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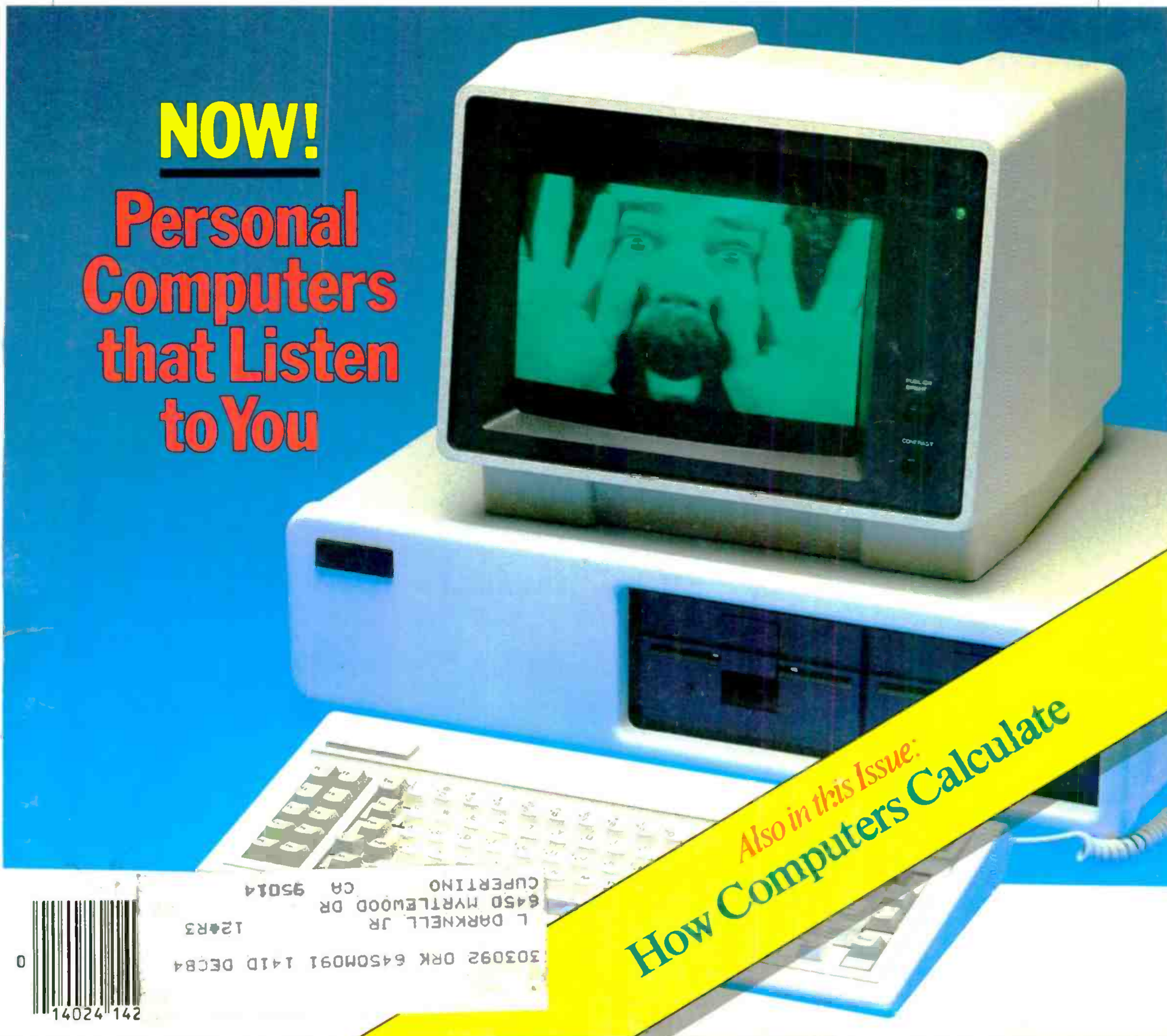

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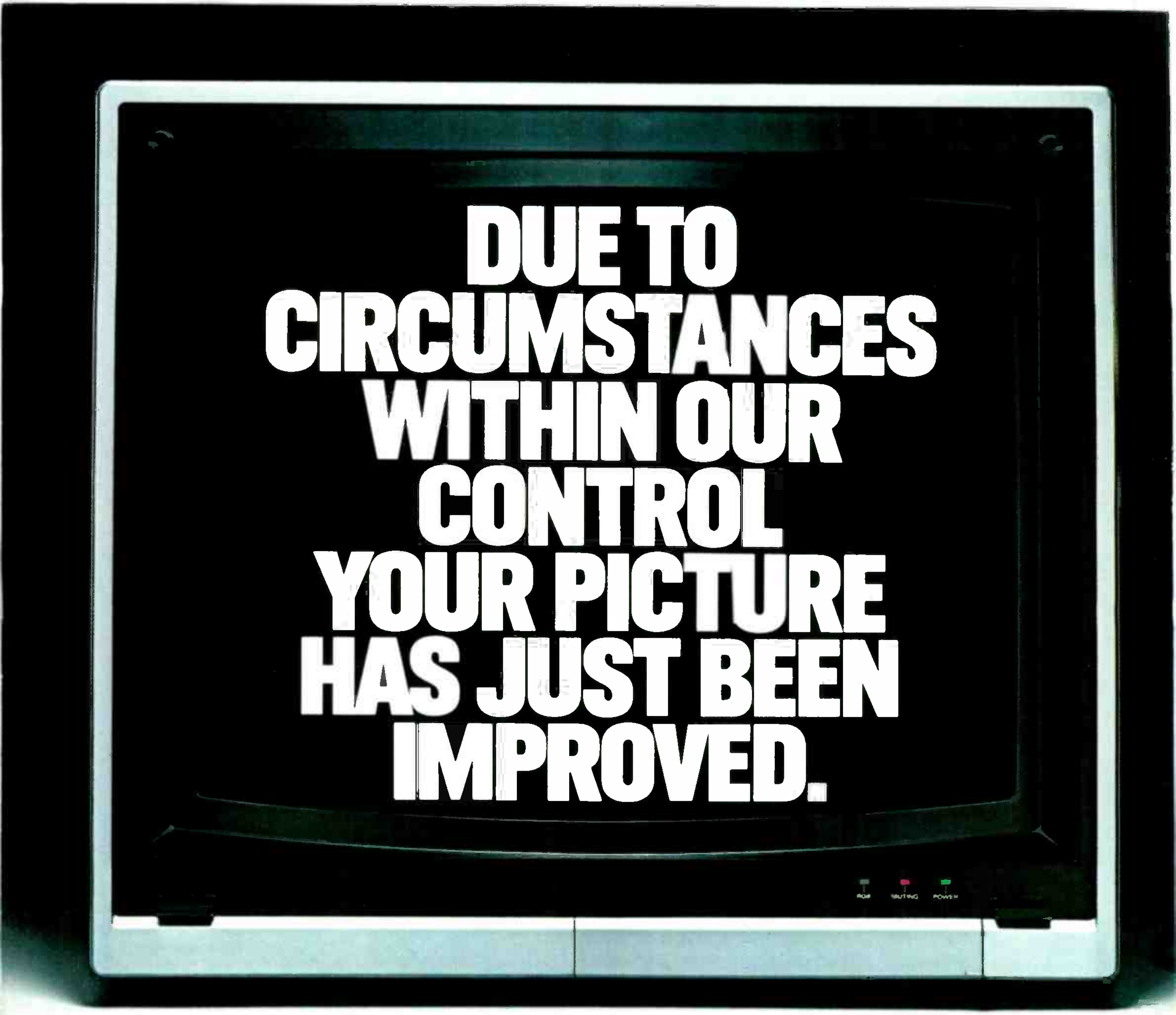

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DECEMBER 1983 VOLUME 21, NUMBER 12

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COVER PHOTOGRAPH BY TRUMAN MOORE

Now from Timex...a powerful new computer.

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Timex introduces a second generation of home computers designed with one purpose in mind: to be useful.

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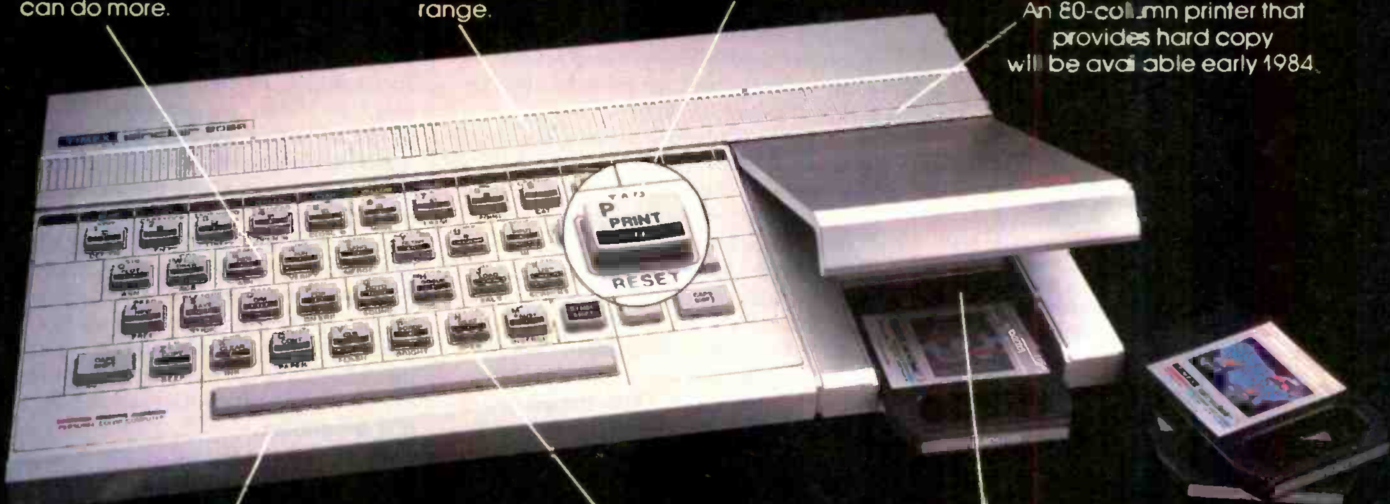

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EDITORIAL

The Year That Was

It was October 3, 1983. "Hello, Barbara," I greeted Coleco's public relations contact at the other end of a telephone line. "How is 'Adam' today?"

Adam wasn't too well, it seemed, though Barbara's exuberant voice didn't betray a hint of this. "It's worth waiting for," she chimed, alluding to the interminable delays in providing reviewers with a sample they could examine.

Adam, as you likely know, is the "family" computer system, announced last June at a trade show, that caused Wall Street analysts to purr and writers about computers to herald its introduction as the first glimpse of a brave new computer world. Causing all the fuss was a computer that comes with a built-in word-processor system and includes a letter-quality daisy-wheel printer for the unlikely package price of $600 before discount.

Full-page advertisements in *The Wall Street Journal* proclaimed its sterling attributes. Everyone waited for a "hands-on" look at it; department and chain store buyers lined up to place orders for the machine that was displayed originally under a smoked-glass enclosure.

It's been four months since the prototype Adam was unveiled. The bloom faded as the green leaves turned brown and no production model was in sight. Ongoing journalistic outpourings stoked the fire, though. It has become sort of a computer-business soap opera: Production is held up owing to time-consuming FCC tests. . . tape data access time was said to be slowed to ensure reliability. . . part of the system failed FCC tests. . . the word-processor software is being debugged. . . suggested retail price now appears to be hovering around $700. . . Adam passed its r-f interference tests. . . Christmas-season sales aren't too important because Adam will be a year-round seller . . arbitrageurs are taking short positions on Coleco stock. . . WP shortcomings were noted during a controlled demonstration last week. . . etc.

In the background of Coleco's corporate siren song has been a bevy of rumors about the impending introduction of other new computers that would shake the industry to its toes. Apple's "Macintosh," for instance, which is reputed to be a small, Lisa-like computer. Another is IBM's alleged preparations to launch a home computer, code-named "Peanut." In fact, I can't recall as much press copy ever written about a product that has never been officially mentioned by its company.

"It is expected to sell for $900 retail." "It will sell for $800." "It'll have 4" disk drives." "Uses 3½" drives." "Will not have an open bus." "No internal expansion." "Upward-compatible with the IBM PC." "Manufactured by another U.S. company, not through Boca Raton, FL nor Greenock, Scotland." "Will be launched in September." "Will be introduced in October." "Won't be sold in 1983." And so on.

Hot on the heels of IBM's non-announcement of its new home computer, there was supposition about the appearance of its new portable—to be called "Crackerjack." Reportedly upward-compatible with the IBM XT, this ghostly computer would cost between $2000 and $4000, said the gossips. But, wait, how about "Popcorn"? A $10,000 competitor to Apple's Lisa, it is reportedly a 32-bit multi-user/multi-task workstation that uses the Unix operating system rather than MS-DOS and a 68000 CPU instead of the PC's 8088 microprocessor.

And speaking of Unix, whatever happened to the Unix-based AT&T computers that were reportedly being readied for 1983 introduction? Word has it that the information-processing giant plans to bundle the multi-user operating system into 32-bit virtual machine chips it is developing.

So maybe the year that was will go down as the year of the "Hype." Meanwhile, Season's Greetings and Happy New Year.

