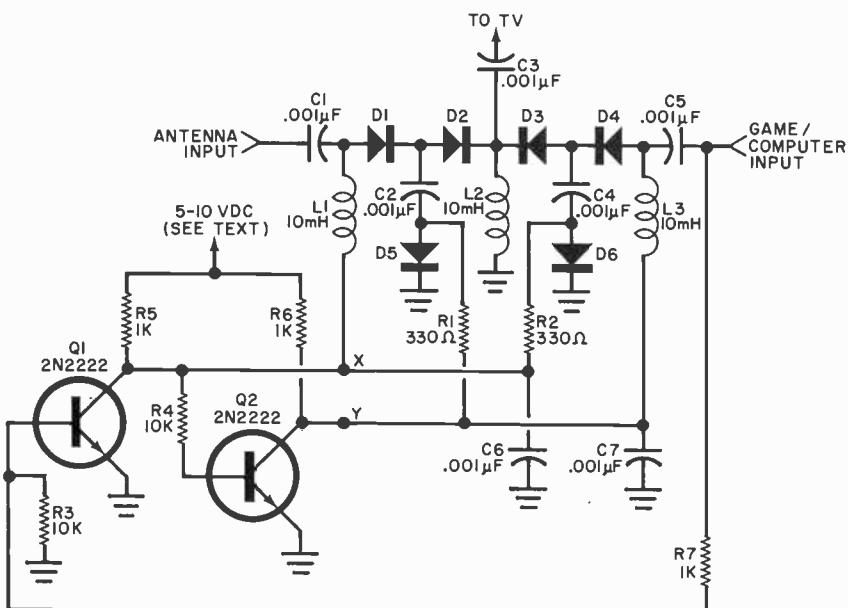


Fig. 1. Circuit operation depends on the switching diodes, D_1 through D_6 .

PARTS LIST

- C1 through C8—0.001- μ F ceramic disc capacitor
- D_1 through D_6 —Silicon PIN switching diode (MPN3401 or similar)
- L1 through L3—10- μ H molded choke (J.W. Miller #9320-30 or similar)
- Q1,Q2—General-purpose npn transistor (2N2222 or similar)
- R1,R2—330-ohm, 1/4-W carbon resistor
- R3,R4—10-kilohm, 1/4-W carbon resistor
- R5 through R8—1-kilohm, 1/4-W carbon resistor
- Misc.—Power supply (see text), F connectors (1 male, 1 chassis-mount fe-

male), 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.

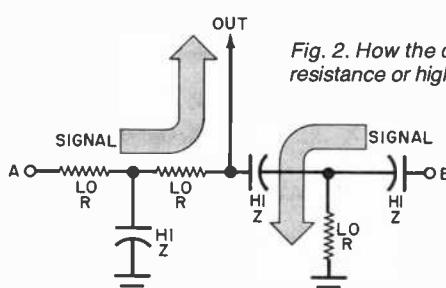


Fig. 2. How the diodes present either low resistance or high capacitance to the input.

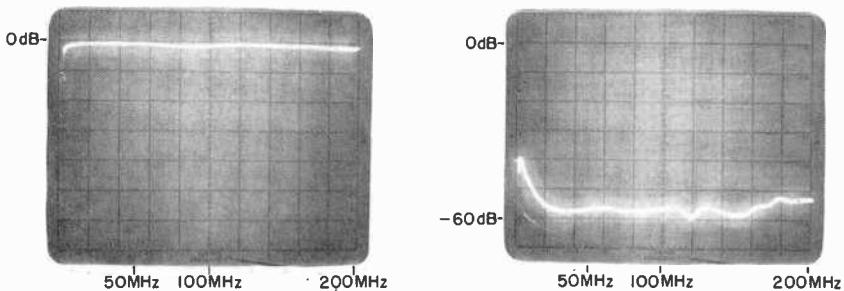


Fig. 3. Scope photos show low (0 dB) insertion loss (left) and high (6 dB) isolation between inputs using the switch.

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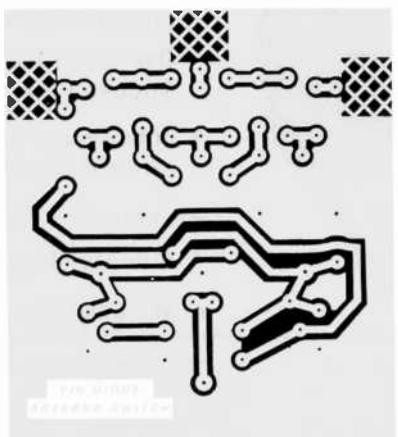


Fig. 4. Foil pattern for the printed circuit board.

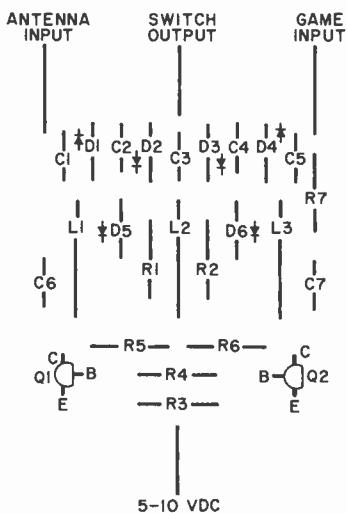


Fig. 5. Component layout for pc board.

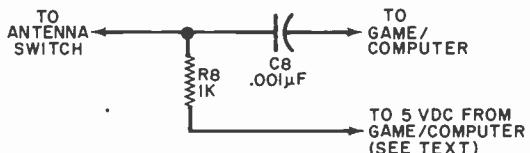


Fig. 6. Circuit for adapter box connected to game or TV.

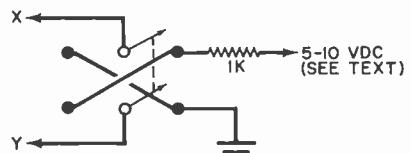


Fig. 7. Use a switch to cut out the automatic circuit.

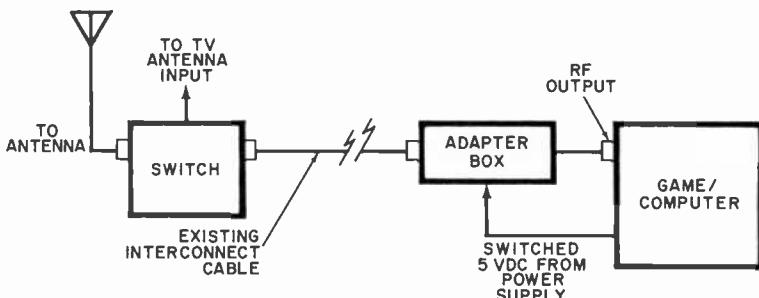
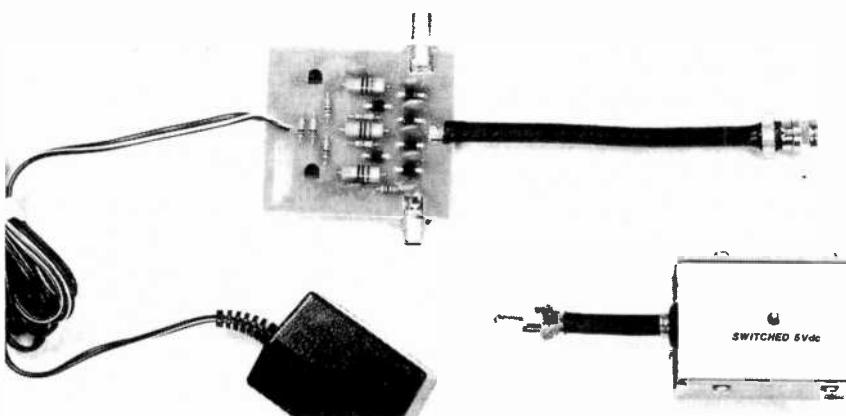


Fig. 8. Use this diagram to connect the automatic switch to the TV and the adapter box and game/computer.



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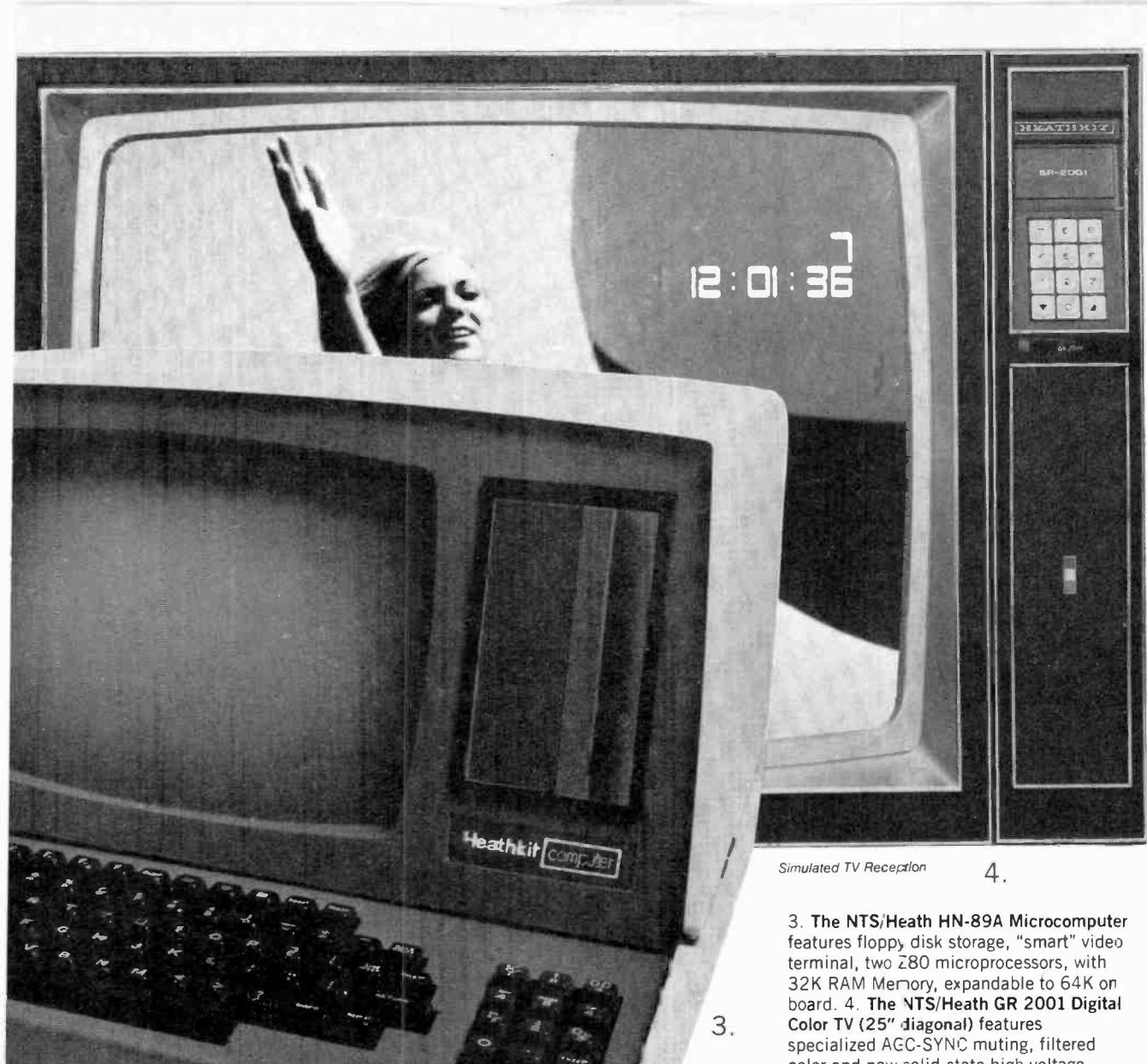