Art Salsberg

LETTERS

MORE ON VIC-20 RECORDING

Regarding "A VIC-20 Cassette Adapter" and a letter on the same subject, both in your September issue, I decided to use a Radio Shack CTR-41 recorder with my VIC-20 (for which I paid only $88) because I couldn't see putting out more for a recorder than I had for the computer. I put together a little interface with an op amp to recover the cassette audio and a 7414 for TTL input to the VIC-20. It worked fine until I picked up a tape made on a VIC-20 recorder. I couldn't load the tape. Then I found an interface at a hamfest and it worked fine with the VIC-20 tape but not with the tapes made with my old recorder. Examining signals on a scope showed that the Radio Shack recorder introduced an extra phase inversion when the signal went from the VIC onto the tape and then back out from the tape playback. I wound up adding a 7414 stage in the playback and another in the output line.—*Cal Sondgeroth, Mendota, IL.*

In "A VIC-20 Cassette Adapter," under Use, the instructions are to connect *J3* to the microphone input connector on the VIC-20 computer. This should be the microphone input connector on the cassette recorder.—*B. Okigbo, Minneapolis, MN.*

ABOUT BITS & BYTES

I was glad to see Sol Libes in print again. I have recently missed his column in one of the other magazines.—*A Fan in Spokane.*

I noticed two things in October's "Bits & Bytes" that I believe are wrong. First, DEC is not abandoning production of its 36-bit computer line. It announced the cancellation of Project Jupiter, a 50-MIPS general-purpose 36-bit time-sharing super-computer; but production of the current 36-bit CPUs will be continued for at least five more years. Second, DEC's 36-bit computers are not minicomputers. Excluding the KS-2020 CPU, the KL-10 line is a mainframe computer.—*Joe Smith, Golden, CO.*

ADDRESS CORRECTION

We were pleased to see a reference in the article "Unix the Easy Way" (September, p. 43) to our operating system, "UniFlex." However, we have recently moved to a new location. Our address is: Technical Systems Consultants, Inc., 111 Providence Rd., Chapel Hill, NC 27514 (Tel. 510-920-0540).—*Daniel E. Vanada, Vice President*

OUT OF TUNE

In the "Hex/ASCII/Decimal conversion Chart" (October, p. 68), the ASCII character for hex 0C should read FF not FP; the ASCII characters for hex 5C and 7C are a reverse slash and a vertical rule, respectively. It could be pointed out, also, that the character for hex 27 is an apostrophe and for hex 2C is a comma, since they appear to be identical the way they are shown.

In "Multiple-Character Generation from your Keyboard" (October, p. 66), the designation F on the line from the interface should be deleted.

In "Keyboard Encoding Schemes" (October, p. 79), in Fig. 13, the Delete key should be between 0_{15} and I_7; the Escape key between 0_{11} and I_1; the Line Feed key between) 0_{10} and I_0; and the Carriage Return key between 0_{13} and I_0. To protect the inputs of 4532 from static electricity, add eight resistors (1 megohm each) between the inputs and the negative supply's ground.


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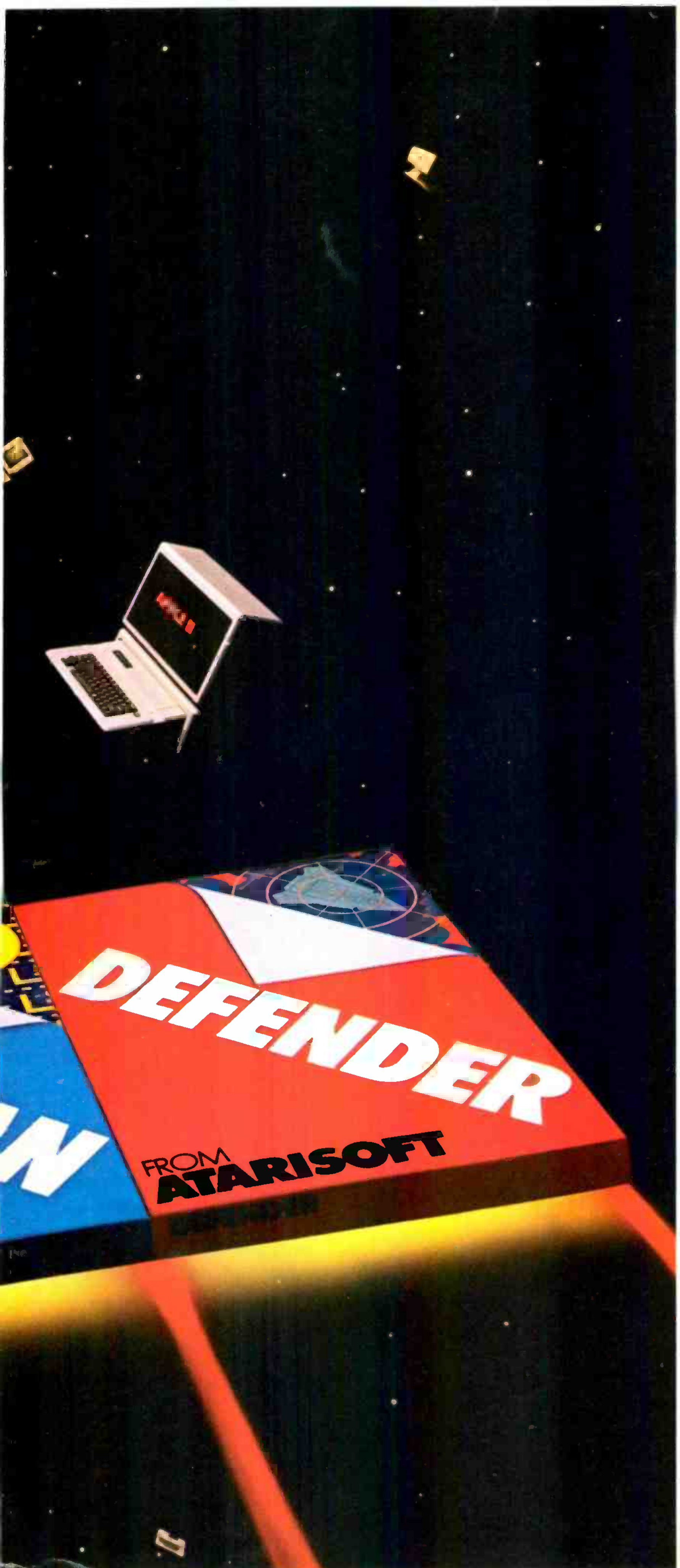

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NEW PRODUCTS

CP/M FOR COMMODORE 64

Now the Commodore C-64 computer can be made CP/M-compatible with the Convert 80 from Estes Engineering, Inc. The power of CP/M comes from a Z-80 with the capability of a disk drive and DMA controller, all on one card that plugs into the C-64's expansion port. The device's versatility comes from its ability to run CP/M software. The interface card with an 8" disk drive is $599; with 5¼" drive, $499; and without drive, $349.

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INTELLIGENT PRINTING BUFFER

Interactive Structures' ShuffleBuffer printing buffer performs mix-and-merge printout operations with any computer equipped with a standard serial or parallel output port. It has the capability of "shuffling" text, graphics, spreadsheet data, and other computer-generated material into any desired combination for printing, plotting, or telephone transmission. It has two additional modes of operation: standard "dumb buffer" function for FIFO printing of material that does not require rearranging or reprinting, and "bypass" to interrupt a printout and produce a separate document on an intermediate basis.

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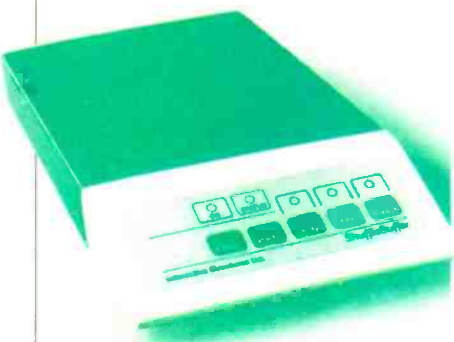

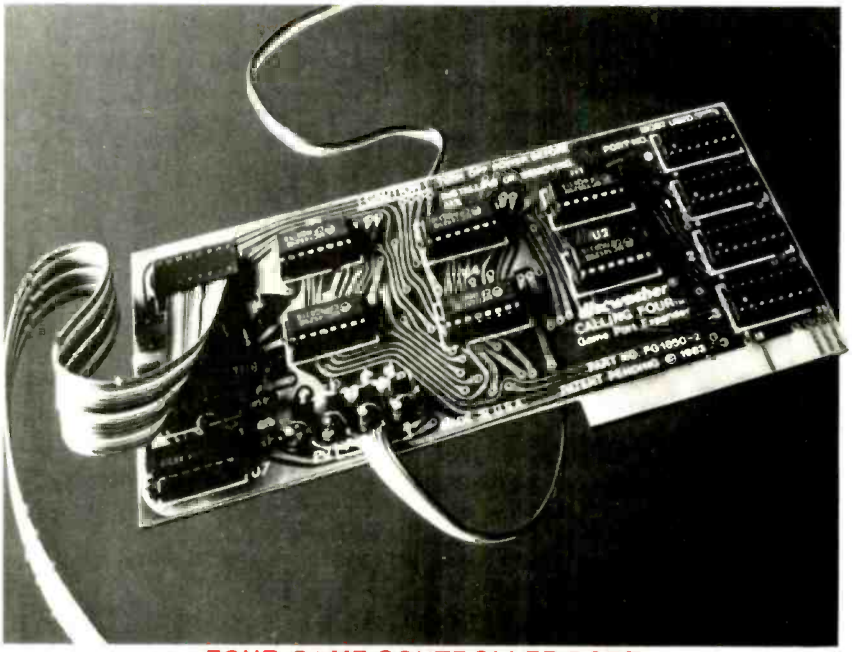

FOUR-GAME CONTROLLER PORT

Discwasher's Calling Four expansion peripheral is designed for use with Apple II, II+, and IIe personal computers. The expander allows the computer to accept such diverse controls as a mouse and a track ball simultaneously, and enables the user to utilize up to four different control devices when writing a program. The card plugs into any one of the computer's expansion slots. Selection of each control is accomplished through simple keyboard entry or software codes. A LED display is used for indicating which of the four ports is in use. Also provided is a demonstration disk containing two programs that illustrate the unit's features. $69.95.

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16-BIT MICROPROCESSOR TRAINER

The Model ET-100 Learning Computer from Heathkit/Zenith Educational Systems is an 8088-based trainer, 16-bit computer, and engineering design and test system all rolled into one. Its standard features include a solderless breadboarding system that provides direct access to all address, data, control, and I/O lines, and four voltage supplies; detached typewriter-style keyboard; 32K of ROM programmed with a CP/M assembler, screen editor, and graphics debugger; 16K (expandable to 64K) of user RAM; cassette port; and composite video output. Price is $999.95 kit, $1499.95 wired and tested. Optional extras include the Model EE-8088 Advanced Microprocessors Course ($99.95) and Model ETA-100 Accessory that adds more memory and I/O ports, disk drive and controller, and a video board ($1299.95 kit, $1999.95 wired and tested).

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COMPUTER ROBOT

The Scorpion from Rhino Robots is a small, sophisticated robot kit for the serious computer hobbyist. It is completely software programmable, with two 6522 interface chips providing 32 lines of I/O and four programmable timers (two can be events counters). It can see, make sounds, and move in any direction at 99 different speeds. The Scorpion controls four motors (two are wheel drives), a speaker, two eyes, two ground tracks, and a two-axis optical scanner. The 6502-based robot comes with 8K of EPROM and 2K of RAM, the latter expandable to 64K bytes. It has the ability to follow a tape on the ground and to read codes on the floor. Its two-axis optical scanner can recognize patterns over a 300° scan horizontally and vertically, with 1.5° resolution of scan per step. The Scorpion follows instructions and answers questions from any host computer with an RS-232C serial interface. $660.

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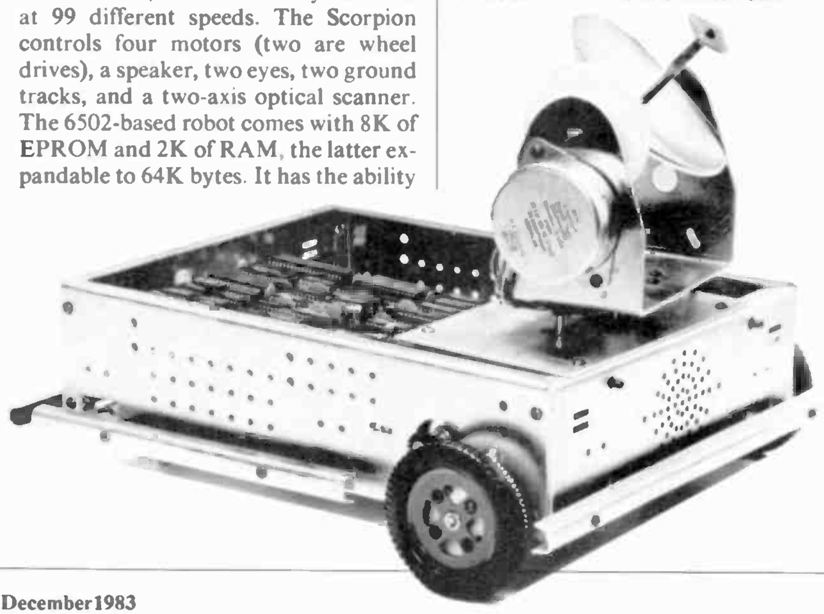

SOFTWARE SOURCES

Financial Planning System. Money Planner from Business Applications Systems is a low-cost financial planning system written for IBM PC and PC-XT and IBM-compatible computers. It lets you plan, budget, forecast, and monitor the effectiveness of your financial activities by providing analyses of three key financial areas: cash flow, net worth, and budgeting. Money Planner is menu-driven and can be used by up to 10 different people or groups, each protected by a special password. Minimum system requirements: 96K of RAM; 80-column video display; two 160K (min.) disk drives; PC-DOS V1.00, V1.10, or V2.00 and diskBASIC; and printer (if printouts are required). $34.50 plus $3.00 S/H. **Address:** BAS, Inc., PO Box 36008, Oaklandon, IN 46236.

Electronic Spreadsheet. PortaCalc from Skyline Marketing is an electronic spreadsheet program for the Radio Shack TRS-80 Model 100 portable computer. It features a 14-column by 26-row workspace and full use of the built-in function keys to save, load, screen print, report print, and look behind the data at the formulas in use. Worksheets can be saved, loaded, or merged, using the computer's memory or cassette. Often-used templates can be saved in memory for instant recall. Two utility programs are included: PortaPrint is an enhancement of the Model 100's text editor that adds the ability to adjust page length and left, right, and top margins and controls page numbering, headers, centering of lines, flush-right justification, and new page selection. PortaDex is a data exchange program that reformats PortaCalc files into DIF format used by VisiCalc. The program is supplied on tape and requires 24K of RAM. **Address:** Skyline Marketing Corp., 4510 W. Irving Park Rd., Chicago, IL 60641.

Software Security System. Secure from Wordmovers can transform files into garbled characters that can be unscrambled only by using the same "keys" that scrambled them in the first place. For extra security, it is possible to encrypt a file more than once. The Secure file-protection program can be used with any computer running under CP/M. $49.95. **Address:** Wordmovers Inc., 15818 Hawthorne Blvd., Lawndale, CA 90260.

NEW PRODUCTS

INK-JET PRINTER

Radio Shack's TRS-80 Model CGP-220 is a "drop on demand" ink-jet printer that can print text and graphics in as many as seven colors. It prints 2600 dots per second in the graphics mode, with a resolution of 640 dots per line. The text mode offers 12 cpi at a speed of 37 (7 × 5) characters per second. Parallel and Color Computer-compatible serial interfaces (600/2400 baud) permit use of the printer with any Radio Shack computer. A screen print utility for the TRS-80 Color Computer allows the printer to create multicolor printouts of color graphics screens produced from any graphics program. $699.

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8/16 BIT PERSONAL COMPUTER

The Rainbow 100+ computer from Digital Equipment Corp. offers 8/16-bit processing and built-in 10M hard disk system, plus dual 5¼" floppy drives. It comes with Z80A and 8088 CPUs; 128K of RAM (expandable to 896K); RS-232C/423 printer and asynchronous/synchronous RS-232C/423 communications ports; memory-mapped video; terminal emulation; and computer-based instruction course called Learn Rainbow. Also supplied with the 100+ is DEC's new Investment Protection Plan. $5475 system unit, $325 video monitor, $245 keyboard, $250 CP/M-80/86 and MS-DOS operating system kit. Owners of Rainbow 100 computers can upgrade to 100+ power with 5M ($1495) or 10M ($2995) hard disk kits that come with the operating system kit.

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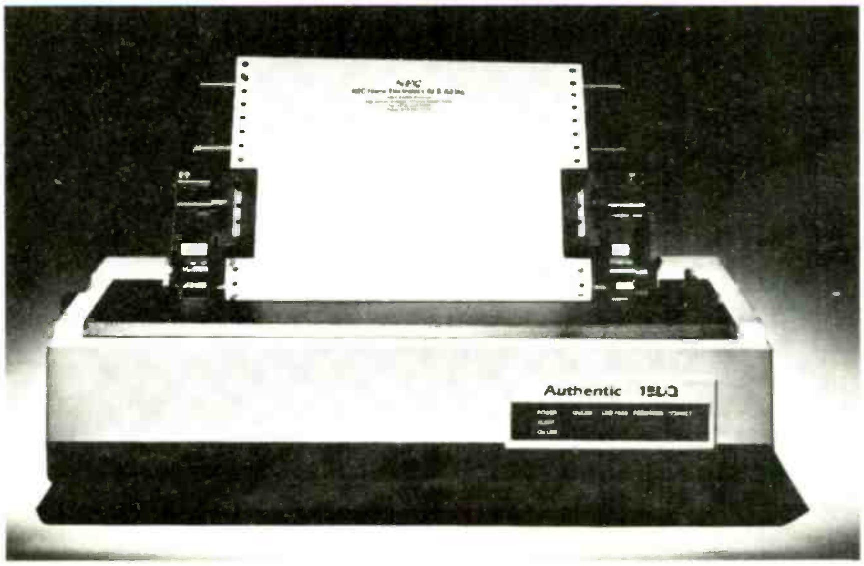

DAISY-WHEEL PRINTER

NEC's Authentic Model 15-LQ daisy-wheel printer provides 10, 12, and 15 cpi pitch, vertical proportional spacing at 10 and 12 cpi, and print speeds up to 14 cps. The bidirectional printer also features a number of word-processing support functions, including boldfacing, superscripting and subscripting, and automatic underlining. It uses 96-character plastic daisy wheels. The letter-quality printer has a built-in Centronics-type parallel interface for connection to a computer. Includes friction and tractor feed. Dimensions are 17½"W × 5"H × 12½"D. $695.

Circle No. 94 on Free Information Card

NEW PRODUCTS

LOGIC ANALYZER ADD-ON

OmniLogic's Model LA-1680 16-channel logic analyzer is an add-on for Radio Shack TRS-80 Models I, III, and 4 computers with 48K of RAM. It provides both state and timing analysis at frequencies up to 20 MHz. Simple menu-driven operation, with "help" pages, are provided for every command and display. The LA-1680 can collect 1000 data samples on each of 16 channels. Triggering modes include the basic AND/OR/NOT, with the trigger point positioned within the 1000-word sample memory. Advanced triggering modes include absence of repetitive event, repeat until correlated with reference memory, and delay by event or time. External trigger and trigger qualifier are also provided. Two connectors supply clock and trigger outputs. $1250.

Circle No. 92 on Free Information Card

COMPUTER/TYPEWRITER SERVICE

Supercord from Cord Ltd. is a patented interface that links nine different electronic typewriters to an even wider variety of personal computers. It is offered in a range of different combinations to enable attachment to specific computers and typewriter models, including RS-232C serial, IEEE-488, and Centronics parallel interfaces. Among the typewriters supported are those from Adler, Brother, Royal, Smith-Corona, and Silver-Reed, with more to come. There is also a Supercord II model that contains a 4K block of print buffer. $395. **Address**: Cord Ltd., 1548 Brookhollow Dr., Santa Ana, CA 92705.

SOFTWARE SOURCES

Graphics Program. Grafox is a stand-alone graphics program written for the IBM PC computer. This is a business graphics package with full color capabilities that draws information directly from any IBM BASIC file or via the Data Interchange Format (DIF). The program is visually oriented and easy to learn, with menu-driven chart description procedures and single-keystroke commands for producing bar, pie, piebar, and line charts. It has the ability to select, sort, average, and total data drawn directly from other databases and then chart it in a variety of ways. $295.

Circle No. 13 on Free Information Card

Introductory Science Software. Software Arts has a new TK!SolverPack for Introductory Science. It includes 12 models, each of which contains the necessary equations, values, and tables for solving particular problems in physics, chemistry, and biology. The models can be used in introductory-level science courses in secondary schools and colleges. The models are usable as is, but can easily be modified by the user. The software package is currently available for the IBM PC and will run in the DEC Professional 350 and Rainbow 100 and Wang Professional computers. $100

Circle No. 18 on Free Information Card

Spelling Checker. Sensible Software has released an improved version of its spelling verification program for use in Apple computers. When used with Apple DOS word processing files, the new Sensible Speller IV displays suspect words in context and allows immediate correction of misspelled words. The program also features extensive dictionary-searching capabilities and automatic suggestion of correct spelling for misspelled words. In addition to the improved version for use with Apple DOS word processors, each Sensible Speller package includes versions for use with Apple CP/M, Apple Pascal, and Silicon Valley's Word Handler word processor. $125. **Address:** Sensible Software, Inc., 6619 Pelham Dr., West Bloomfield, MI 48033.

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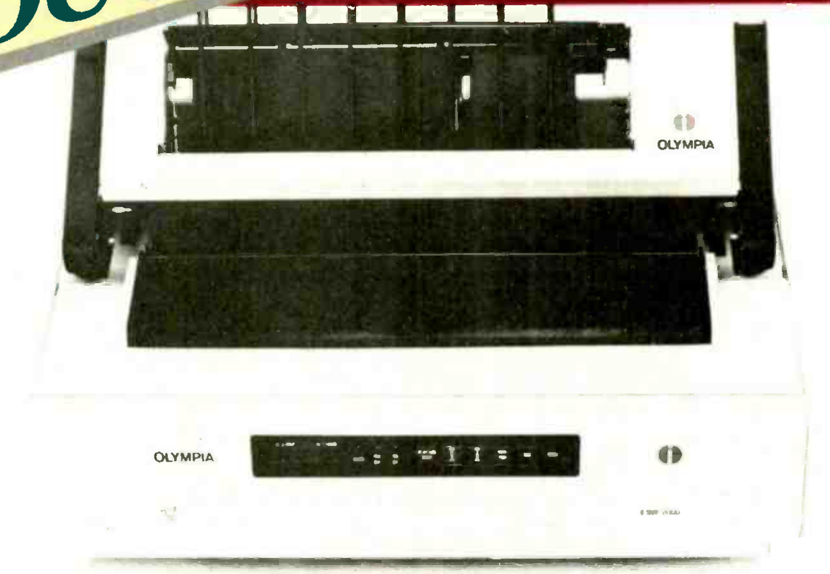
NEW PRODUCTS

HARDWARE/SOFTWARE DEBUGGER

A powerful hardware/software debugging tool for program development on the IBM PC and compatible systems, called the PC Probe, has been introduced by Atron Corp. It consists of a plug-in card that fits into any available expansion slot in the computer, an umbilical cable and probe that plugs into the computer's 8088 socket, and sophisticated debugging software on a floppy diskette. Designed for all standard PC high-level languages, the PC Probe contains all necessary support for debugging. Since it can access all PC bus signals, as well as the CPU, the device can monitor and trap on interrupts and DMA requests. The Probe's software, including symbol and macro tables, are contained in 64K of on-board memory-protected RAM. $1595.

Circle No. 93 on Free Information Card



LETTER-QUALITY PRINTER

Olympia's Model ESW 3000 is a formed-character, letter-quality printer designed for high-speed printing. Microprocessor-controlled, it features automatic shortest-path-seeking logic and bidirectional paper and carriage movement. Printing speed averages 40 characters/second, using 100-character printwheels. The printer can handle forms up to 17" wide and offers 10/12/15-pitch selection, with $\frac{1}{120}$" horizontal microspacing. Vertical spacing can be $\frac{1}{6}$", $\frac{1}{4}$", or $\frac{1}{3}$" and offers 96 positions/in. bidirectionally. Among the printer's attributes are: bidirectional horizontal and vertical tabulation; bold, expanded, and double-print enhancements; ability to produce up to seven copies on a single pass; automatic paper feed to top of form; 4K print buffer; RS-232C serial, Centronics-compatible parallel, and IEEE-488 interfaces; and control panel. Options include a bidirectional forms tractor and a sheet feeder.

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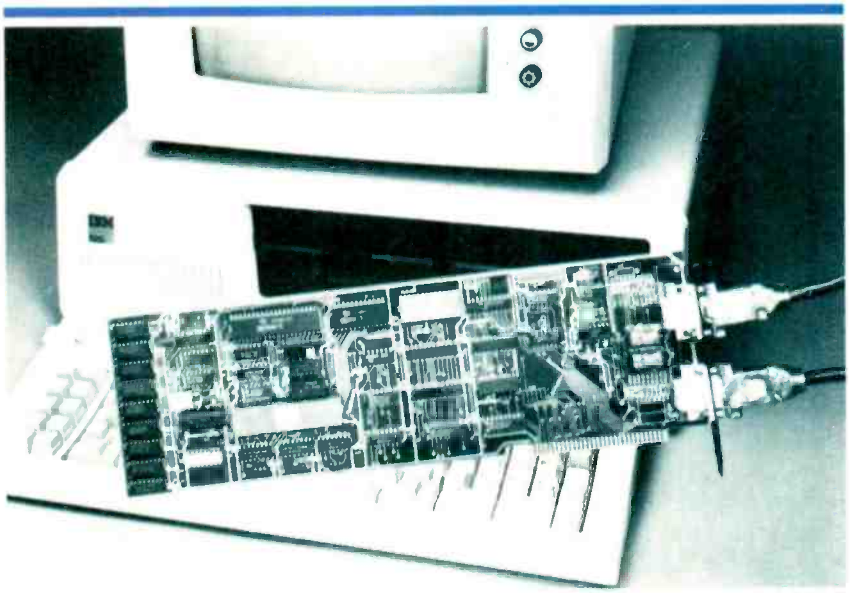


LOCAL AREA NETWORK

The PerComNet PN-IBM interface card for the IBM PC is a local area network from Percom Data. It is designed around the Western Digital WD2840 control processor to give the host computer the ability to permit key peripherals, like a hard disk drive, to be shared among two or more computers. Its features include: token passing reliability; 64K FIFO buffer; signal regeneration at each node; user installation simplicity; NBS encryption for data security; support for simultaneous voice/data security transmissions; and operating-system compatibility for MS-DOS, CP/M, and Unix. The network interface plugs into the IBM PC or similar computer and is then linked to the network through a unique Percom Data cable interface. PerComNet interface adapters will soon be available for S-100, Multi-Bus, and STD Bus microcomputers.