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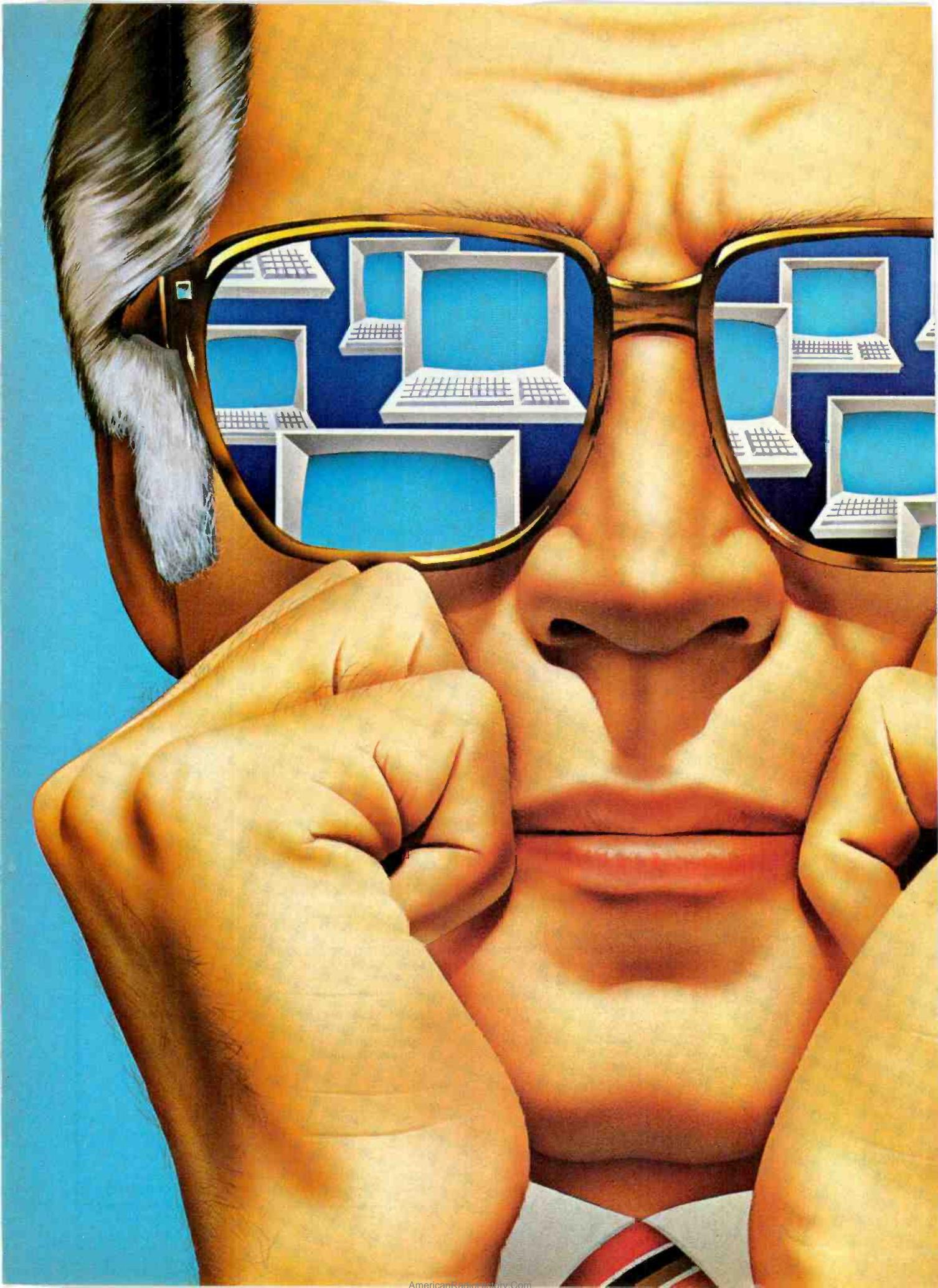
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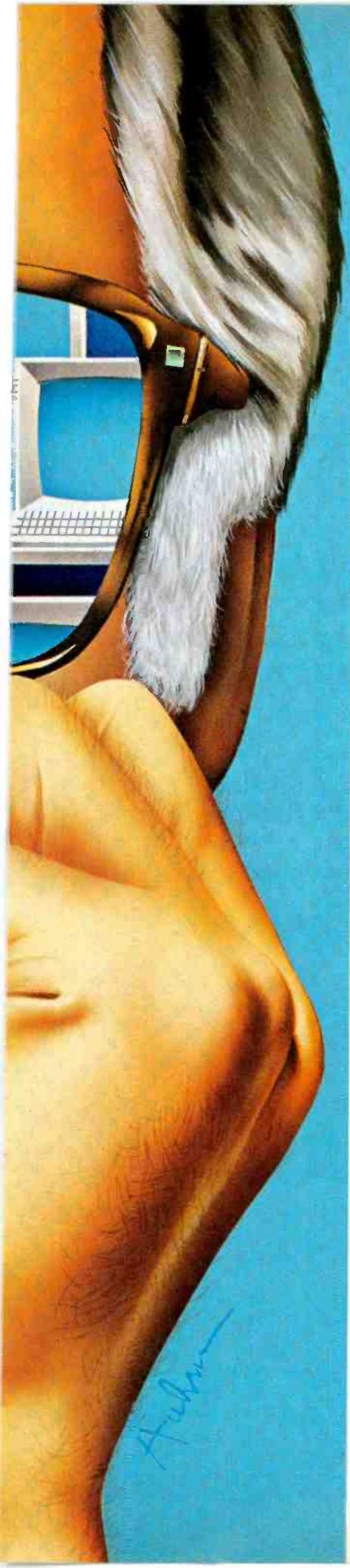
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COMPUTER CLONES

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 than the 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.

F₁—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 5 1/4" disk drives which run PCDOS.

Franklin's ACE 1000 Runs With The Best!

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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) in-

cluding 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 5½" 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 interpreter 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.

LNBASIC 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 LNBASIC 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 $\frac{1}{4}$ " 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, MULTIDOS, 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 mem-

ory 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 occurrence 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 pro-

cessing. 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.

...COMPUTER CLONES

The Basis-108 has a wide range of video displays. 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 trad-

ing 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 PC-DOS, 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.

The Hyperion Computer. From Dynalogic Info-tech of Ottawa, Canada, this is a 20-lb portable computer with a 7" amber screen, two 5 $\frac{1}{4}$ " 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, includ-

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



ing 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- μ F 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

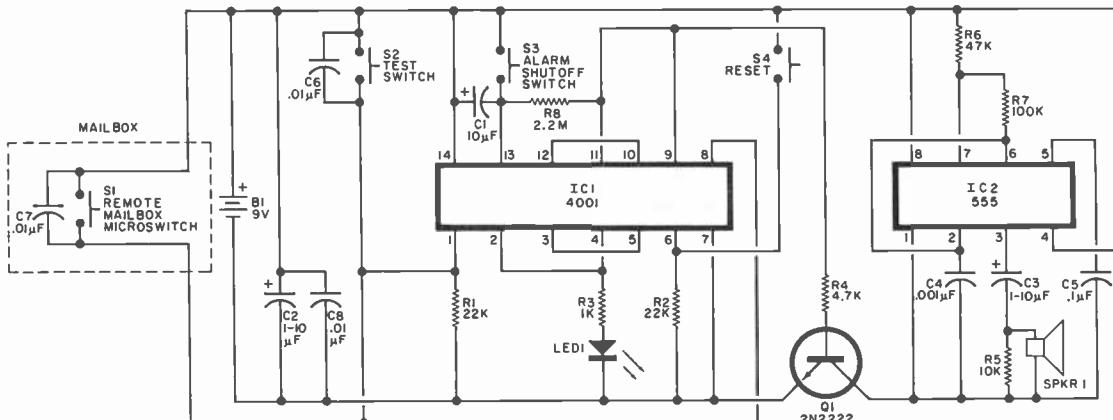


Fig. 1. Heart of the circuit is the 4001 chip set up as a dual set-reset latch.

- B1—9-V battery
- C1—10- μ F, 25-V electrolytic
- C2,C3—1-10- μ F, 25-V electrolytic
- C4—0.001 μ F, 25-V ceramic disc capacitor
- C5—0.1- μ F, 25-V ceramic disc capacitor
- C6,C7,C8—0.01- μ F, 25-V ceramic disc capacitor
- IC1—4001 quad NOR gate
- IC2—555 timer
- LED1—Red or green light-emitting diode

PARTS LIST

- Q1—2N2222 npn silicon transistor (or similar)
- The following are 1/4-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, hook-up wire, case, mounting hardware, construction adhesive, etc.

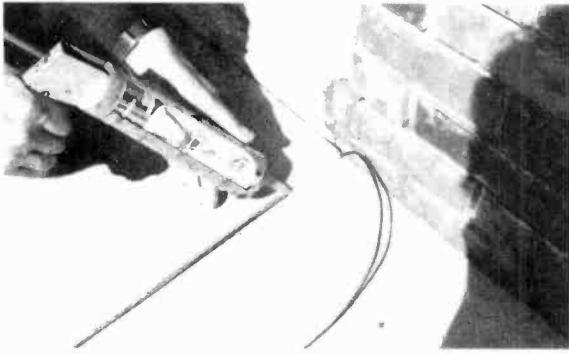


Fig. 2. Cement the wire into a groove in the sidewalk using some sort of construction adhesive.

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.

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13810	SOLV30-15	15 .74	5.5/8.47x7.83/3.16	O/P-4	\$9.95
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		4042	.75	4522	1.20
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		4044	.75	4527	1.90
		4046	.90	4528	1.20
		4047	.90	4531	.90
		4049	.50	4532	1.90
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		4053	.90	4543	2.70
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		4060	1.39	4556	.90
		4066	.75	4557	.90
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LM733	.95	75453	.35

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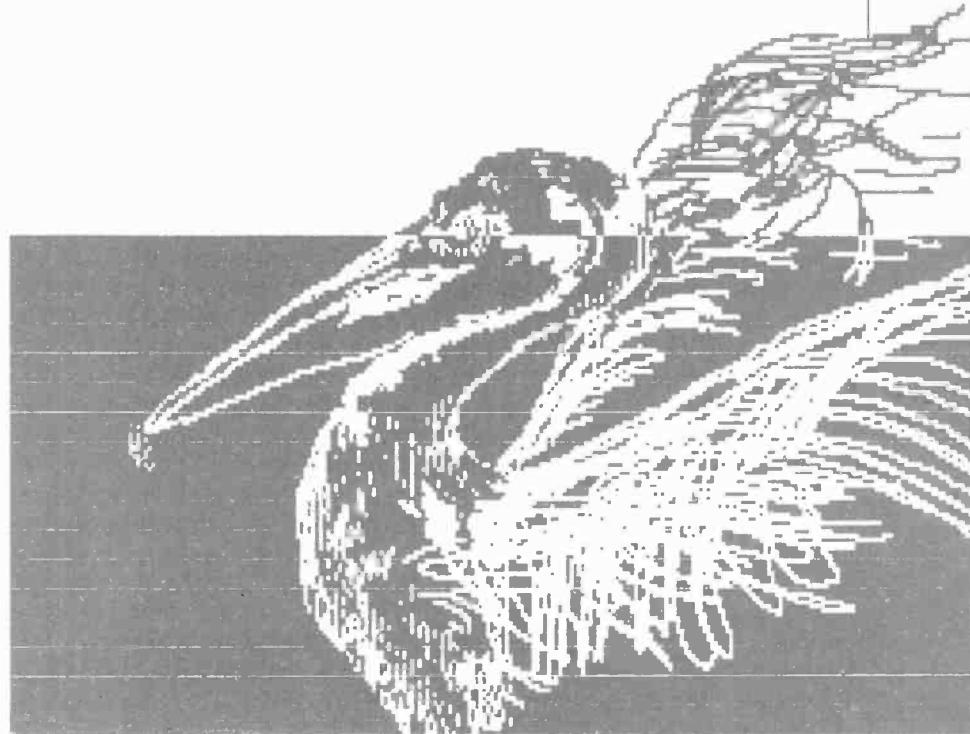


CIRCLE NO. 30 ON FREE INFORMATION CARD

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

...GRAPHICS

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 Graftax option in order to print graphics in normal or dual-density modes. The MX-100, with a built-in Graftax 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 hexadecimal 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

"A B C D E F G H" 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.

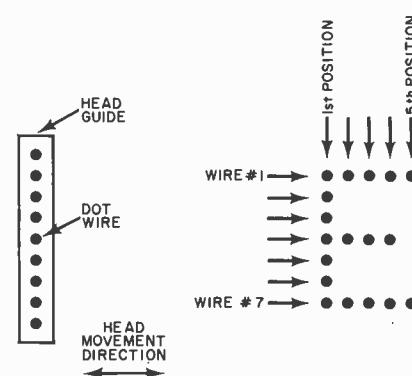


Fig. 1. Different print wires make dots in rows to form characters.

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/Graffax
	MX-80FT/Graffax
	MX-100
Heath Co.	Heath H25
Integral Data Systems	IDS 460
	IDS-560/G
C. Itoh	IDS Prism 80
	IDS Prism 132
	Prowriter
	Comet II
Malibu Electronics	Malibu 200
Okidata	Microline 82A
	Microline 83A
	Microline 84
NEC	Pacemark 2350
Radio Shack	(2 color)
Sharp/Radio Shack	NEC 8023A
	Line Printer VII
	Pocket Computer
	Printer
Star Micronics Inc.	Gemini-10
	Gemini-15

TESTING 1
TESTING 2
TESTING 3
TESTING 4
TESTING 5

Fig. 2. Pattern created by Table II.

...GRAPHICS

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.

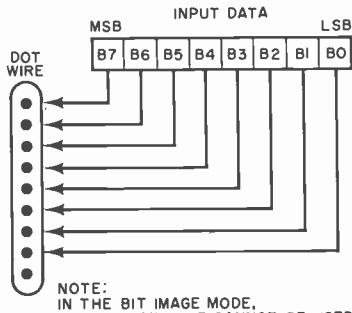


Fig. 3. Relationship between input data and print wires.

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

PIN	1	2	3	4	5	6	7
128							
64	*	*	*	*	*	*	*
32	*						*
16	*						*
8	*						*
4	*						*
2	*	*	*	*	*	*	*
1							

Fig. 4. Converting a shape to numbers.

PIN	1	2	3	4	5	6	7
128							
64							*
32							*
16							*
8	*	*	*	*			
4							*
2							*
1							*

Fig. 5. Changing numbers changes shape.