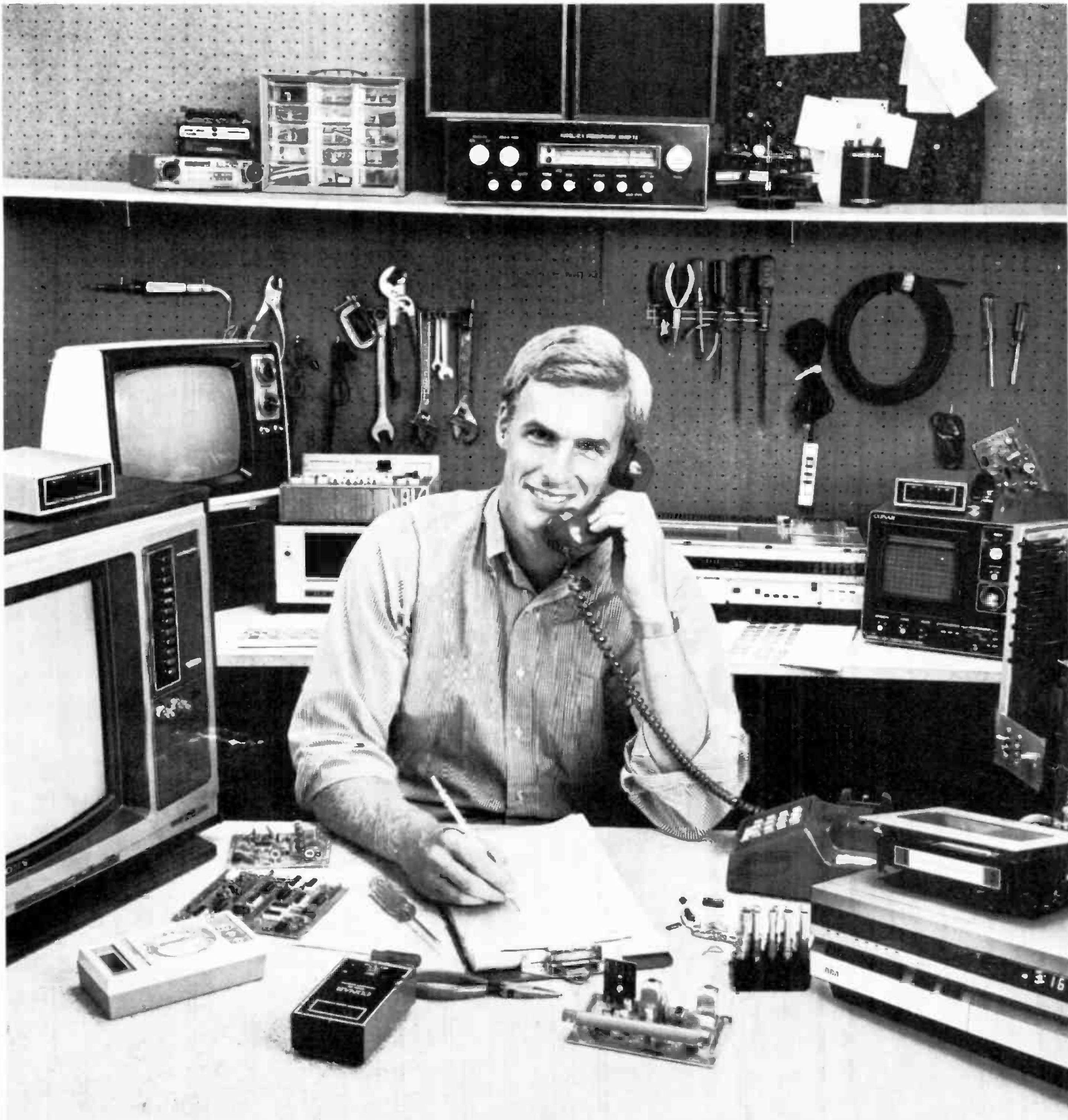
Circle No. 91 on Free Information Card

SOUND PROCESSING SYSTEM

The DX-1 Sound Processing System from Decillionix is a hardware/software package for the Apple II computer for recording, processing, and playing back real sound. The record and playback technique is eight-bit analog-to-digital and digital-to-analog "sound sampling." With one of the system's six software menus, a collection of prerecorded sounds can be played in real time on the Apple keyboard. With another menu, random reproduction of real sounds can be generated. Other software menus enable the user to record and reproduce any sound, and include the ability to program variations in pitch, volume, duration, and sequence. Sounds can be played in reverse and also stored on disk. The DX-1 plugs directly into any slot in the Apple II or IIe and accepts low-to-medium-level signal sources, including a microphone. $239. Address: Decillionix, PO Box 70985, Sunnyvale, CA 94086.

(Continued on page 20)

Wouldn't you like to have a new skill you could call your own? Learn TV, audio, and video servicing with at-home training from NRI.



You can learn to service and repair TVs, stereos, electronic musical instruments and amplifiers, car and portable radios, record and tape decks, videocassette recorders and disc players, almost any kind of electronic equipment on the market. And you can learn to do it at home, in your spare time, without quitting your job or wasting time and gasoline on night school. NRI will train you, as it has over a million and a quarter others, with effective methods proven over 69 successful years.

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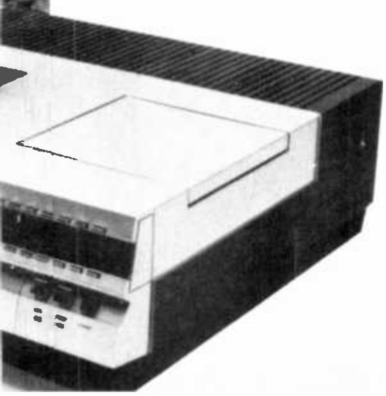

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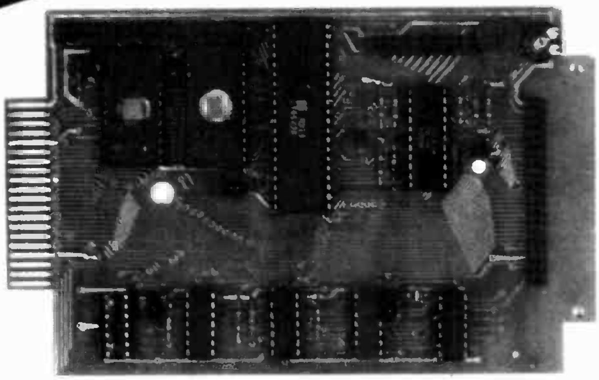
NEW PRODUCTS

SOFTWARE SOURCES

Program Library System. The Arranger II from Triple-D Software provides an automatic means for organizing program libraries. It gathers every program name and useful information about each disk (type of DOS, number of tracks, free space, system or data file) and compiles and stores it on its own disk for future reference. A unique name or number is recorded on each disk in the user's library. Arranger II can then rapidly locate any desired program and print out alphabetical program lists, individual disk contents, free disk space chart, disk labels, and more. The software has an 11,000-word capacity, with 255 per disk. $49.95. **Address:** Triple-D Software, PO Box 642, Layton, UT 84041.

Text Processor. Logical Systems' The BASIC Answer (TBA) runs on the **TRS-80** Model 4 computer under TRSDOS 6.x and 5.1, and on the TRS-80 Models I and III and Lobo Systems Max-80 under 5.1. This is a text-processing utility designed to allow the programmer to construct BASIC code in a structured manner. TBA allows the BASIC programmer to produce structured, self-documenting code and supports the use of labeled branching that results in relocatable BASIC subroutines. In addition, variable names and labels of up to 14 significant alphanumeric characters are supported. Through "conditional translation," production of multiple program versions is greatly simplified. Global and pseudo-local variable types are supported. $69.00 for TRS-80 Models I, III, 4, and Lobo Systems MAX-80 TBA V5.1; $79.00 for TBA V6.x (add $4.00 S/H for each). **Address:** Logical Systems, Inc., 8970 N. 55 St., PO Box 23956, Milwaukee, WI 53223.

Tree-Forth. Soft Magic Corp. has announced availability of a version of Forth for the **Sinclair** and **Timex** lines of computers. Called Tree-Forth, it is a compiler (not interpreter) directive that operates about 10 times faster than interpreter BASIC, while providing the conversational attribute of BASIC. Tree-Forth is supplied in a 64K EPROM chip that replaces the ROM chip inside the computer. $49.95 plus $2.00 S/H. **Address:** Soft Magic Corp., 1210 W. High St., Bryan, OH 43506.



MULTI-FUNCTION SUBSYSTEM

Magnum Distributing has announced availability of the Model CMJ-1F multifunction subsystem for the Radio Shack TRS-80 Color Computer and TDP System 100 personal computer. The device plugs into the cartridge port and provides a speech synthesizer, one serial and two parallel ports, 4K or 8K of EPROM/ROM space, two counter/timers, and an extender port. The speech synthesizer is said to be able to vocalize any word in any language and is accessed through BASIC. The extender port enables the user to access a disk controller or ROMPAK without having to disconnect the CMJ-1F from the computer. $199.95. **Address:** Magnum Distributors, Inc., 1000 S. Dixie Hwy. W., Suite 3, Pompano Beach, FL 33060.

RGB VIDEO MONITOR

The Taxan Model RGBvision 420 is designed to be an IBM-look-alike RGB color video monitor with high-resolution graphics capability at 630 horizontal lines, 0.38-mm dot slit, and 20-MHz bandwidth. Other features include a black-stripe, nonglare picture tube; a mode selector switch for use with computers other than IBM; contrast control; and horizontal, vertical, and screen size controls. $699. **Address:** TSK Electronics Corp., 18005 Cortney Ct., City of Industry, CA 91748.

LES SOLOMON ON COMPUTER HARDWARE

An Eye- and Temper-Saving Proposal

IT seems every computer, video game, VCR, or closed circuit TV camera that has provisions for using a TV receiver as a video display employs either channel 3 or channel 4 on the vhf band. There are some other electronic items that use different channels, but they are in the minority.

I called the FCC to try to find out why channels 3 and 4 are so popular. Well, it seems that there is no regulation covering this channel usage; and the whole thing boils down to a sort of "grandfather's clause." (If the FCC wants to clear this up with me, let someone there drop me a line.)

I never liked these channels anyway. Where I work in midtown Manhattan there is terrific r-f power on Channel 2 (CBS) and Channel 4 (NBC). Even with the protective guard band between channels, when using channel 3 (or any other vhf channel) for viewing a computer display, I get enough adjacent-channel interference to make a mess of the video.

Assuming that computers and video games have FCC type approval (as indicated by little labels on the back or underside), does this mean that receiver r-f and i-f design and shielding leaves something to be desired? If so, why do people blame the computer when it's really the TV receiver that's at fault?

It must be a masochist's fantasy come true when he tries to use a channel-3/4 video system in areas where good signals are received on channels 2, 3, 4, *and* 5. This must make displays for computing and game playing really great!

On the other hand, isn't it nice that some major TV receiver manufacturers are providing a direct video input jack on some of their newer models. To these wonderful folks: Welcome to the computer age!

[Incidental technical note: Channels 4 and 5 can both be used in the same area. Although they are numerically adjacent, they are not frequency-adjacent, since there is a 4-MHz gap between them. There is also an 86-MHz gap (including the FM band) between channels 6 and 7.]

To get a clear display when testing a system here in New York, I have been using a modulator on a high-uhf channel where nobody lives for a bucketful of MHz in either direction (at least around here), and the spectrum is quiet. I am not quite certain that this is legal, but it makes a big difference in the display.

Really, what I want to know is, since the FCC has previously assigned special "quiet" frequencies (10.7 MHz for FM i-f, 43 MHz for TV i-f, etc.), why not assign an unused high-uhf band to be used strictly by computer and video game signals?

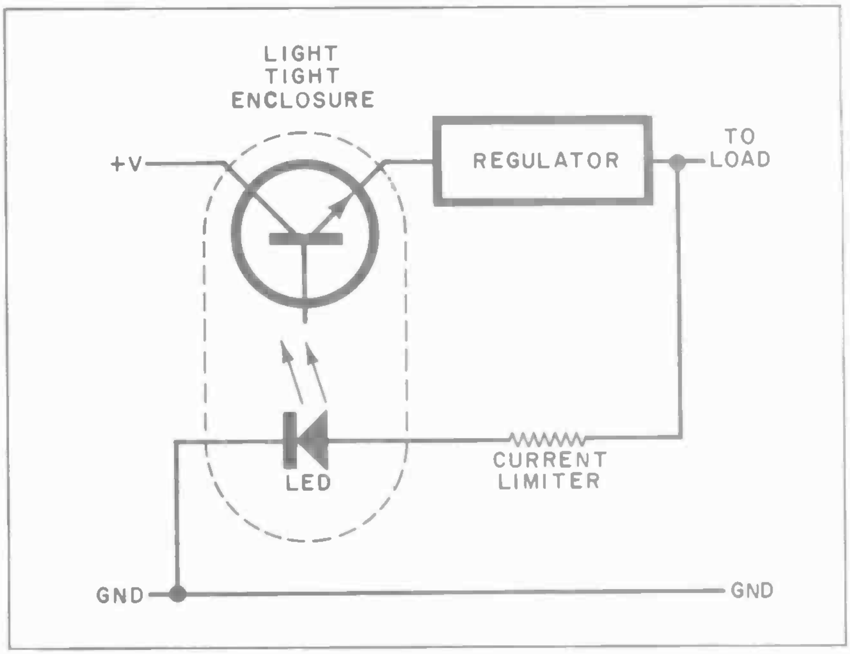
There are wide areas of unused uhf frequencies between channels 14 through 83. Why can't we use r-f modulators on an empty channel in the range? We would not interfere with anyone and could watch clean displays for a change.

Protection Circuit. Being an avid dabbler in hardware, I have created my fair share of accidental short circuits. To save the cost of replacing relatively expensive voltage regulators and power supplies when I make such mistakes, I have recently concocted an automatic power-down protection circuit. A schematic is shown in the accompanying diagram.

The circuit is faster than a fuse and automatically "resets" itself when the short is removed. The normal regulated dc input line is opened, and a phototransistor or photoresistor (any type that can handle the current) is connected in series with the source and regulator. Between the output of the regulator (which can be almost any desired voltage) and ground is a LED and an associated current-limiting resistor, whose value depends on the dc voltage being monitored. The LED is placed physically close to the surface of the photosensitive device and the two are covered by a layer of black electrical tape to form a light-tight enclosure. As long as the regulator is delivering its rated output, the LED glows and causes the photo device to have a low resistance. Full current is thus allowed to flow.

If, for any reason, a short circuit occurs on the output side of the regulator, the LED goes dark, the resistance of the photo device increases, and the regulator shuts off. When the short is removed, the LED glows, and the regulator resumes operation.

Like most of the circuits I have discussed in this column, this one is basic, and the reader is urged to experiment with it. For example, if your power requirements are more than a simple photo device can handle, use a high-power npn transistor whose base is driven by the photo device, which, in turn, is controlled by the LED. In fact, not even the regulator is required since this protection circuit can be used as "plain vanilla" in series with the power lead. Once you get the idea of how the thing works, it's simple. So why not try your ideas. ◇



Bits&Bytes

NEWS, VIEWS & GOSSIP/BY SOL LIBES

RUMORS & GOSSIP

▶ Look for Commodore to shortly discontinue the VIC-20, drop the price on the 64 even further, and introduce a new portable machine using the Z8000 16-bit microprocessor to sell in the $500-to-$600 range. The aim is to undercut new entries from IBM and Apple. . . . Shugart is expected to start demoing its laser-based optical disk soon. Word is that it will cost $5000 or so and store 1.5 gigabytes (that's 1,500,000,000 characters), and you will not have to worry about a head crash when you bump it or get dirt or moisture on the disk. . . . Atari anticipates the debut of a home computer with integrated telephone and the capability to control home appliances and heating/cooling systems. . . . Sharp Corp., which recently demonstrated a portable computer with an 8-line by 80-character display, is reportedly on the verge of bringing out a liquid-crystal display with a capacity of 24 lines by 80 characters. . . . Beta testing of Version 3.0 of MS-DOS, which was supposed to begin in June, has reportedly been moved to September. This probably means that the product may not appear until next year. It is still not clear whether Version 3 will be adopted by IBM for the PC. Talk is that the new version will include features such as multitasking, mouse input, and enhanced graphics capability. . . . Meanwhile, Apple is expected to present its long-rumored "Macintosh" computer in January with first deliveries to customers expected in February. It is expected to be a 68000-based transportable unit having a 9" display, a resolution of 512 × 375 pixels, and 128K bytes of RAM, and to sell for well under $1500. Reports are that the unit will use a 3.5" floppy storing a full megabyte, and have a significant portion of the system software in ROM and a user interface similar to the Lisa. When the Mac appears, I expect to see the price of the Apple IIe drop to $700 or under and become available to mass merchandisers. . . . Anticipated soon from several vendors are Winchesters with intelligent interfaces that contain microprocessors capable of re-microcoding themselves to adapt to their environment. In other words, they would contain their own operating systems. It will be possible with this system for the drive to have a signature that marks it by lot and manufacturing date. This could be used to ward off software pirates. The chip to do this is already in evaluation by disk designers. . . . Gavalin shook the industry with the May premiere of a true full-function portable priced at just under $4000. Now there are rumors that a similar machine is due shortly for one-third the price. . . . It is said that Microsoft will have a plug-in board for the IBM PC that replaces the 8088 microprocessor with an 80286 true 16-bit unit so that users can run Xenix, Microsoft's version of the Unix multi-user, multiprocessing operating system. . . . It is anticipated that Radio Shack will, later in 1984, introduce a new TRS-80 Model 100-like portable that is IBM PC compatible. It will use a CMOS version of the 8086 microprocessor that is now available in sample quantities. The Model 100 (which is currently the hottest selling portable on the market) now uses the CMOS version of the Intel 8085 8-bit microprocessor.

APPLE DOINGS

▶ Apple, once the bread and butter of Computerland sales, has been largely replaced by the IBM PC. Last year, when Apple tried to renegotiate a better contract with Computerland, the franchiser balked and dropped the line. Many of the Computerland stores were then forced to buy their Apple equipment directly from Apple, losing their Computerland discount, while still paying an 8% royalty to Computerland on each sale. The result was that Computerland stores selling Apples were at a serious disadvantage compared to independent retailers. Unable to compete with price discounts, many Computerland stores dropped the Apple. Apple responded by reducing the price on equipment, offering it to more retail outlets such as department stores, and packaging together systems with more competitive prices.

Apple has disclosed that it has filed suit against 28 Hong Kong companies selling copies of the Apple II and that, in all but five cases, it has succeeded in getting restraining orders. The units, which sell for as low as $300, are for the most part made in Taiwan and imported to Hong Kong. Some even bear the Apple nameplate logo.

Another Apple-II compatible machine, called the "Dragon," that has been widely sold in Europe, is expected to be marketed soon in this country by Tano Corp., New Orleans, LA. The price is expected to be $400 less than that of the Apple IIe.

In the meantime, Apple declared over $42 million in profits for the last quarter, a 59% increase. It also announced production of its millionth computer and shipped the Lisa right on schedule. However, demand for the IIe has reportedly flattened out as business-user sales have decreased. The bulk of the IIe sales are now to the home and school markets.

Apple has run into some new challenges with the Lisa. Many customers are complaining about the hard disk drive's limited capacity (only 5M bytes with about 4M bytes used by the Lisa software, leaving only about 1M byte for the user's files) and slowness in reading. (It can take more than half a minute to load the word processor and a text file before one can enjoy the machine's marvels.) The company is expected shortly to upgrade the Lisa to a faster drive with 10M-byte capacity. Secondly, Lisa floppy disks, which are unique to the Lisa, are scarce as hens' teeth.

Apple is soon expected to introduce an option for the Lisa to enable it to run IBM PC software. This project is reportedly being handled by Microsoft for Apple, with the product becoming available by '84. The option is seen as an important asset for the business world. Users will then be able to run the Lisa operating system, MS-DOS, CP/M-68K, Xenix, and UniPlus+. The last two are operating systems, and will require addition of a second drive and extra user ports. UniPlus+ is already being distributed by UniPress, Highland Park, NJ; Xenix should be available soon.

Apple is also expected to launch a new marketing strategy involving three computer lines—Apple IIe, Macintosh, and Lisa—with the Apple III being dropped.

TIMEX/SINCLAIR SALES DROP

► Sales of the Timex 1000 (né Sinclair ZX81), once the most popular home computer, have plunged. Orders for its new 1500 and 2000 models are far less than projected. Timex, which pioneered the super-cheap home computer and led in the pricing battles, sold 550,000 units in its first five months. Sinclair had sold 150,000 ZX81s before turning distribution over to Timex. So far, well over a million units have been manufactured.

The 1000 has sold for as low as $27.95, and typically sells for about $45. The Commodore VIC-20, TI-99/4A, and Atari 400, which sell for only $30 to $40 more, offer color, more memory, better keyboards, and more features. As a result, they've hurt sales of the 1000, and many retailers have abandoned the unit. Even the Timex 1500, which generally sells for about $80, does not stack up well against these units. And the model 2000 is facing stiff competition from the somewhat higher-priced Commodore 64, which has better keyboards, graphics, and sound.

Timex has therefore begun selling its systems to mail order companies and to companies that will package the unit with encyclopedias and textbooks. Also, the units are being offered by banks and real-estate developers as give-aways in sales promotion programs.

In England, Sinclair has unveiled a continuous-loop tape drive interface for its Spectrum color computer. It has an 85K capacity and an average access time of 3.5 seconds, and sells for $76, plus $7.50 for a tape cartridge. The unit is expected to be introduced in the U.S. for the Timex 2000 systems. The drive requires a $50 interface unit (only $30 when purchased with drive). The unit that is needed, which fits under the computer, also provides an RS-232 port and local-area network connection device.

COLECO's ADAM

► Coleco, the only current games maker turning a profit, showed its Adam integrated home computer in June, promising delivery in late August. It then pushed the delivery date back to mid-October and raised its suggested retail price from $600 to $700. (The dealer price will be about $575.) The final unit will have a tape recorder for mass storage and a slow-speed daisy-wheel printer. A modem, memory expansion, and disk drive options are expected early next year. Also, Coleco expects an option that will increase the current 32-character line to 80 characters on a TV.

Coleco disclosed that it has signed an agreement with StarCom to market its "Dragon's Lair" arcade game, which employs a laser disk and, reportedly, a new dimension in game technology. The company has also signed an agreement with AT&T to develop a home video game service via telephone. AT&T will make and sell the video game machine, which includes a modem.

RESEARCH COOPERATIVES BEGIN PROJECTS

► The Semiconductor Research Cooperative, a subsidiary of the Semiconductor Industry Association, disclosed that it is initiating development of a pilot program to demonstrate the manufacturability and reliability of a 4-megabit memory device. SRC, formed two years ago, is an alliance of 18 companies, among them IBM, GE, Motorola, CDC, DEC, Intel, AMD, HP, Silicon Systems, and Monolithic Memories.

The other research cooperative, Microelectronics & Computer Technology Corp., an R&D venture owned by AMD, Allied Corp., CDC, DEC, Harris, Honeywell, Martin Marietta, Mostek, Motorola, National Semiconductor, NCR, RCA, and Sperry, has announced that it will be doing research in advanced computer architecture, computer-aided design and manufacturing, system and circuit chip packaging, and software technology.

SOMEWHERE OVER THE RAINBOW?

► Digital Equipment Corp. seems to be following in IBM's footsteps in the personal computing area. DEC has assumed that its Rainbow computer was going to take the marketplace by storm, but instead it met with a ho-hum reception. Although a very good design, the heart of the problem was that DEC tried to keep everything to itself so that customers would be totally dependent on DEC for software, peripherals, and even supplies. For example, DEC did not provide any way for users to format disks and therefore forced them to buy pre-formatted disks from it at a very steep cost. And the refusal to release technical documentation discouraged independent software and peripheral suppliers from developing products.

But try as it might, it could not stop the independents. One company brought out a formatting program for the Rainbow. DEC has finally conceded, recognizing that the tactics they used in the minicomputer area are just not going to work in the personal computer market. So DEC has now released a utilities disk with a format program on it, plus other utilities to assist software development. In addition to this, they are promising a technical manual similar to the one published by IBM for its PC.

SEC HALTS SOFTWARE ACCOUNTING METHODS

► The Securities and Exchange Commission has told software developers to stop treating software development costs as an asset in their books and consider it an expense. This accounting technique was used by some companies as a way of increasing paper profits by reducing expenses and increasing the value of the business.

RANDOM NEWS BITS

► One of Tokyo's largest department stores, Seibu, is offering two industrial-type robots for sale in their store. At $25,000 apiece, they are not likely to sell many but they sure are attracting crowds. . . . Imports of ICs *from* Japan for the first four months of the year reportedly increased 63% for packaged ICs and a whopping 252% for unpackaged ICs. By contrast, shipments of ICs *to* Japan increased 11%. . . . According to the "Books In Print" reference guide, there are now 2400 computer books in print, with the overwhelming majority published in the last 18 months. An estimated 20 new titles are released each week. . . . Intel is promising that it will start production on a new 1-megabit bubble memory device late next year that they expect to sell for $99 in quantity.

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- ☐ *High school was hard for me and electronics sounds like it may be hard to learn.*
- ☐ *I can't afford any more education.*
- ☐ *I have a family now.*
- ☐ *I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.*

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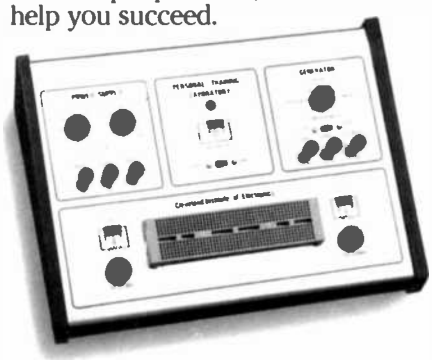

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COMPUTER VIDEO GAMES

Hands-On Reviews of Recently Released Game Software

HIGHRISE

Diskette for Apple II/IIe
MicroLab, Inc., 2699 Skokie Valley Road, Highland Park, IL 60035; 312-433-7550. $30.00

Graphics ****
Gameplay ****
Sustained Interest ****
Type: *Keyboard educational strategy game*
Memory Required: *48K*

MicroLab put this "game" in its MicroLearn educational library since it's supposed to teach skills in spatial relations and planning. Trouble is, it's so much fun it's hard to remember that I'm learning something while playing it.

In it, Barnaby, my master builder, piles blocks of various shapes and sizes on top of each other. When the stack reaches a certain height, he climbs up the "building" to the next level. If the wrong kinds of blocks are juxtaposed, the building collapses; so planning, selection and strategy are important.

You're also running against the clock with this educational game, and it's possible to rack up some really impressive point scores—that is, until you reach level five or six, at which time the shapes of the building blocks get so weird that it's hard to gauge which will balance properly on what.

This game's great for the whole family. It's what games rarely are: educational and a lot of fun.