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

TABLE II—BIT-IMAGE PROGRAM

```
10 FOR I = 1 TO 5  
20 PRINT CHR$(27); "K"; CHR$(8);  
CHR$(0); "ABCDEFGH"; "TESTING";!  
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	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	0	0
2	2	0	1	1	0	0	1	1	0
1	1	1	0	1	0	1	0	1	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

...GRAPHICS

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 halftone.

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 or 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 Sensible 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 lit-

tle annoying things that should not exist in commercial 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 peripheral 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

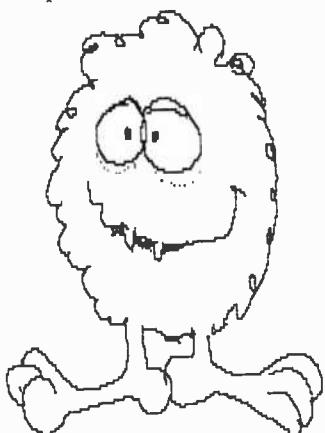
graphic image 90 degrees in a clockwise direction.

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 commercial 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 VIC-TOR, 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 Graftax 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. ◇

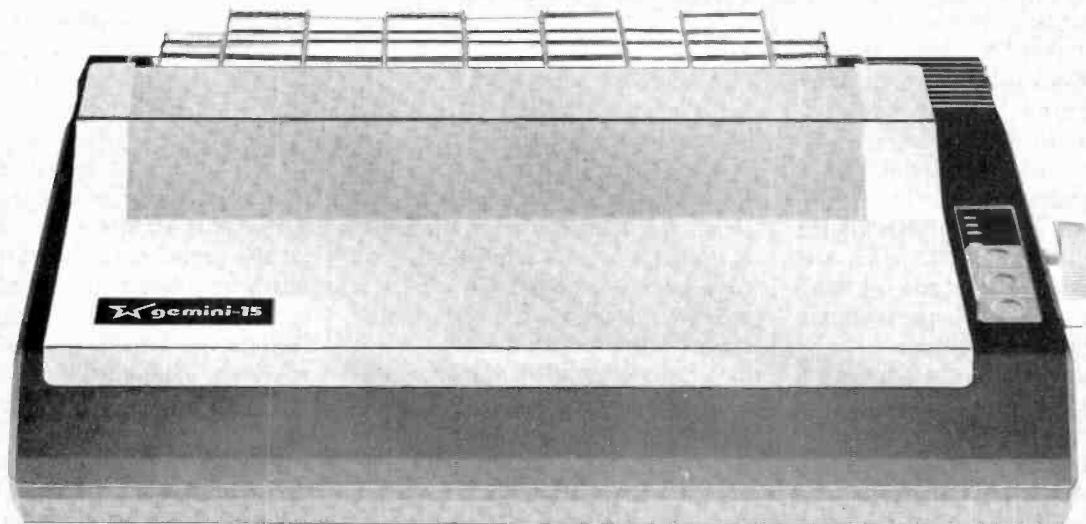


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The 68000 CPU

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, instruc-

tion 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 instruc-*

tions 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.*

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

*Motorola, Inc.

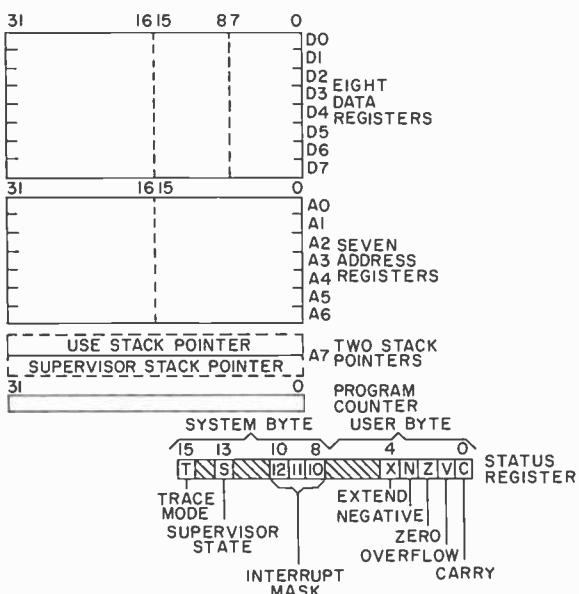


Fig. 1. Programming model of the 68000 microprocessor.

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MICROPROCESSOR DATA BOOK
by S.A. Money
427/062 Pub. Pr., \$35.00 Club Pr., \$27.00

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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.

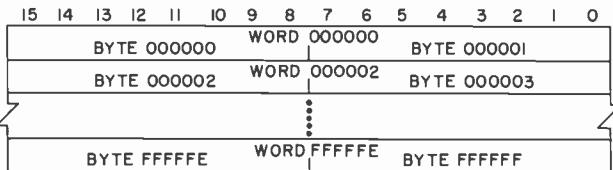


Fig. 2. The memory organization can directly address 2^{24} bytes.

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

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 addressing 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 helps 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 environ-

ments. 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, in-

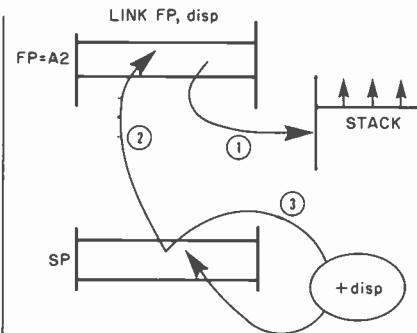


Fig. 3. How the LINK basic instruction is implemented.

cluding 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.

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 re-

quires 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 UDS and 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 (AS) indicates the beginning of a memory access and the data transfer acknowledge (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/W) line is set to show a read of memory. At time (2), the address strobe (AS) signal is asserted to indicate the beginning of a bus cycle, and the lower data strobe (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 DTACK signal to show that the data is available. The processor then latches the data into the chip and negates the 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

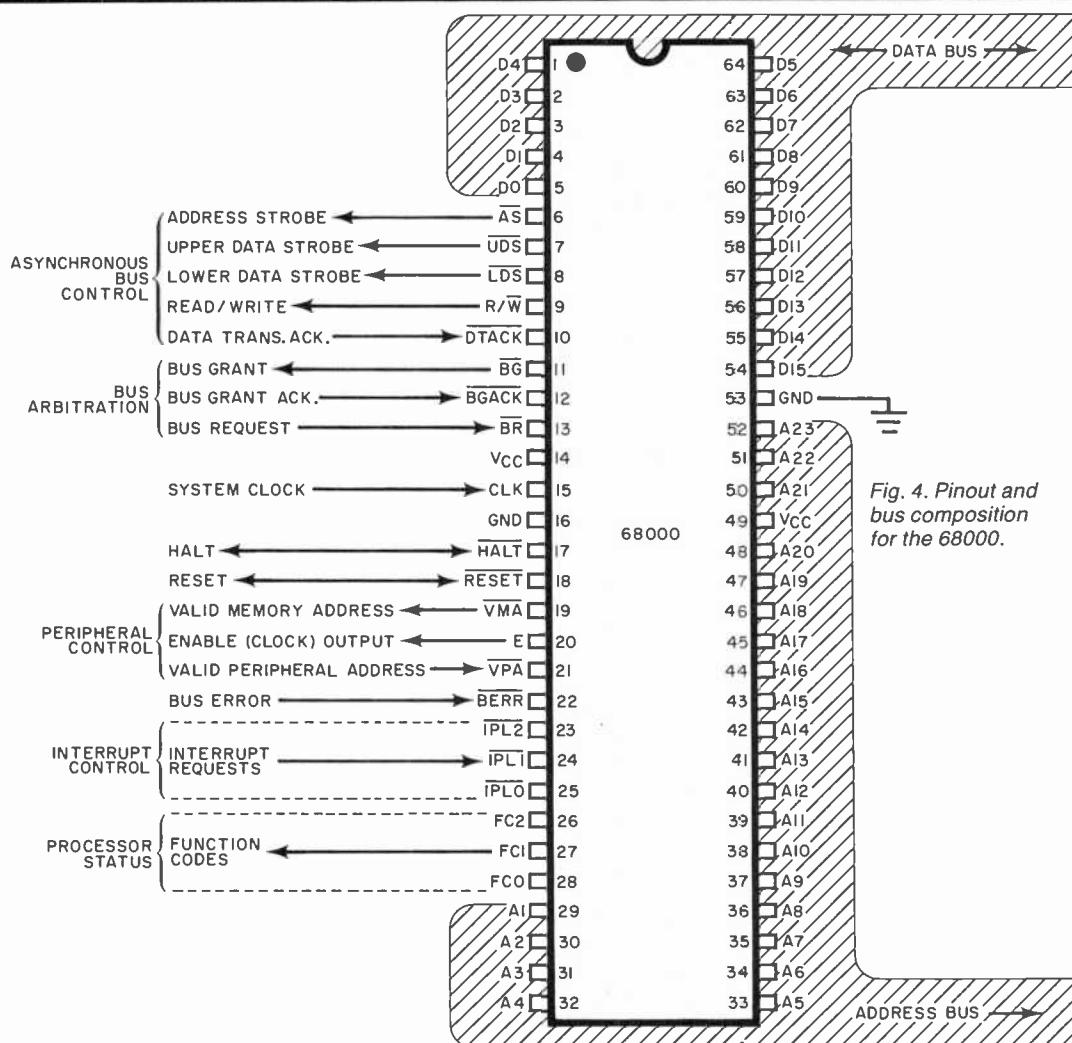


Fig. 4. Pinout and bus composition for the 68000.

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 (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 (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 (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 (IPL_0 - 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 ac-

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

cesses. 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.

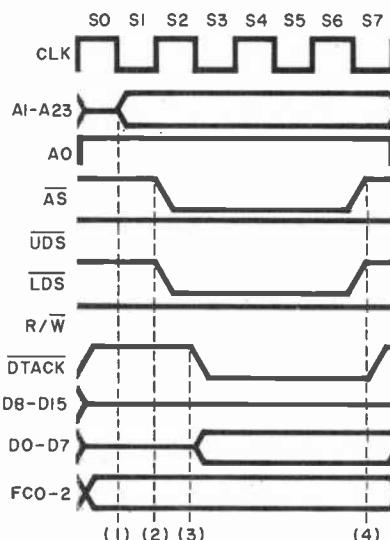


Fig. 5. Timing diagram of a byte read cycle.

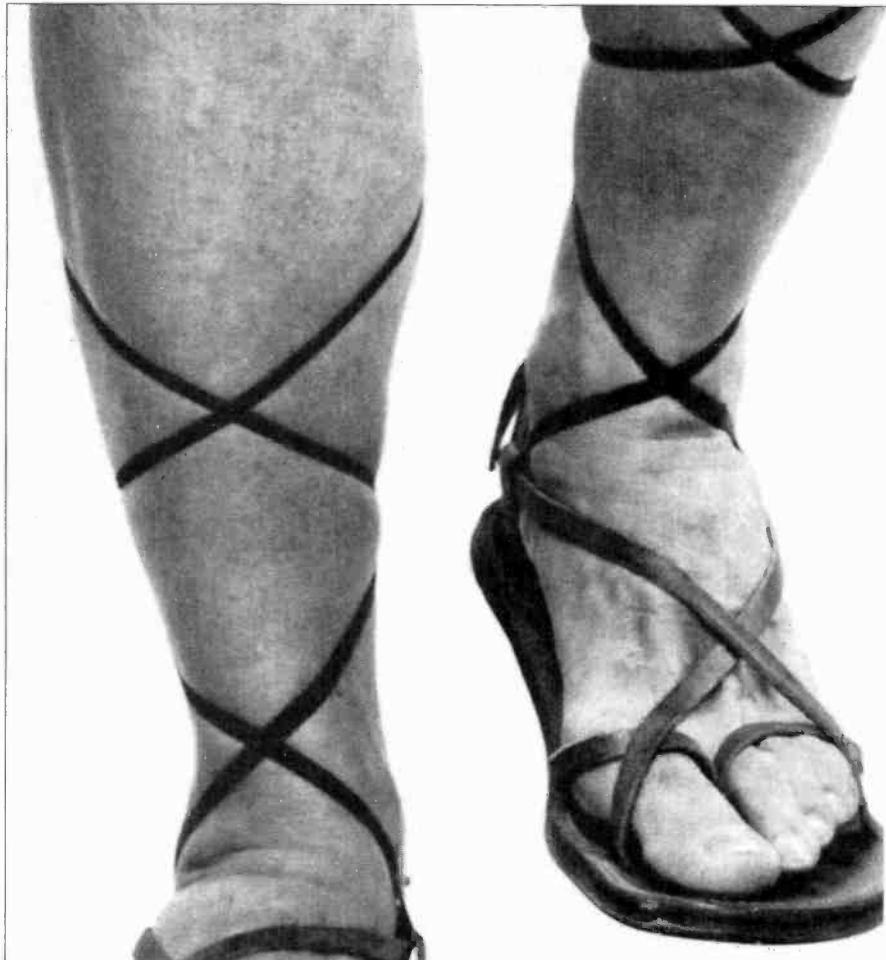
Another typical 16-bit CPU is the Mostek MK68200 optimized for control applications. It contains 4K bytes of ROM, 256 bytes of RAM, and three 16-bit timers. It can be slaved to a 68000. The MC68010 supports virtual memory and virtual machine, terms formerly associated only with mainframes.

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



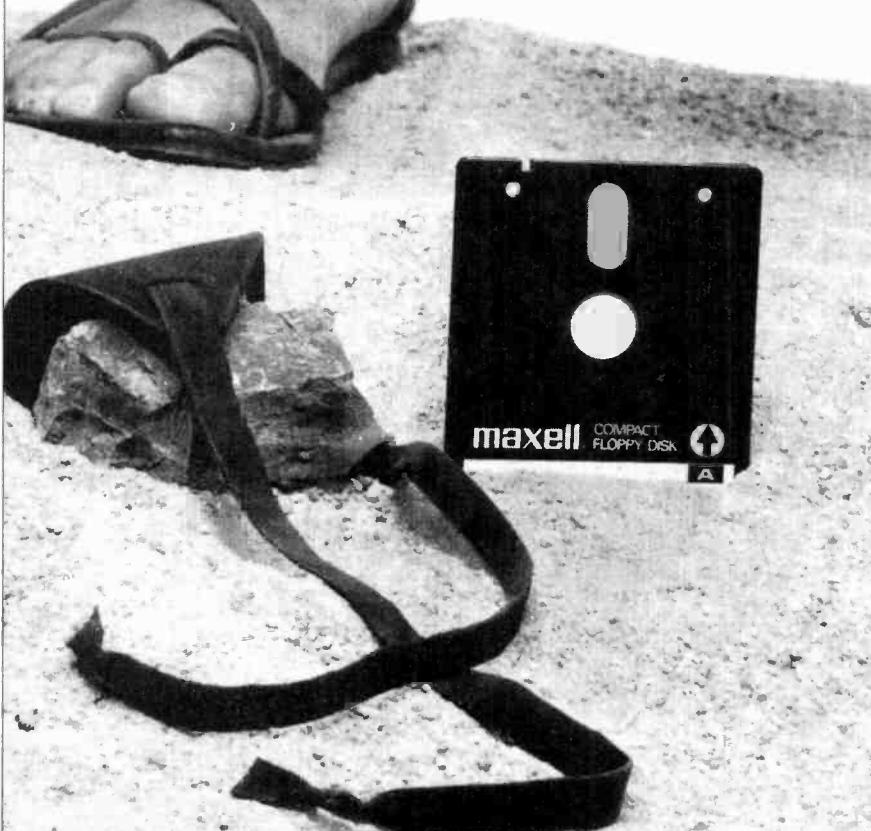
The 3" vs. 3 1/2" Minifloppy Battle

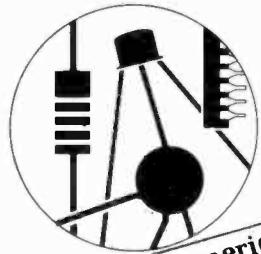
By Leslie Solomon

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





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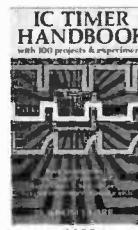
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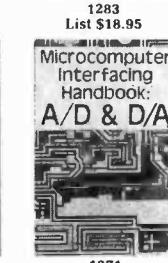


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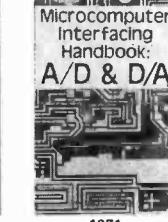
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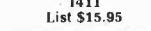
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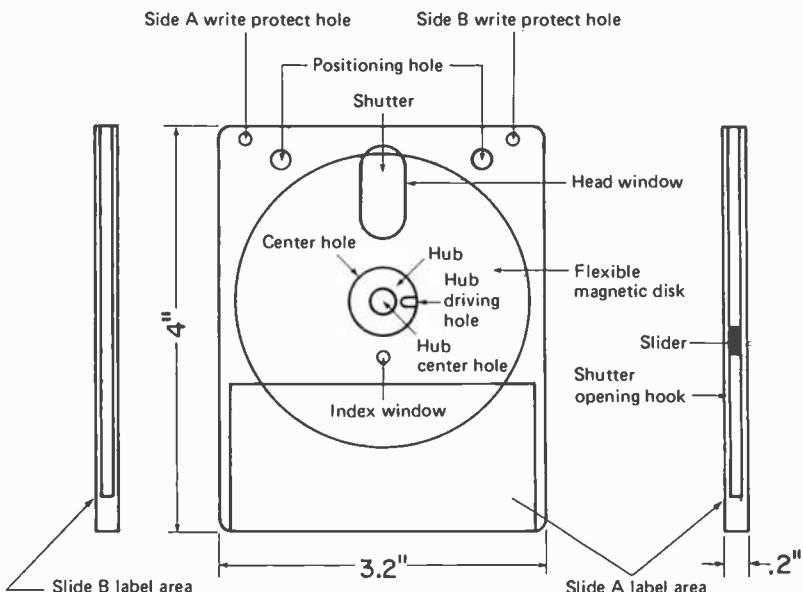
even stored in one's jacket pocket.

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 5½" 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 5½" 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 5½" 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



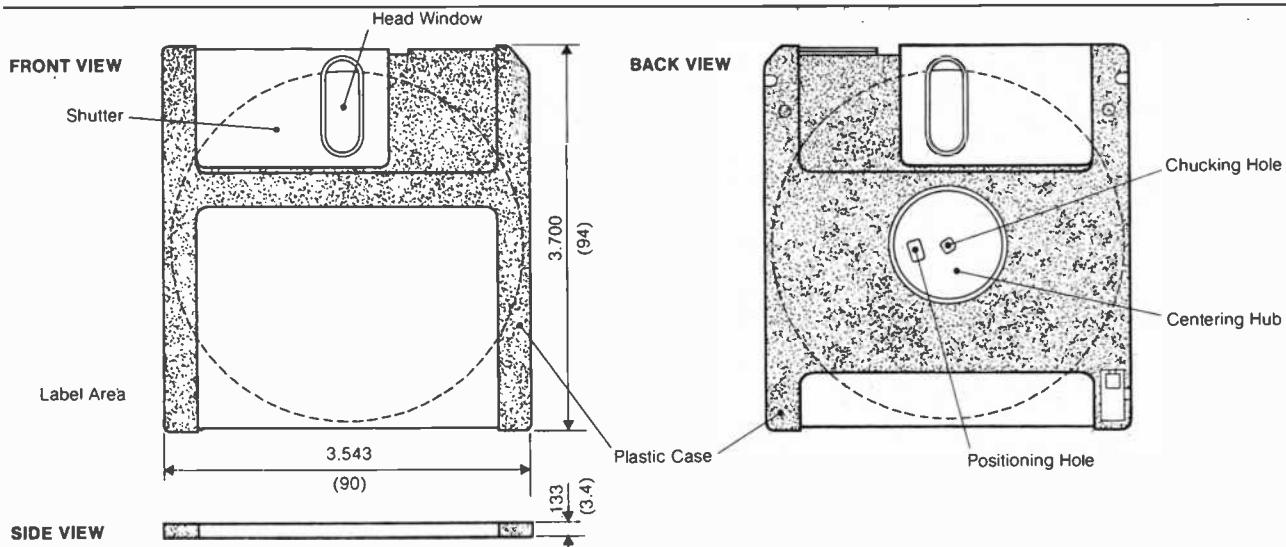
Construction of the Hitachi 3" Compact Floppy Disk

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 Otron, for example, are leaning toward the Hitachi approach, while Jonos Ltd. and



Physical parameters of the Sony Micro Floppy Disk.

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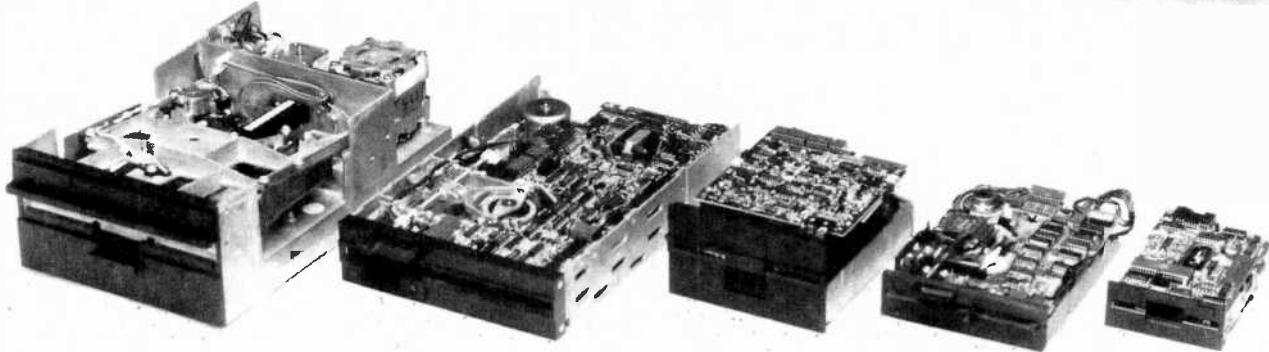
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The shrinking world of disk drives is shown by a conventional 8" at left, followed by a half-size 8", conventional and half-size 5 1/4", and 3 1/2" drive at far right.

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 5 1/4" 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 5 1/4" sys-

tems. The diskette magnetic coating has the same recording capacity as a double-density 5 1/4", making it possible to transmit data from a 5 1/4" 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
Per disk	161.2	322.5	164	184
Per track	2.3	4.6	2.048	2.304
Per sector	256	512	128	256
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 5 1/4" diskette, the floppy disk drive volume appears to be about 75% smaller than the 5 1/4" 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.

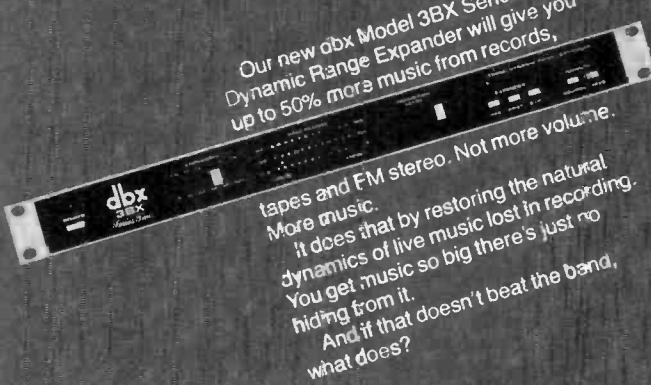
Tandon who is looking into the Sony approach, uses a double-sided diskette that can support 875K bytes, and a drive that is only 1½" H × 4" W × 6½" D.

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 QTC, 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. ◇

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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 McIntosh 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

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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.

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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.

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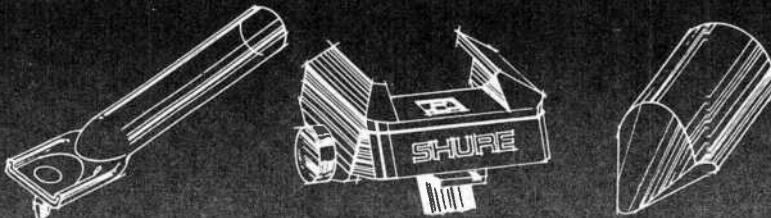
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COMPUTER HOTLINE

A monthly column devoted to answering your questions on computers

By Stan Veit

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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.



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...HOTLINE

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