JUMPMAN JUNIOR

ROM Cartridge for Atari 400/800
EPYX (Automated Simulations, Inc.), 1043 Kies Ct., Sunnyvale, CA 94086; 408-745-0700. $34.99

Graphics ***
Gameplay ****
Sustained Interest ****+
Type: *Joystick action game*
Memory Required: *Resident ROM*

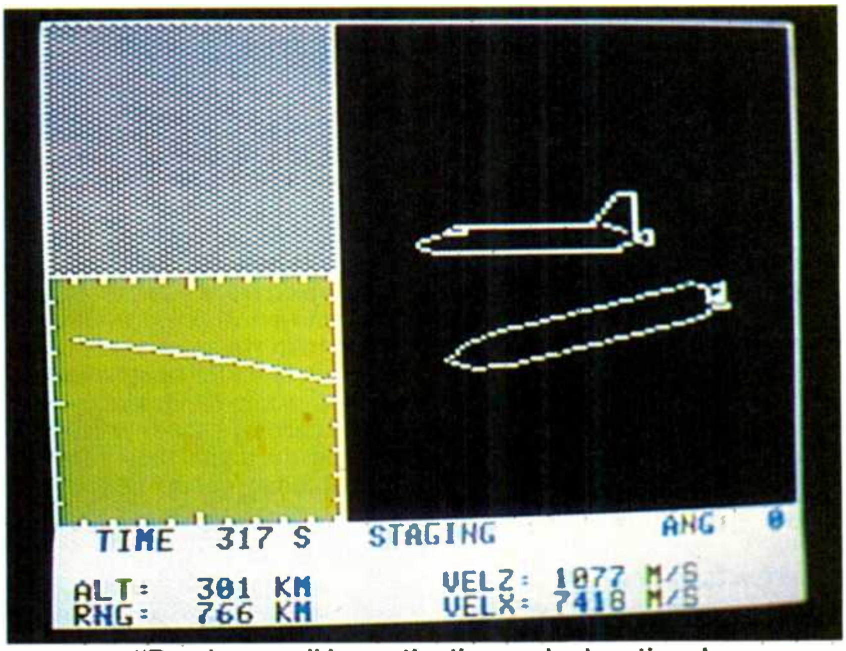
Jupiter Jumpman fans, rejoice! There's now an easier (?) well, at least simplified version of the Epyx classic, and it comes in cartridge form!

Instead of the 30+ levels of the original, Junior has only 12 levels, and as the apprentice, he has to try harder. The game has eight speed levels, and the cart lets you preview all 12 screens before you start.

As with the original, you find yourself on a Jupiter Command Substation that's been invaded and mined by the Alienators. In your quest to find their bombs, you have to climb, jump and use strategy. You also have to dodge bullets, ride elevators, avoid electrocution traps and moving walls.

You can have up to four players in this game, and each player starts with four lives. You get a free life for every 7500 points you score—easier said than done.

For each bomb collected and defused, you score 100 points and receive bonus points as you leave each level. If you missed Jupiter Jumpman, try this one.



"Rendezvous" is captivating and educational.

RENDEZVOUS

Diskette for Apple II series
Edu-Ware Services, Inc., PO Box 22222, Agoura, CA 91301-0522; 213-706-0661. $39.95

Graphics ***
Gameplay ****
Sustained Interest ****+
Type: *Keyboard simulation game*
Memory Required: *48K*

If you've a yearning to pilot a spacecraft, Rendezvous goes a long way toward fulfilling it. From the moment you start the ignition for the blast-off, your Shuttle spacecraft is under your control.

To hit the right "window" you must immediately start to change the angle of the ascent—as soon as the gantry disappears from the screen. Key parameters are displayed on the bottom of the screen: vertical and horizontal velocity, time left to burn in each stage, time into mission, altitude and down-range (distance).

Once you've reached orbit, the screen shows you your orbit path and the orbit of the existing satellite that you must rendezvous with. It takes a lot of practice and patience to maneuver the difficult operations of catching up and not burning up in the atmosphere.

Staging (drop-off of spent booster) is automatic, and you must reach an altitude of at least 192 kilometers to get into orbit. Then the fun really begins with course corrections (a lot of guesswork), projections of flight path, and the actual rendezvous. As of this writing, your reviewer still hasn't successfully met up with the satellite, but practice makes perfect. This program is both captivating and educational in a way that's guaranteed to keep you burning the midnight oil.

LUNAR LEEPER

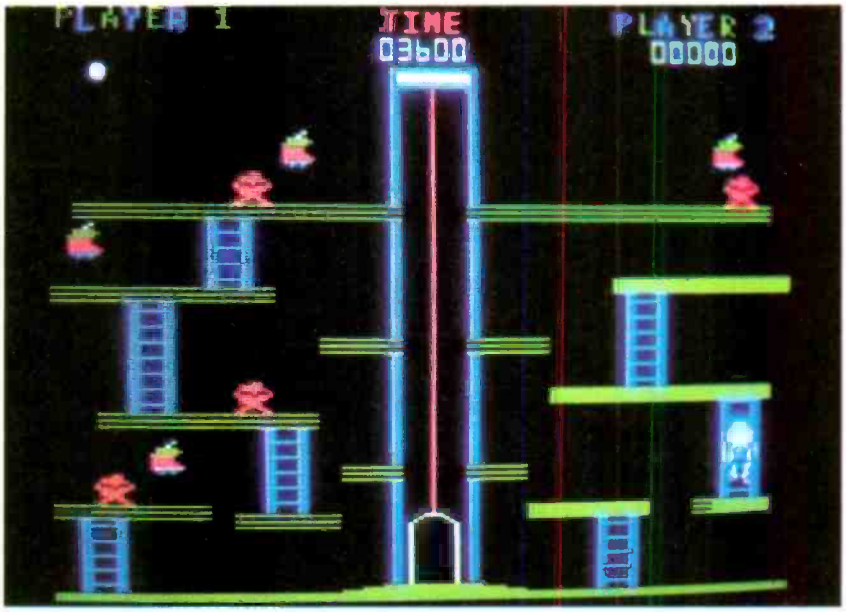
ROM Cartridge for VIC-20
Sierra On-Line, Sierra On-Line Bldg., Coarsegold, CA 93614; 209-683-6858. $29.95

Graphics ****
Gameplay ***
Sustained Interest ***
Type: *Joystick action game*
Memory Required: *Resident ROM*

This new one from Sierra is hard as the

dickens to play without getting clobbered. The graphics are some of the best we've seen for the VIC to date, and the humanitarian aspect of the gameplay (rescuing stranded humans on the moon) isn't lost on us.

Gameplay has a shoot-em-up and dodge-'em script. It isn't at all easy to shoot the Lunar Leepers (the enemy); your spaceship has no brakes, so it takes some dexterity to avoid getting blopped (you don't get zapped and you don't get bopped—just "blopped") while rescuing the stranded humans. It's exciting and different, as twitch games go.



The elevator in "Miner 2049ER" is keyboard controlled.

OLD IRONSIDES

Diskette for Apple II
Xerox Educational Publications,
245 Long Hill Road, Middletown,
CT 06457; 203-347-7251. $39.95

Graphics ★★★★
Gameplay ★★★★
Sustained Interest ★★★
Type: *Joystick/keyboard strategy/action game*
Memory Required: 48K

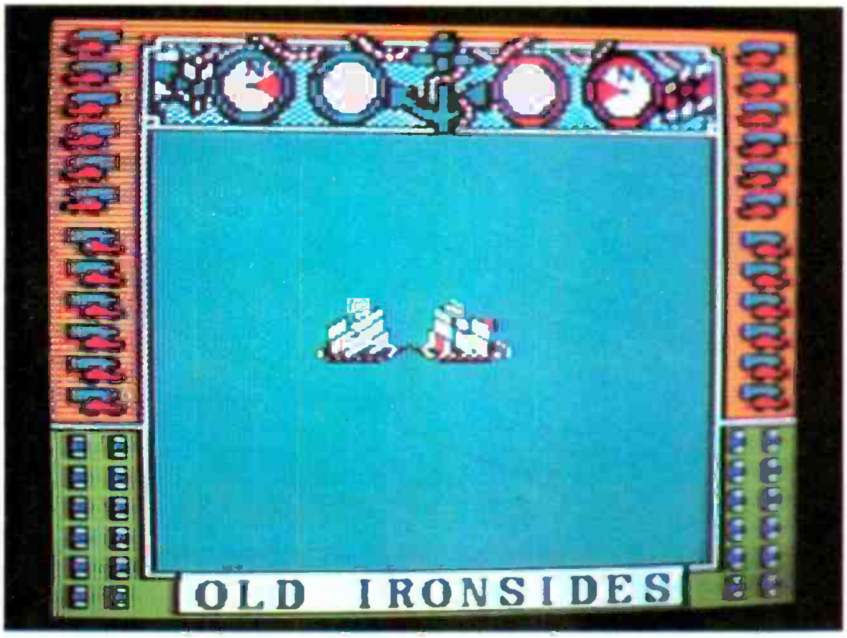
The combination "Logbook and Instruction Manual" is the first introduction to this classic game of sailing ships and battle on the high seas. Like the program itself and the packaging, it is masterfully presented with loads of space to keep a log of your ship's adventures and battles—but the logbook is so beautiful it's a shame you have to write in it.

The game works with a combination of paddle controllers and keyboard. If you don't have Apple paddles, the keyboard is split down the middle for the two players. The screen is artfully framed by a curlicued period-map border. The two ships are beautifully crafted, and the broadsides that you fire are excellent and difficult to learn to control at first.

You can get sunk by cannon fire, ramming, explosion of the powder magazine, loosing your mast and drifting into fog, thereby getting lost.

A sense of direction is very important and very hard to come by. Experienced captains can use the wind direction, the fog and ramming routines to advantage, but it's sure hard to learn. I guess that this is what is meant by a *fun-type* educational program. You're forced to learn compass headings, ship's controls and procedures, and dealing with simulated battle conditions on the high seas of 150 years ago. It's a real winner.

The "Old Ironsides" screen is framed by an old map.



MINER 2049ER

Diskette for Apple II and Atari 400/800
MicroLab, Inc., 2699 Skokie Valley Road,
Highland Park, IL 60035; 312-433-7550.
$30.00

Graphics ★★★★
Gameplay ★★★★
Sustained Interest ★★★★
Type: Joystick action game
Memory Required: 48K

This game is on its way to becoming a classic. Your hero, Bounty Bob, goes through a total of 10 levels (screens) of increasing difficulty—masking all floor levels by walking on them at least once.

Bob must avoid being destroyed by the roving mutants, but they turn green and can be chomped by Bob after he gets energy from eating an apple. The apples, by the way, look like the computer's logo and hang in the most unconventional locations.

Bob can also be destroyed by falling off a platform, but you have to be a real klutz to let this happen. It takes a little practice to get that miniplatform masked in Screen 1. The third screen has an elevator controlled by the keyboard, and there are moving platforms in levels 5, 6 and 7. Level 6 has a radioactive pool, and other levels contain a lift, and deadly stompers—and finally Bob gets shot out of a cannon.

As with so many games that are multilevel, it takes a long time to become proficient enough to reach the highest (most difficult) level or screen.

Inside Apple

Vol. 1, No. 4

A dot matrix printer that will improve your image.

Meet the Apple® Imagewriter, the newest dot matrix printer for your Apple Personal Computer.

And with all that it has going for it, just maybe the best dot matrix printer on the market.

Take legibility, for instance.

The Imagewriter crams 140 x 160 dots into each square inch. So you get text that's highly readable and high resolution graphics, besides.

And is it fast.

The Imagewriter cruises at an unbelievable 120 characters per second. And that's just in the text mode. It's even faster printing graphics. 180 characters per second, to be exact.

What's more, the graphics dump is up to 60% faster than other comparably priced dot matrix printers. And that makes the Imagewriter fast enough to handle the Lisa.™

Yet it's just as at home with an Apple III or Apple IIe. Thanks to Apple software experts who designed the control electronics to give the Imagewriter perfect compatibility. Not to mention some special capabilities like superscript and subscript, to name just two.

Now, with all this high-speed performance, you'd expect the Imagewriter to make the Devil's Own Noise. It doesn't. In fact, the Imagewriter is specially constructed — with overlaid seams and special sound-deadening materials — to achieve a remarkable 53 dB. How loud is a remarkable 53 dB? You'd make more noise if you read this aloud.

The Imagewriter even has quiet good looks, since we designed it to look like the rest of the Apple Family.

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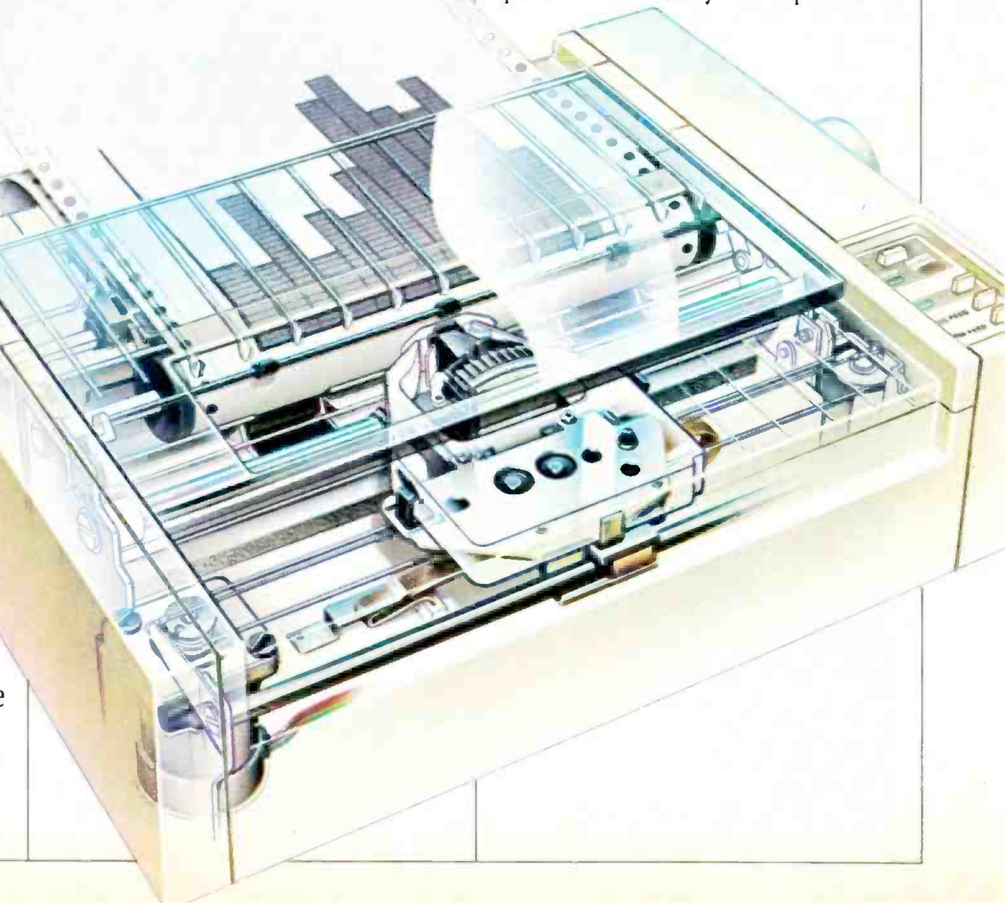
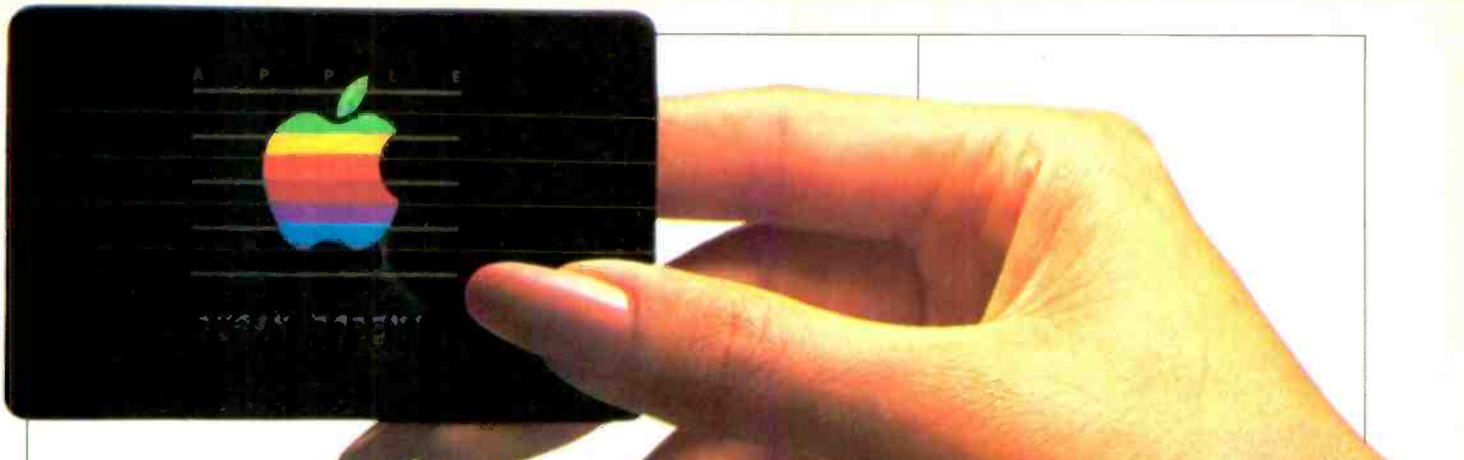
Yet even with all its improvements, the Imagewriter is a better deal than any other dot matrix printer with comparable performance. And you can print that.





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Like all our products, it works simply:

Fill out an application (short, to the point and annotated in English) at an authorized Apple dealer honoring the Card. Your salesperson will call in the application and in most cases get an approval for you right on the spot.

You can then take your Apple system home. You don't even have to wait for the Card; we'll mail it out to you. And by the time you get it, you'll probably be well into doing whatever you bought your Apple system to do.

There is no annual fee for the Card, although a couple of restrictions do apply. The first purchase must include an Apple Personal Computer and you have to put 10% down. And subsequent purchases need to be at least $100 if made with the Card. Oh, yes — you'll also have a credit limit.

When you use the Apple Card to make additional purchases, all you have to do is show the Card and sign the invoice. As long as it's within your credit limit, of course. Our dealers get a little nervous when someone signs for half their inventory. You understand.

You'll also receive monthly statements that include the latest purchases, credit available, and the minimum payment due. You'll also be happy to know Apple Card credit terms are affordable and the payments can be spread out. It's all spelled out for you at the time your Card is approved.

So stop by a participating authorized Apple dealer and get an Apple Card. Just think of it as credit where credit is due.

Give your floppy disks the boot.

We call it the "floppy disk shuffle." It happens when you have two or more software programs on floppies and you need to work with both. What do you do? You put one disk in, boot it, do your work, take it out, put the other disk in, boot it, do your work — you get the idea.

Well, you can stop shuffling any time now.

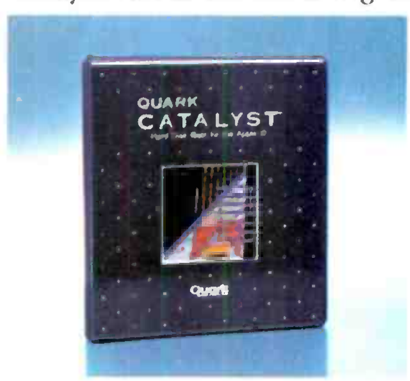
Thanks to a unique new software program called Catalyst™ from Quark, Inc. Specially designed for your Apple III and ProFile™ hard disk.

Catalyst allows you to take a wide variety of software programs and store them on your ProFile. Once they're on your ProFile, you just select the program you want from the Catalyst menu that appears on your monitor — then Catalyst does the rest. You'll never have to boot those programs again.

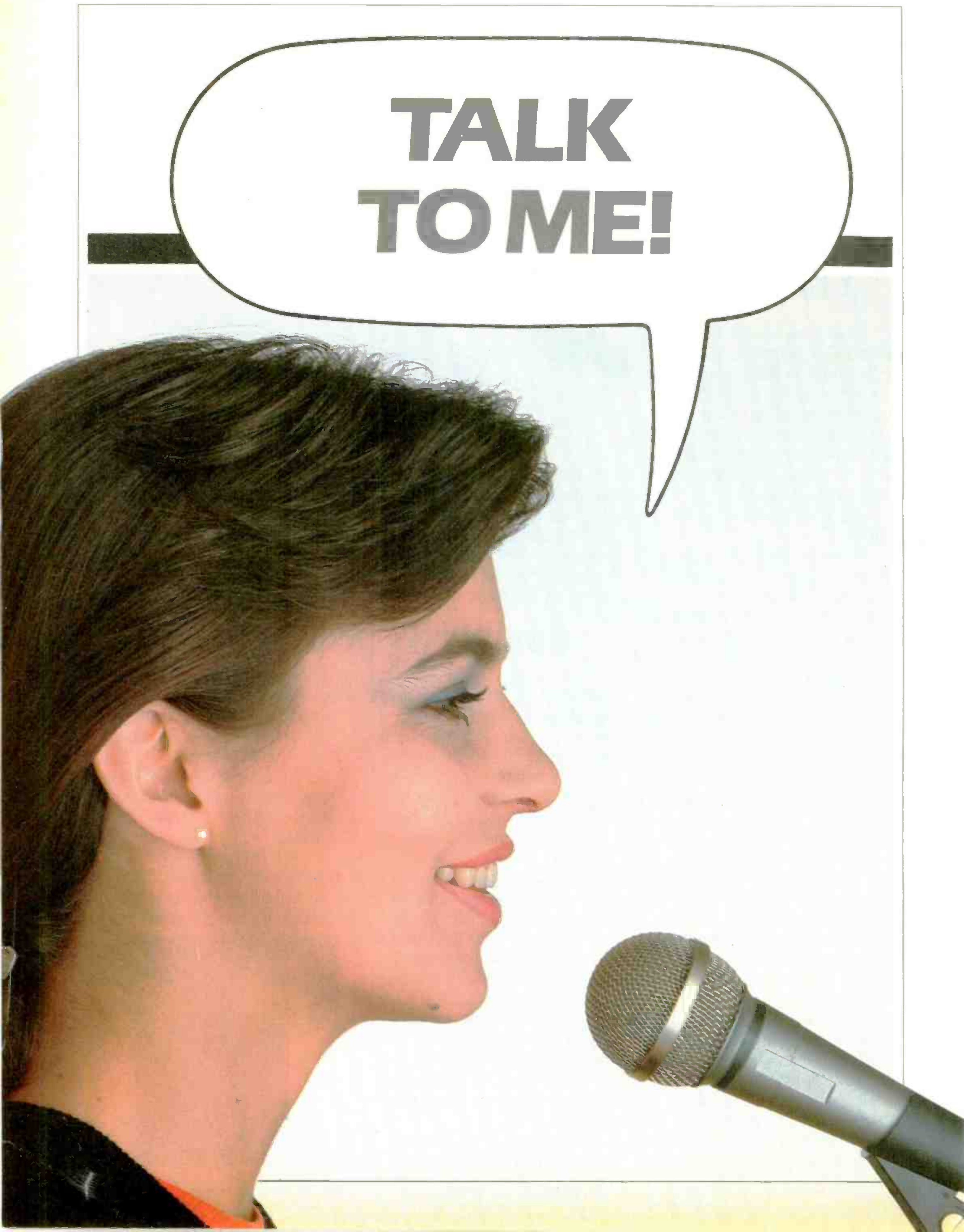
What kinds of programs will work with ProFile and Catalyst? Almost anything written for the Apple III including copy-protected programs like VisiCalc,* Quick File™ and Apple Writer III. Or languages like Pascal, BASIC, or COBOL.

And once you've loaded these programs into your ProFile, the only diskette you may ever need is the Catalyst.

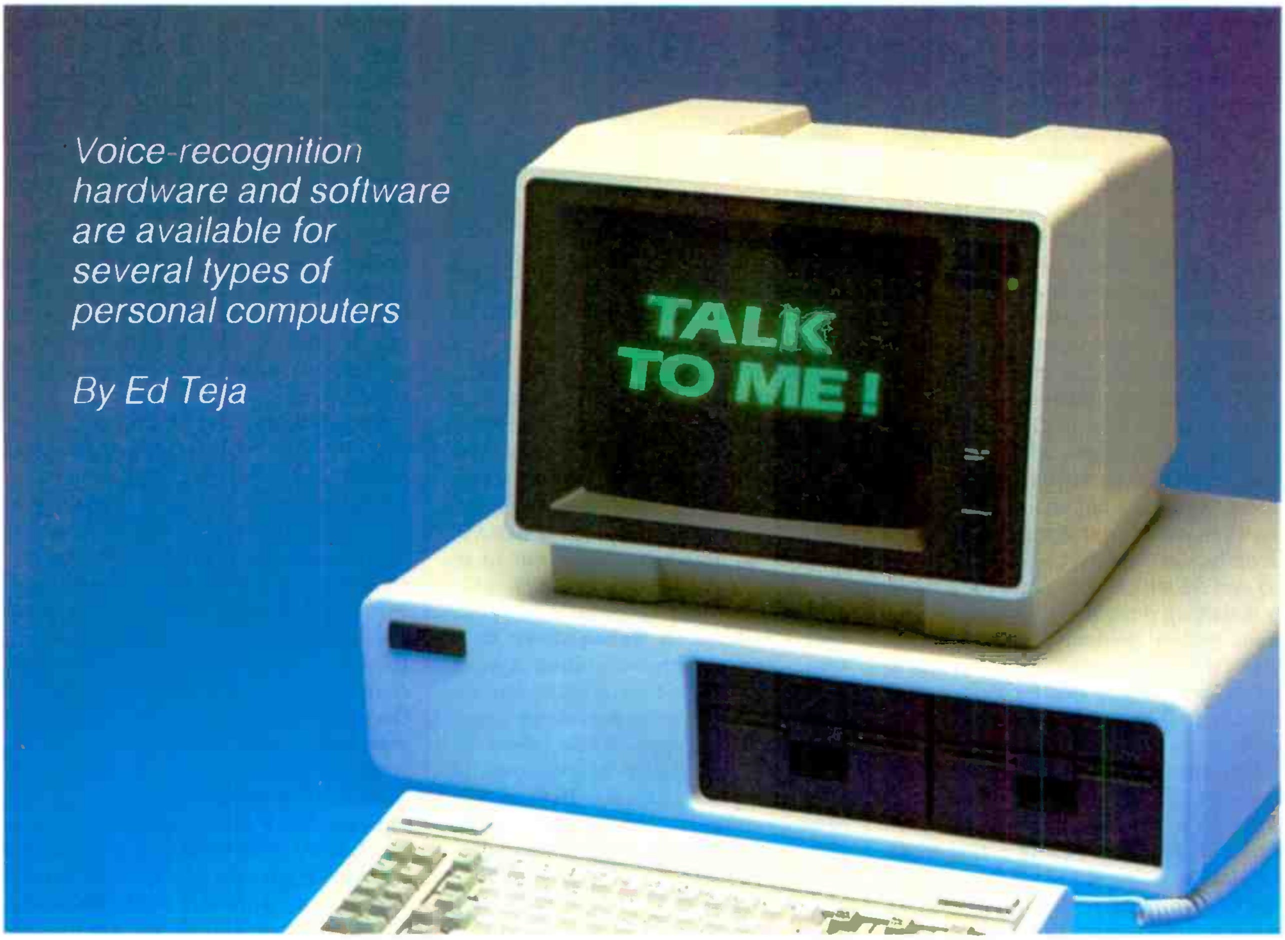
So if you have an Apple III and a ProFile and more floppies than you care to flip through, get yourself a Catalyst. And boot those disks for good.