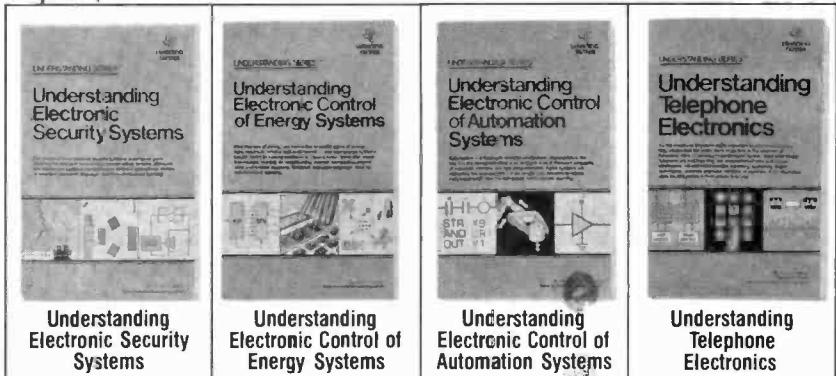
Q. We are about to buy a personal

computer to use in our business, the principle use of which will be applications using electronic spreadsheets. Can you help in selecting a machine for this purpose?—I. Fila, Racine, WI.

A. Electronic spreadsheets such as Visicalc, Supercalc, 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. ◇

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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.

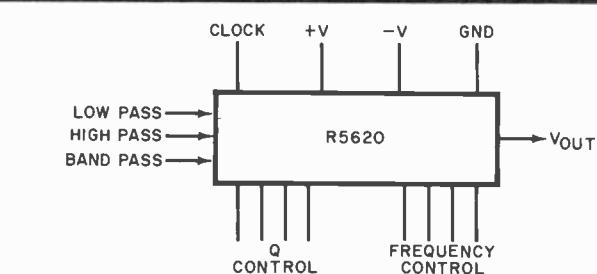
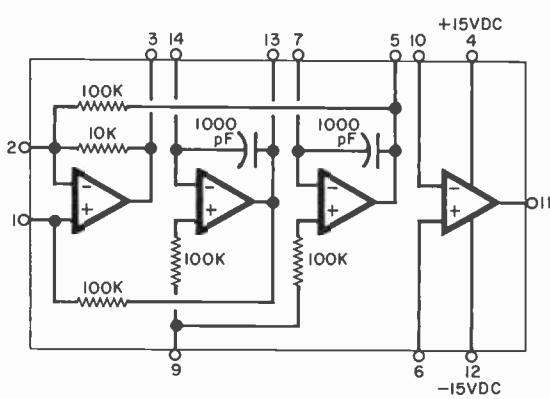
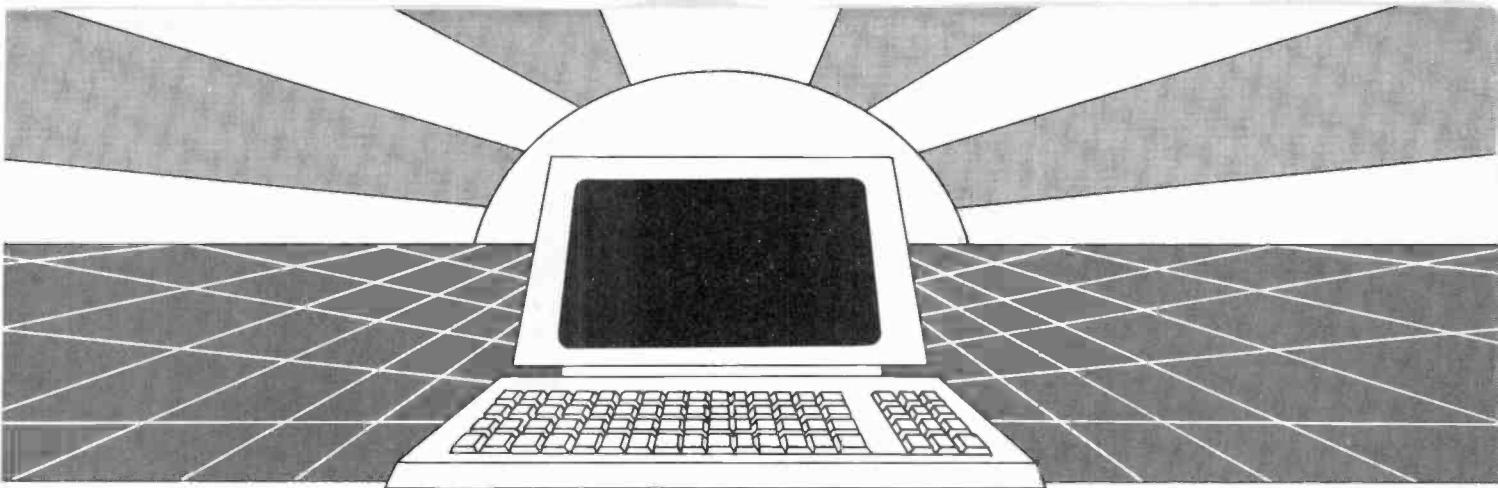


Fig. 2. External connections to R5620 Universal Active Filter.

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



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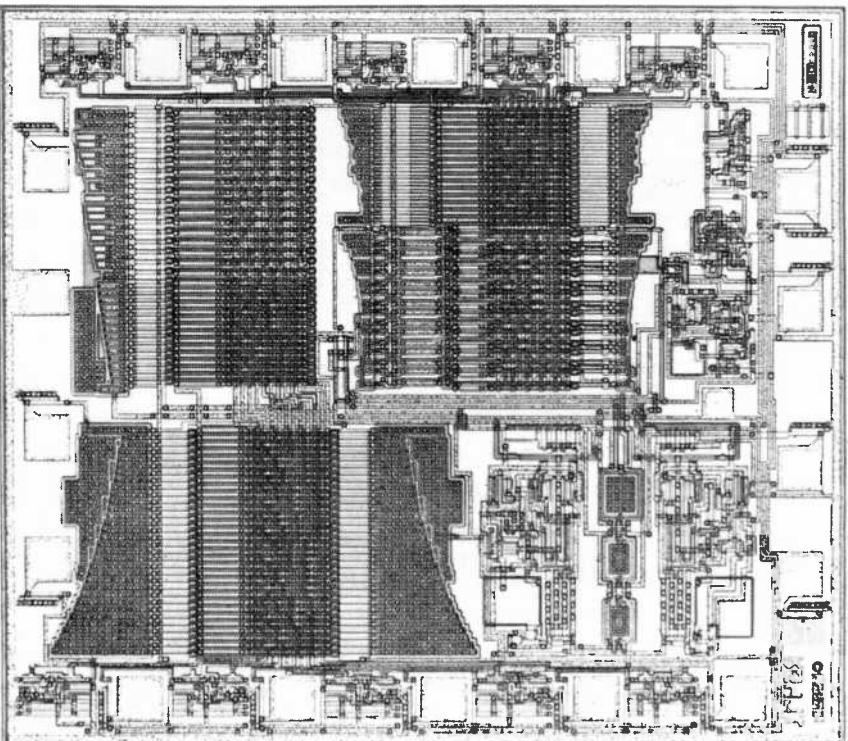
A New CMOS Microcontroller. Four-bit dedicated microcontrollers are widely used in a host of consumer applications. Recently, there's been a major swing from NMOS to CMOS microcontrollers, and now the number of CMOS units is nearing the NMOS total.

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 μ W. Furthermore, the CMOS part is much faster. When operated from a 5-V supply, its minimum instruction cycle time is only 4 μ s, 11 μ s 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 512×8 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 Guillermin 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).

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 ar-

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

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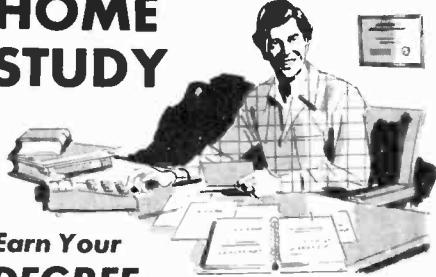


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ray of active regions. Each stripe is 3 micrometers wide and extends the length of the laser. The radiation from adjacent stripes is optically coupled to provide phase locking and transverse mode stability.

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. ◇



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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 Otronix 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 Christensen'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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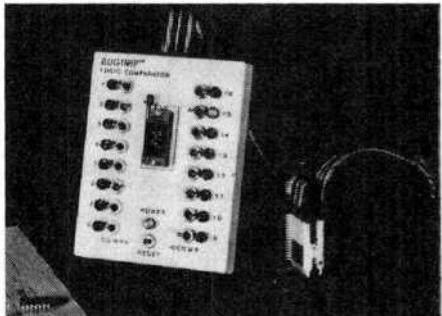
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...COMPUTER BITS

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. A 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 5 1/4" 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. ◇

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EXPERIMENTER'S CORNER

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 ($1'' \times 3'' \times 4.5''$) 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 $1\frac{1}{3}$ 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 $1\frac{1}{3}$ 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

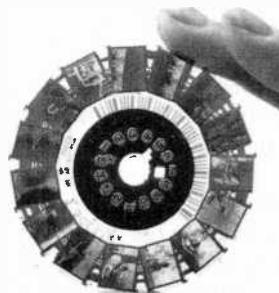


Fig. 2. A processed 15-exposure disc negative showing frame numbers and identification codes.

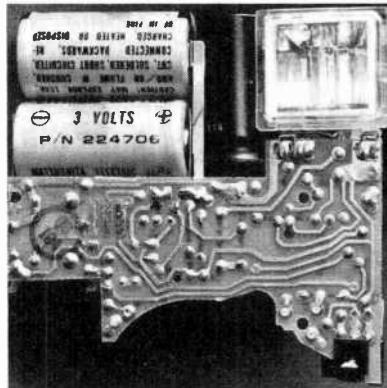


Fig. 3. One version of the circuit board in a disc camera.

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

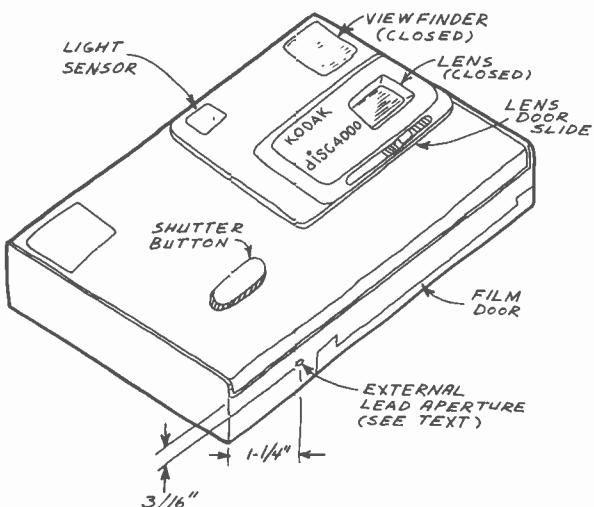


Fig. 4. Location of external leads aperture.

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and be careful to avoid bridging solder between the closely spaced terminals on the board. A rubber-bulb solder slinger 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

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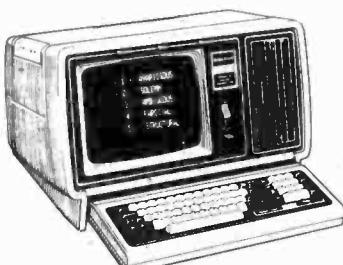
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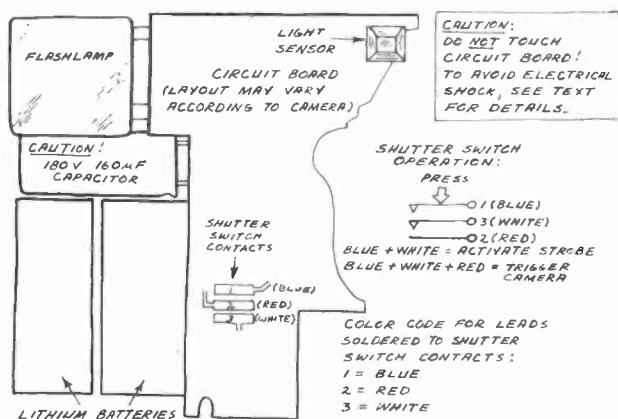


Fig. 5. Connecting leads to the shutter switch terminals.

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. ◇

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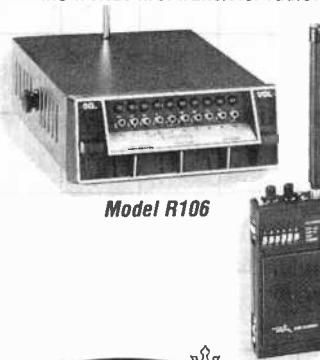
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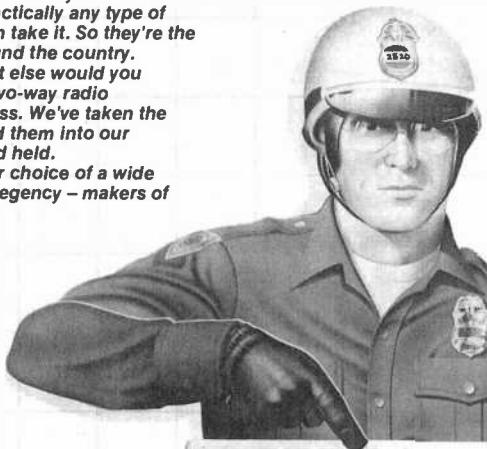
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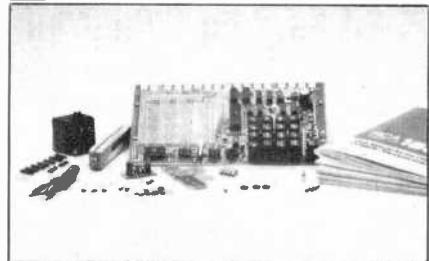
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47	C & D Electronics	107
50	Capar Components Corp.	108
2	Classified Advertising	130,132-138
	Cleveland Institute of Electronics, Inc.	34-37
1	Communications Electronics	119
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53	Focus	110
63	Franklin Computers	69
	Gilco International, Inc.	107
	Grantham College of Engineering	107
21,38	Heath Co.	27,28,29,30,66,67
41	Jameco Electronics	126,127
65	JDR Microdevices	128,129
51	J & R Music World	101
20	Leading Edge	Cover 2
15	McIntosh Laboratory, Inc.	101
26	MFJ Enterprises	117
	Memotech	7
	Microhouse	8,9
17	National Technical Schools	60-63
	Netronics, R & D Ltd.	109,117
	New Horizons	97
	NRI Schools	16-19
29	Pan Am Electronics	114
71	Panasonic	118
4	Protecto Enterprises	57
55	Quest Electronics	130
40	Radio Shack	55,131, Cover 3
6	RCA MicroComputer Products	6
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RF-6300 8-Band AM/FM/SW

This Panasonic Command Series™ shortwave receiver brings the state of the art closer to the state of your pocketbook.



With PLL Quartz Synthesized Tuning and Digital Frequency Readout.

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Communications Electronics, the world's largest distributor of radio scanners, is pleased to introduce Panasonic Command Series shortwave receivers. Panasonic lets you listen to what the world has to say. Unlike a scanner, a Command Series radio lets you listen to shortwave broadcasts from countries around the world, as well as the U.S.A. It's the space age shortwave performance you've been waiting for...at a down to earth price you can afford.

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List price \$749.95/CE price \$529.00

Bands: LW 150-410 KHz, MW 520-1610 KHz, SW1-5 1.6-30 MHz, FM 87.5-108 MHz.

The new Panasonic RF-6300 Command Series PLL synthesized 8-band portable communications receiver, lets you hear the world. The RF-6300 has features such as microcomputer pre-set tuning and PLL quartz synthesized digital tuner. Microcomputer stores up to 12 different frequencies for push-button recall. FM/MW/LW/SW1-5 reception. Manual tuning knob. Wide/Narrow bandwidth selector. Double superheterodyne system. Fast/Slow manual tuning. Built-in quartz digital alarm clock. 5 inch dynamic PM speaker. 3 antennas. Multi-voltage. Detachable AC cord. Operates on 6 "D" batteries (not included). Made in Japan.



Panasonic
RF-6300



RF-4900

Panasonic® RF-4900

List price \$549.95/CE price \$399.00
Bands: MW 525-1610 KHz, SW1-8 1.6-30 MHz, FM 88-108 MHz.

The Panasonic RF-4900 shortwave receiver features a 5-digit fluorescent display for all 8 SW bands, as well as for AM/FM, AC or battery operation. Full coverage from 1.6 to 30 MHz on SW. Covers SSB and CW. Premix Double Superheterodyne. Fast/slow 2 speed tuning. AFC Switch on FM, narrow/wide selectivity switch for AM and SW. Antenna trimmer. Calibration control. FET RF circuit. Mode switch for AM-CW/SSB. BFO Pitch control. ANL switch for AM. RF gain control. Tuning-Battery meter with meter function switch. Separate bass and treble tone control. Dial light switch. Digital display on/off switch. Separate power switch. Rack type handle. Made in Japan.

Panasonic® RF-3100

List price \$369.95/CE price \$269.00
Bands: MW 525-1610 KHz, SW1-29 1.6-30 MHz, FM 88-108 MHz.

The Panasonic RF-3100 portable 31-Band portable radio has PLL Quartz-Synthesizer tuning that "locks" onto SW stations. Operates on AC or battery. SW frequencies from 1.6 to 30 MHz. are in 29 bands. All-band 5-digit frequency readout. Horizontal design with front mounted controls for shoulder strap operation. Double superheterodyne for clean SW reception. BFO pitch and RF gain controls. Separate bass and treble controls. Wide/Narrow bandwidth selector. Meter for tuning and battery strength. LED operation indicator. Meter light switch. 3½" PM dynamic speaker. Comes with detachable shoulder belt. Battery power (8 "D" batteries not included). Made in Japan.

Panasonic® RF-2900

List price \$349.95/CE price \$249.00
Bands: MW 525-1610 KHz, SW1-3 3.2-30 MHz, FM 88-108 MHz.

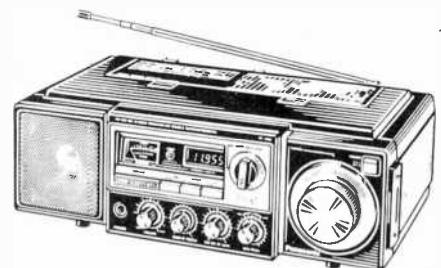
The Panasonic RF-2900 is a portable five-band shortwave radio with digital five digit fluorescent frequency display. Full coverage from 3.2 to 30 MHz. on SW. Covers SSB and CW. Double superheterodyne receiver. Fast/slow two speed tuning. AFC switch on FM, narrow/wide selectivity switch for AM and SW. FET RF circuit. BFO switch and pitch control. RF gain control. Tuning battery meter. Separate bass/treble tone control. SW calibration control. Dial light switch. Digital display on/off switch. Separate power switch. Detachable dial hood included. Rack type handle. Includes whip antenna and ferrite core antenna, speaker, earphone, recording output jacks, AC line and detachable adjustable shoulder belt. Made in Japan.



Command Series
RF-2900

CIRCLE NO. 1 ON FREE INFORMATION CARD

Panasonic Command Series



Panasonic
RF-3100

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To get the fastest delivery from CE of any receiver send or phone your order directly to our Consumer Products Division. Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. All sales are subject to availability, acceptance and verification. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless CE is instructed differently. International orders are invited with a \$20.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance.

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DX LISTENING

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

...DX LISTENING

MONDAY

0810-0825	R. Australia	Spectrum (first, third, fifth Sundays); 11775, 9570	0005-0035	R. Japan	Hullo America; 21610, 17825 (also 0150)
0815-0859	BBC	The Pleasure's Yours; 15070, 11955, 9640, 9510	0010-0028	Kol Yisrael	Calling All Listeners; DX Corner; 15585, 11640, 9815 (also 0210)
1000-1015	R. Korea	Week in Review; 9570	0015-0030	R. Moscow	Moscow Mailbag; 9600 (also 0215)
1100-1115	HCJB	Música Nacional; 11960, 9765, 6050	0015-0030	VOA	Critic's Choice; 17730, 17640, 15205, 9850, 6130, 5995
1100-1130	Sri Lanka B.C.	Radio Monitors International; 17850, 15120, 11835	0015-0055	R. Peking	Music Album; China Anthology; Letterbox; 17855, 17680, 15120 (also 0115, 0215, 0315, 0415)
1115-1129	BBC	Letter from America; 21710, 21660, 11775, 11750, 9510, 6195	0030-0115	BRT, Belgium	Music Box; Radio World; 11695
1130-1159	AFRTS	The Source Report; 15430, 15330, 11805, 9700 (also 1430)	0045-0055	Spanish Foreign R.	DX Program; 11880, 9630 (also 0145 and 0615)
1130-1259	BBC	Play of the Week; 21710, 21660, 11775, 11750, 9510	0100-0145	BBC	Features; 15260, 15070, 11335, 9410, 7325, 6175, 6120, 5975
1140-1155	R. Australia	The Body Program; 9580, 5995	0106-0128	R. Canada Int'l	Shortwave Listeners' Digest; 5960, 11850 (also 0406)
1212-1225	R. Australia	Report from Asia; 9580, 5995	0130-0150	R. Australia	Concert Hall; 21740
1215-1255	R. Peking	Music Album; China Anthology; Letterbox; 9820	0131-0156	Austrian R.	Letter from Austria; Profile; Postbox; 9770, 5945
1231-1249	Austrian R.	Letter from Austria; Shortwave Panorama; 21535	0135-0159	AFRTS	Face the Nation; 21570; 6030 (also 0635)
1235-1259	AFRTS	Perspective # 1; 15430, 15330, 11805, 9700 (also 1735)	0150-0213	Swiss R. Int'l	Various monthly features; 15305, 11715, 9725, 6135 (also 0435)
1307-1328	VOA	New Products: Critic's Choice; 9565; 9545	0200-0257	R. Nacional, Brazil	Sunday Special; 17830, 15290
1310-1320	CBC No. Service	Voice of the Pioneer; 9625, 6065	0210-0228	R. Canada Int'l	Mailbag 5960 (also 0310)
1320-1343	Swiss R. Int'l	Various monthly features; 25780, 21570 (also 1535)	0230-0300	VOA	Studio One; 17730, 15205, 9650, 6130, 5995
1330-1359	CBC No. Service	The Food Show; 9625, 6065	0230-0320	R. Nederland	The Happy Station; 9590, 6165 (also 0530)
1330-1400	VOA	Studio One; 9565; 9545	0239-0244	R. Australia	Australian Perspective; 21740, 17795
1300-1525	R. Finland	Sunday Best; 15400, 21475	0300-0330	Austrian R.	Lieder von Heute; 9770, 5945
1335-1359	AFRTS	Perspective # 2; 15430, 15330, 11805, 9700 (also 1835)	0308-0328	R. Budapest	Various features; 11910, 9835, 9585
1400-1428	R. Sweden	Mailbag; 21615	0330-0345	R. Australia	Spectrum; 17795 (first, third, fifth Sundays)
1405-1659	R. Canada Int'l	Sunday Morning; 17820, 15240, 11955, 9625	0330-0359	BBC	Anything Goes; 9410, 6175, 5975
1430-1458	BBC	Comedy series; 21710, 21660, 15070, 11750	0331-0356	Austrian R.	Letter from Austria; Profile; Postbox; 9770, 5945
1435-1459	AFRTS	Speaking of Everything; 15430, 15330, 11805, 9700 (also 1935)	0335-0359	AFRTS	Meet the Press; 21570, 6030
1459-1529	BBC	African Perspective or Theatre; 21590	0400-0428	R. Budapest	Hungarian History; 11910, 9835, 9585
1515-1559	BBC	Concert Hall; 21710, 21660, 17830, 15260, 11750	0431-0449	Austrian R.	Letter from Austria; Shortwave Panorama; 12015
1535-1559	AFRTS	World News This Week; 15430, 15330, 11805, 9700 (also 2035)	0535-0559	AFRTS	This Week with David Brinkley 6030 (also 1035)
1611-1630	VOA	Voices of Africa; 26040, 15410	0630-0659	BBC	Man, Myth and Music; 15070, 11955, 9510, 6175
1615-1634	BBC	From Our Own Correspondent; 21710, 21660, 17830, 15260, 11750	0730-0750	R. Australia	Concert Hall; 11775, 9570
1630-1700	HCJB	Selecciones Interamericanas; 15160	0830-0859	BBC	Anything Goes; 15070, 11955, 9640, 9510
1635-1659	AFRTS	Listen Closely; 15430, 15330, 11805, 9700 (also 2135)	1000-1015	HCJB	Música del Ecuador; 11925, 9745, 6130
1645-1659	BBC	Letter from America; 21710, 21660, 17830, 15260, 11750	1040-1050	R. Korea	Inside North Korea; 9570
1709-1738	BBC	Meridian; (as above)	1130-1159	BBC	Pageant of the Past; 25650, 21710, 21660, 11750, 9510
1715-1730	R. France Int'l	P.O. Box 9516; 21580, 21515, 17860	1210-1229	R. Finland	Voices of Finland; 15400, 21475 (also 1310, 1410)
1715-1744	BBC	African Perspective or Theatre; 21470	1211-1226	R. Moscow	Science & Engineering; 9600
1807-1859	R. Canada Int'l	Bonsoir Africa; 17820, 15260	1215-1244	BBC	Quiz program; 21710, 21660, 11775, 11750, 9510
1830-1900	VOA	Music Time in Africa; 26040, 15600	1234-1256	Austrian R.	Profile of Austria; Post Box; 21535
1830-1959	CBC No. Service	The Entertainers; 11720, 9625	1240-1250	R. Australia	Australian Perspective; 9580, 5995
1915-2000	BRT, Belgium	Music Box; Radio World; 17595	1315-1340	R. Japan	DX Corner; Crossroads; 9505, 11815
2010-2028	Kol Yisrael	Calling All Listeners; DX Corner; 15585, 11640, 15475, 13745	1345-1414	BBC	Documentaries; 21710, 21660, 15070, 11750
2015-2029	BBC	Letterbox; 15260, 15070, 12095	1415-1427	CBC No. Service	Steven Freygood's Shortwave Report; 11720, 9625
2030-2120	R. Nederland	The Happy Station; 21685, 17695, 17605, 15220, 9715	2130-2159	BBC	London Sinfonietta; 15260, 15070, 12095, 9410
2105-2159	CBC No. Service	Drama; 11720, 9625	2130-2200	HCJB	DX Party Line; 21477.5, 17860, 15340
2113-2128	VOA	Critic's Choice; 26040, 15410, 9760	2330-2359	BBC	Quiz Program; 15260, 9590, 9410, 7325, 6175, 6120, 5975
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.)			

(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 $\frac{1}{4}$ " mechanical paper punch to cut identical circles of foil and a cylinder of conductive foam. After sol-

dering 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-constant 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 R_3 . Pressure applied to R_1 lowers its resistance, thus increasing the voltage applied to the comparator's noninverting input. When this voltage exceeds the reference voltage determined by R_3 , the comparator

output swings to near the positive supply voltage. This turns on Q_1 and illuminates LED_1 .

The circuit in Fig. 3 has practical applications as an input stage to a pressure-sensing logic circuit or microcomputer. Resistor R_3 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). ◇

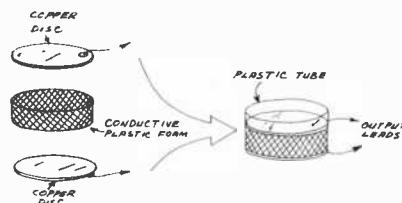


Fig. 1. Pressure-sensitive resistor.

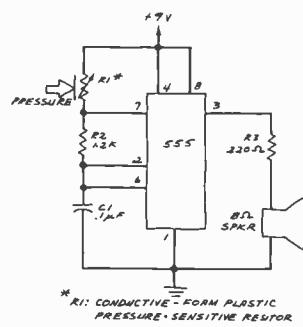


Fig. 2. Tone generator.

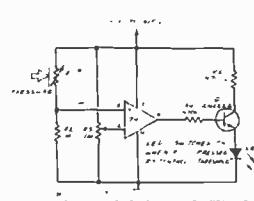


Fig. 3. Pressure-controlled comparator.

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. 19-key keypad. Key debouncing built-in. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3 1/2" H x 8 1/4" W x 8 3/4" D.

JE600/DTE-HK (After assembled) \$99.95

JE600 Kit PC Board & Components (no case) \$59.95

K19 19-Key Keyboard (Keyboard only) \$14.95

DTE-HK (case only) 3 1/2" H x 8 1/4" W x 8 3/4" D \$44.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most electronic systems. The kit comes complete with a standard keyboard assembly, a keyboard PCB [62-keys], IC's, sockets, connectors, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-defined 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: 3 1/2" H x 14 1/2" W x 8 3/4" D.

JE610/DTE-AK (After assembled) \$124.95

JE610 Kit 62-Key Keyboard, PC Board, \$ 79.95

K62 62-Key Keyboard (Keyboard only) \$ 34.95

DTE-AK (case only) 3 1/2" H x 14 1/2" W x 8 3/4" D \$ 49.95

NEW! JE212 - Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT. Provides -12V DC from incoming SVDC \$ 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, and 12VDC @ 500mA.
- 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, similar in construction to above)
JE200 Reg. Power Supply Kit (SVDC, 1 amp) \$ 14.95
JE205 Adapter Brd. to JE200 \$ 15.95
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: 3 1/4" x 4 1/4" x 1". Wt. 6 oz.

Model 2830 \$29.95

KEYBOARDS — POWER SUPPLIES



16 1/2" L x 5 1/4" W x 1" H



16 1/2" L x 5 1/4" W x 1" H



23" L x 5 1/4" W x 1" H



18 1/2" L x 5 1/4" W x 1" H

MICRO SWITCH 69-KEY KEYBOARD

Data Entry Keyboard, Enclosed Output: 8-bit Parallel EBC DIC. Switching: Hall Effect, 24-pin Edge Card Connection. Complete with Pin Connection. Part No. B695D12-2 (Fits Into DTE-20 Enclosure) \$19.95 each

DATANETICS 74-KEY KEYBOARD
ASCII Encoded Keyboard, Output: Even Parity ASCII. Supply voltage +5, -12 volt. Switching: Hall Effect, 24-pin Edge Card Connection. Complete with Pin Connection. Part No. KB354 (Fits Into DTE-20 Enclosure) \$29.95 each

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. B85SD18-1. \$29.95 each

MICRO SWITCH 88-KEY KEYBOARD (PARALLEL)
Data Entry Keyboard used in a Dialog 1640 Terminal. Supply Voltage +5V, -12V. Switching: Hall Effect, 24-pin Edge Card Connection. Schematic included. Uses 8048 Encoder Chip. Part No. B85SD12-2 (Fits Into DTE-20 Enclosure) \$69.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED
Output +5VDC @ 1 amp (also +3.0VDC req.) Input 115VAC 50Hz. Two-tone (black/white) self-enclosed case, 6" x 3" cond. black power cord. Size: 6" W x 7" D x 2" H. Wt. 3 lbs. Part No. PS51194 \$19.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED
Output +5VDC @ 1 amp, +3.6-42VDC adj., 400mA or less, 30VAC (isol.) @ 1.5 amp, Input 115VAC 60Hz. Circuit brkr, red/brown, self-align, case w/4 rubber feet, 6 ft. L. 3 cond. blk. pow. cord. On/off switch. 5 1/4" W x 7" H x 2 7/8" D. Wt. 7 lbs. Part No. PS407D \$24.95 each

POWER SUPPLY — 5VDC @ 2.4 AMP REGULATED
Input 115VAC, 47-440Hz. Output 5VDC Adjustment @ 3 amp, 5VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1.0mV rms, 5mV p-p. 2 mounting surfaces. UL recognized. Size: 4" W x 4" L x 2 7/16" D. Wt. 2 lbs. Part No. DPS-1 \$29.95 each

POWER SUPPLY — 5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.5 amp. Fan voh. /power supply select switches (115/230VAC). Output: 5VDC @ 7.5 amp, 12VDC @ 1.5 amp. Blk. pow. cord. 11 1/2" W x 13 1/4" D x 3 1/4" H. Wt. 6 lbs. Part No. PS94V0 \$49.95 each

MULTI-VOLTAGE POWER SUPPLY — +5, +12, -12VOC 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: 12 1/2" L x 4 7/8" W x 3 1/2" H. Part No. RAQ250 \$39.95 each

SORENSEN Regulated Power Supplies

Sorensen's open construction (SOC) power supplies are series-regulated solid-state systems, designed to provide reg. DC voltages at 6 levels (2-28 vrange). 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 have three mounting surfaces (Series A/B, bottom mounting only).

Part No. Series Adjustment Range Input Current Rating Output Voltage Range Output Current Rating Size (Inches) Weight Price

Part No.	Series	Adjustment Range	Input Current Rating	Output Voltage Range	Output Current Rating	Size (Inches)	Weight	Price
2203-2	B	0.2-2.1	0.48	5.0-12.0	4.3-10.0	2 1/2" W x 3" D x 1" H	1.5 lbs	\$18.95
2203-5	B	0.2-2.5	0.55	5.0-12.0	4.3-10.0	2 1/2" W x 3" D x 1" H	1.8 lbs	\$20.95
2203-8	E	4.25-5.5	1.80	15.0-12.0	12.0-14.0	2 1/2" W x 3" D x 1" H	3.8 lbs	\$38.95
2203-12	F	4.25-8.25	2.50	21.5-17.5	18.0-24.0	2 1/2" W x 3" D x 1" H	4.8 lbs	\$49.95
2203-16	E	11.4-12.5	3.0	12.0-17.5	8.8-14.0	2 1/2" W x 3" D x 1" H	4.8 lbs	\$49.95
2203-20	E	14.25-15.75	5.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	6.8 lbs	\$59.95
2203-25	E	14.25-16.75	5.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	7.8 lbs	\$69.95
2203-30	E	14.25-18.75	6.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	8.8 lbs	\$79.95
2203-35	E	14.25-20.75	6.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	9.8 lbs	\$89.95
2203-40	E	14.25-22.75	7.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	10.8 lbs	\$99.95
2203-45	E	14.25-24.75	7.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	11.8 lbs	\$109.95
2203-50	E	14.25-26.75	8.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	12.8 lbs	\$119.95
2203-60	E	14.25-28.75	8.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	13.8 lbs	\$129.95
2203-70	E	14.25-30.75	9.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	14.8 lbs	\$139.95
2203-80	E	14.25-32.75	9.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	15.8 lbs	\$149.95
2203-90	E	14.25-34.75	10.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	16.8 lbs	\$159.95
2203-100	E	14.25-36.75	10.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	17.8 lbs	\$169.95
2203-120	E	14.25-38.75	11.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	18.8 lbs	\$179.95
2203-140	E	14.25-40.75	11.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	19.8 lbs	\$189.95
2203-160	E	14.25-42.75	12.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	20.8 lbs	\$199.95
2203-180	E	14.25-44.75	12.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	21.8 lbs	\$209.95
2203-200	E	14.25-46.75	13.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	22.8 lbs	\$219.95
2203-220	E	14.25-48.75	13.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	23.8 lbs	\$229.95
2203-240	E	14.25-50.75	14.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	24.8 lbs	\$239.95
2203-260	E	14.25-52.75	14.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	25.8 lbs	\$249.95
2203-280	E	14.25-54.75	15.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	26.8 lbs	\$259.95
2203-300	E	14.25-56.75	15.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	27.8 lbs	\$269.95
2203-320	E	14.25-58.75	16.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	28.8 lbs	\$279.95
2203-340	E	14.25-60.75	16.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	29.8 lbs	\$289.95
2203-360	E	14.25-62.75	17.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	30.8 lbs	\$299.95
2203-380	E	14.25-64.75	17.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	31.8 lbs	\$309.95
2203-400	E	14.25-66.75	18.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	32.8 lbs	\$319.95
2203-420	E	14.25-68.75	18.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	33.8 lbs	\$329.95
2203-440	E	14.25-70.75	19.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	34.8 lbs	\$339.95
2203-460	E	14.25-72.75	19.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	35.8 lbs	\$349.95
2203-480	E	14.25-74.75	20.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	36.8 lbs	\$359.95
2203-500	E	14.25-76.75	20.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	37.8 lbs	\$369.95
2203-520	E	14.25-78.75	21.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	38.8 lbs	\$379.95
2203-540	E	14.25-80.75	21.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	39.8 lbs	\$389.95
2203-560	E	14.25-82.75	22.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	40.8 lbs	\$399.95
2203-580	E	14.25-84.75	22.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	41.8 lbs	\$409.95
2203-600	E	14.25-86.75	23.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	42.8 lbs	\$419.95
2203-620	E	14.25-88.75	23.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	43.8 lbs	\$429.95
2203-640	E	14.25-90.75	24.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	44.8 lbs	\$439.95
2203-660	E	14.25-92.75	24.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	45.8 lbs	\$449.95
2203-680	E	14.25-94.75	25.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	46.8 lbs	\$459.95
2203-700	E	14.25-96.75	25.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	47.8 lbs	\$469.95
2203-720	E	14.25-98.75	26.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	48.8 lbs	\$479.95
2203-740	E	14.25-100.75	26.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	49.8 lbs	\$489.95
2203-760	E	14.25-102.75	27.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	50.8 lbs	\$499.95
2203-780	E	14.25-104.75	27.5	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H	51.8 lbs	\$509.95
2203-800	E	14.25-106.75	28.0	12.0-17.5	7.0-14.0	2 1/2" W x 3" D x 1" H</		

**4164 64K DYNAMIC \$6.25
200 NS**

**TMM2016 2KX8 STATIC \$4.15
200 NS**

ALL MERCHANDISE 100% GUARANTEED!

CALL US FOR VOLUME QUOTES

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

	Capacity	Intensity	(μ W/Cm ²)
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

SOND 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
7220	99.95
CRT5027	39.95
CRT5037	49.95
DP8350	49.95

BIT-RATE GENERATORS

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
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
TMS56011	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
MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MM5832	6.95

CLOCK CIRCUITS

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

12.0 Mhz

Z80B-CPU	29.95
Z80B-CTC	39.95
Z80B-PIO	3.50
Z80B-SIO/0	1.80
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74LS00	.24	74LS86	.39	74LS169	1.75	74LS323	2.75
74LS01	.25	74LS90	.55	74LS170	1.49	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.69	74LS352	1.29
74LS03	.25	74LS92	.55	74LS174	.55	74LS353	1.29
74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS211	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	9.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
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7403	.19	74142	.25	4006	.89	4538	1.95
7404	.19	74143	.25	4007	.29	4539	1.95
7405	.25	74145	.60	4008	.95	4543	1.19
7406	.25	74147	.75	4009	.39	4555	.95
7407	.29	74148	1.20	4010	.45	4556	.95
7408	.24	74150	1.35	4011	.25	4581	1.95
7409	.19	74151	.55	4012	.25	4582	1.95
7410	.19	74152	.65	4013	.38	4584	.75
7411	.25	74153	.55	4014	.79	4585	.75
7412	.30	74154	1.25	4015	.39	4702	12.95
7413	.35	74155	.75	4016	.39	74C00	.35
7414	.49	74156	.65	4017	.69	74C02	.35
7415	.25	74157	.55	4018	.79	74C04	.35
7416	.25	74164	.85	4024	.65	74C32	.39
7417	.25	74165	.85	4025	.29	74C42	1.29
7418	.45	74166	1.00	4026	1.65	74C48	1.99
7419	.45	74167	2.95	4027	.45	74C73	.65
7420	.19	74170	1.65	4028	.69	74C74	.65
7421	.35	74172	5.95	4029	.79	74C76	.80
7422	.35	74173	.75	4030	.39	74C83	1.95
7423	.29	74174	.89	4034	1.95	74C85	1.95
7424	.29	74175	.89	4035	.85	74C86	.39
7425	.35	74176	.79	4040	.75	74C89	4.50
7426	.23	74177	.75	4041	.75	74C90	1.19
7427	.49	74178	1.65	4042	.69	74C93	1.75
7428	.35	74179	1.15	4043	.29	74C174	1.19
7429	.35	74180	.75	4044	.79	74C175	1.19
7430	.35	74181	2.25	4046	.85	74C150	5.75
7431	.69	74184	2.00	4047	.95	74C151	2.25
7432	.19	74185	2.00	4050	.35	74C157	1.75
7433	.23	74186	18.50	4051	.79	74C160	1.19
7434	.23	74190	1.15	4053	.79	74C161	1.19
7435	.45	74191	1.15	4060	.85	74C162	1.19
7436	.23	74192	.79	4066	.39	74C163	1.19
7437	.34	74195	.85	4068	.39	74C164	1.39
7438	.33	74196	.79	4071	.29	74C174	1.19
7439	.45	74197	.75	4072	.29	74C175	1.19
7440	.35	74198	1.35	4073	.29	74C192	1.49
7441	.59	74199	1.35	4075	.29	74C193	1.49
7442	1.10	74221	1.35	4076	.79	74C195	1.39
7443	.95	74246	1.35	4078	.29	74C200	5.75
7444	.50	74247	1.25	4081	.29	74C221	1.75
7445	.59	74248	1.85	4082	.29	74C373	2.45
7446	.35	74249	1.95	4085	.95	74C374	2.45
7447	2.15	74251	.75	4086	.95	74C901	.39
7448	.35	74252	2.25	4093	.49	74C902	.85
7449	.50	74273	1.95	4099	1.95	74C905	10.95
7450	.35	74276	1.25	41409	12.95	74C906	.95
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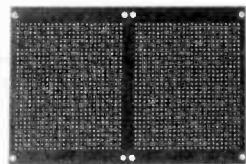
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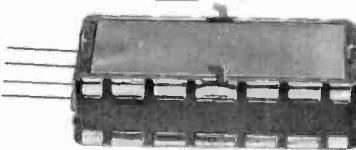
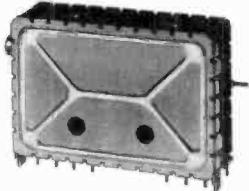
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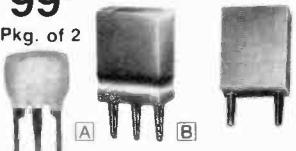
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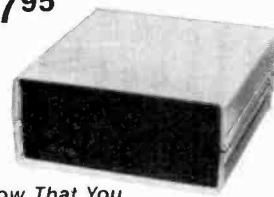
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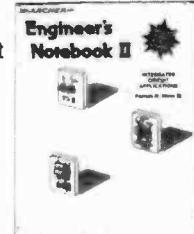
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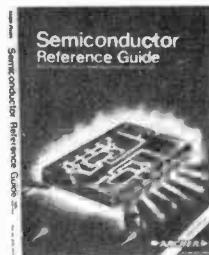
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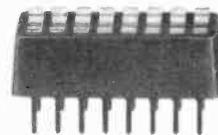
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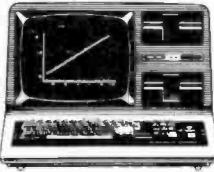
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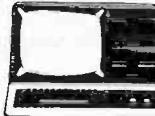
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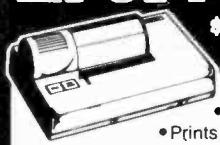
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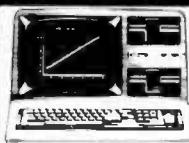
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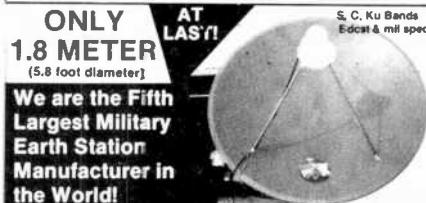
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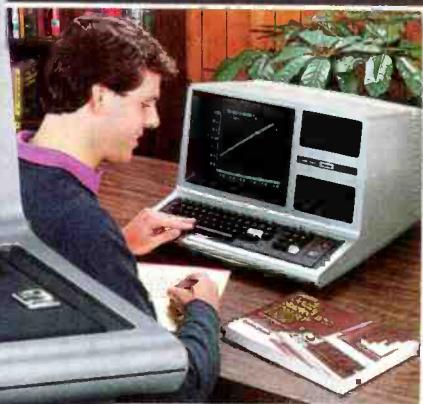
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