Circle No. 35 on Free Information Card


TALK
TO ME!

EARS FOR YOUR COMPUTER



Voice-recognition hardware and software are available for several types of personal computers

By Ed Teja

WHEN one person talks to another, it's a natural and efficient means of communication. But when a human being talks to a computer and the machine responds, the process seems like magic. There's nothing magical about computer voice recognition, however. It's currently available for several different types of personal computer systems.

Originally, spoken input (both of commands and data) for computers was restricted to expensive voice data entry systems. Recognizing even a few vocabulary words required a lot of computing power, so these systems had a separate, powerful computer that acted as a speech recognizer. Speech-recognition systems have been around since 1970, but as late as 1978 a system for banking applications that recognized only digits cost over $60,000. However, new recognition techniques and advances in VLSI (very-large-scale integration) have made voice input possible and practical for personal computers.

The Technology. Speech recognition is typically a pattern-matching process. The recognizer captures a spoken word and matches it to reference words stored in memory. There are several techniques both for capturing and matching the spoken input, but the differences are subtle.

Basically, as the diagram in Fig. 1 shows, speech enters a microphone as an analog signal—sound waves. The recognizer filters the sound into as many as 16 separate frequency bands and then digitizes the waveform in each band. These frequency bands contain information that we use when we hear and understand speech. Filtering eliminates a lot of garbage that has nothing to do with speech, such as noise.

After filtering the signal, the recognizer converts the analog signals into digital ones. The digital values represent intensity levels within the frequency band. The human ear can perceive about 250 distinct intensity levels and about 1000 unique pitches in the frequency range from 20 Hz to 16 kHz. Digitizing the data breaks it down into *pitch* (frequency band) and *intensity* (digital value).

There are a number of digitizing techniques: pulse-code modulation (PCM) gives the most accurate digitization, but uses a lot of memory; adaptive pulse-code modulation (ADPCM) uses less memory but loses fidelity. Fortunately, fidelity is not a priority in recognition. Not all of the sounds of speech have meaning. The recognizer only needs those sounds that actually mean something. Nearly every recognizer uses some sort of data compression technique, such as ADPCM, to save memory and speed recognition.

Regardless of the digitization technique, the computer just stores the digital data for each spoken word, or utterance, as an individual data pattern. This is known as the enroll mode. Some systems will average the data from several repetitions of each word in an attempt to get a typical pattern for each vocabulary word. But notwithstanding the number of samples, the recognizer does nothing to the data. It just stores it. The set of data patterns created for each speaker is called a template. In a personal computer, these templates are often stored on a floppy disk until needed.

When you want the recognizer to listen to what you have to say, you put it in its active mode. Now, when the recognizer digitizes the words you speak, it stores them in a buffer for analysis. It can then compare this input pattern to all of the stored patterns (for that speaker) and see which one comes the closest to matching it precisely. Of course, the input pattern seldom if ever matches any of the stored patterns exactly. But it will usually match one far better than any others. The *best fit* will be presented as the word you spoke.

It works like this: Suppose that when you say a particular word, the recognizer senses a 100-Hz sine wave like that shown in Fig. 2A. (Using a real word rather than a simple tone as an example would complicate the example but wouldn't change it. You can imagine this same process going on for the output of each filter bank.) If the recognizer takes four samples of the wave and digitizes it accurately, it would store a reference pattern similar to that shown in Fig. 2B.

Now suppose you repeat the same word, but this time for some reason (stress, perhaps), the sine wave looks like the one shown in Fig. 3A. When the recognizer digitizes this input word, it gets the pattern shown in Fig. 3B. And now you have a problem. The patterns don't match exactly. In fact, when the decimal values of each signal are added, and the sums are subtracted from each other, the result has a decimal value of five. But what does that mean? Nothing by itself; the error must be taken in context. The context, in this case, is how well the input matches any other reference patterns. When the recognizer looks at the patterns for all of the other vocabulary words, it might not match any other word closer than, say, seven. Although there's no *exact* match between the input and the stored pattern, the desired match does turn out to be the *best* match.

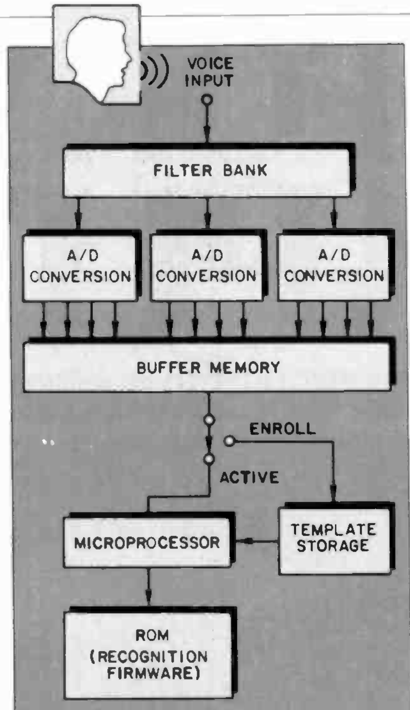


Fig. 1. Voice-recognition block diagram.

Using a Speech Recognition System. Any speech-recognition system uses a microphone for input. Some require a special noise-cancelling close-talking headset type, while others let you use cheap carbon microphones or even a telephone handset. But the type of recognition strategy doesn't depend on the type of microphone you speak into. It's just that more expensive microphones make it easier for the recognizer to do its job.

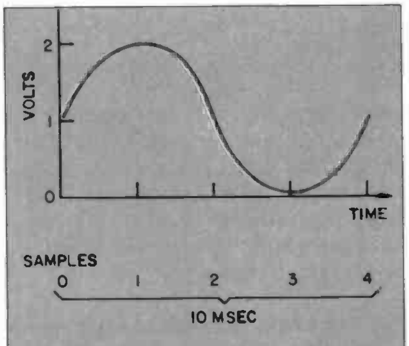
Some recognizers are *speaker dependent*—that is, they can recognize the input only if a speaker has already recited vocabulary words to it. This process, whereby the speaker is prompted to say all of the words at least once before he or she can use the recognizer, is known as enrollment. A speaker who has stored voice patterns for each word is enrolled in the system. Some manufacturers refer to enrollment as training, but it isn't. Training implies that learning takes place. The recognizer is not an artificial intelligence. It is a machine that matches known patterns to unknown patterns. It cannot be trained.

If you use a speaker-dependent recognizer, you must know how to instruct the computer to call up your particular voice pattern files from storage. It then matches your spoken input with the set of patterns you previously enrolled for the vocabulary words. If it tried to match your words to someone else's patterns, it might not recognize any words at all.

Background noise and other factors that affect the way speech sounds in the air will also affect the accuracy of the recognizer. But you can correct for some problems before they even cause any trouble. If you are going to use the recognizer in a noisy room, you should enroll words while in that same room and under the same conditions. Even factors that have nothing to do with sound directly, such as stress, can affect the way you say a word. This means that you have to pay attention to the environment if you want to get the highest accuracy from your recognizer. Studies indicate that, if you enroll on a system in the relaxed atmosphere of your home and then try to use it in a factory or office, it won't work well at all. Changing the environment between enrollment and use too drastically is almost as bad as enrolling the wrong speaker altogether.

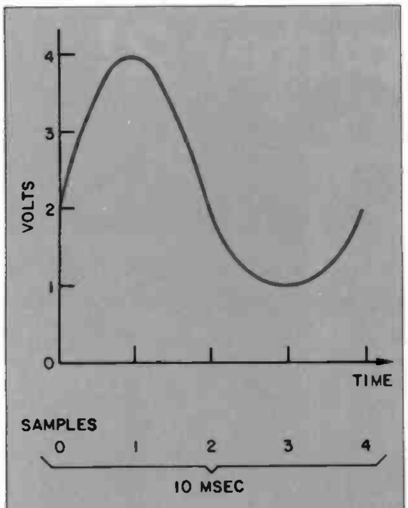
You'll never get a perfect match between the word you just spoke and the pattern you stored previously. However, sometimes the match is closer than others. Most recognizers allow you to adjust the level of match that the recognizer will respond to. You can actually select how close the match has to be before you consider it good enough for your purposes. When you adjust the level of match that you will accept, you are telling the recognizer that a certain error is either acceptable or too far off to be trusted.

This adjustable acceptance level is known as a recognition (if you're an op-



SAMPLE	DIGITAL REPRESENTATION	DECIMAL VALUE
1	0010	2
2	0001	1
3	0000	0
4	0001	1

Fig. 2. Digitizing a sine wave.



SAMPLE	DIGITAL REPRESENTATION	DECIMAL VALUE
1	0 1 0 0	4
2	0 0 1 0	2
3	0 0 0 1	1
4	0 0 1 0	2

Fig. 3. Digitizing a distorted wave.

timist) or rejection (if you're a pessimist) threshold. If the best match is above the threshold you select, the recognizer will accept the match and pass the word to the host computer. If the best match is below that level, the recognizer will ask you to repeat the word. You'll have to experiment with the recognizer to find the best level. It might even change for each speaker. Some speakers can say each word pretty much the same way each time, others can't. For certain jobs, you'll want to insist on a very close match, such as when the computer is controlling a critical function. Other times, when you are entering a lot of data, for example, it might be easier to allow the recognizer to make a few mistakes and fix them later with an editor.

Another Kind of Speech Recognition System. In order to make voice input easier to use, manufacturers are developing products that are *speaker independent*—they can recognize a word that's in their vocabulary regardless of who says it. You don't need to enroll. To accomplish this, the manufacturer takes extensive samples of large groups of people saying the vocabulary words and then tries to create a template that represents the way most people say the words. So, in a sense, everyone is always enrolled. The templates in this type of system are usually stored in ROM. This is especially useful for games, or when you want a number of people to be able to use the system.

Because research into how we understand what we hear is still quite new, most of these speaker-independent systems have small vocabularies (less than 10 words) that contain carefully selected words. These words require careful selection so that the recognizer won't have trouble distinguishing them from each other.

There are only about 40 basic speech sounds (phonemes) in the English language, and some of them aren't very easy to tell apart, even for a human listener. *Pot* and *pop*, for example, would be bad word choices for a recognizer (speaker dependent or independent) because they are short and quite similar. The shorter the word, the fewer clues that the recognizer has to the word's identity. Pop and pot are easily confused; you wouldn't want the two of them in the same vocabulary. A better choice would be *explosion* and *pot*. These two words would be easy for both humans and machines to distinguish from each other.

But some words are tricky. Eight, for example, sounds like repeat, and nine gets confused with five. The more words a particular vocabulary has, the greater the chance of confusing any two words (and the greater the cost of collecting and analyzing speech samples). Vendors of speaker-independent systems therefore choose to offer smaller, but extremely effective, vocabularies.

Most speaker-independent systems are far less accurate than speaker-dependent (enrolled) systems, but they offer the convenience of letting anyone walk up to a product, such as a toy or personal computer, and operate it with a voice command. Improved recognition techniques, being developed at companies like Votan, Interstate Electronics, and other voice-recognition research facilities, should close the performance gap soon. But at present, speaker-independent systems will make more mistakes than speaker-dependent systems.

The Chips Themselves. Most of the voice recognition systems you'll find for personal computers are based on custom-designed chips. The chips make it simple to design a complete-voice-input system because they take care of the recognition part of the problem. A designer only needs to add support circuitry, just as for a microprocessor.

The first commercial recognition chips came from Interstate Electronics. This firm's latest speaker-independent chip, the VRC008, which is intended for use in low-cost peripherals, requires only the support components shown in the schematic in Fig. 4. Sanyo Electric Ltd. has licensed the hardware and firmware for use in a Japanese action toy that will recognize six Japanese words. Interstate also offers a two-chip speaker-dependent recognizer, the VRC101 and VRC102.

Intel doesn't make or depend on special speech chips for recognition. Instead, it uses its 2920 family of digital signal processing chips (DSP) to convert the analog signals of words into useful (for the computer) digital signals. Intel's strategy is to produce a recognition board product that plugs into its Multibus computer systems and works with all of the firm's standard products.

Texas Instruments also makes a DSP chip called the TMS320. This high-speed processor can execute five-million instructions per second, and compute thousands of precise data values (reportedly faster than any other DSP chip currently on the market). This ultra-fast computing speed is essential for the computations needed in a speech-recognition system.

Add-On "Ears." One of the first low-cost peripherals to give personal com-

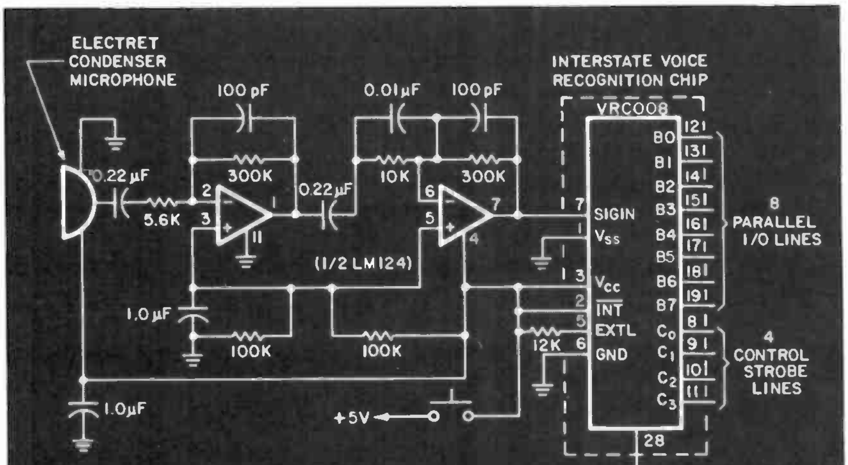


Fig. 4. Complete system using an Interstate Electronics chip.

puters "ears" was Scott Instrument's VET (voice entry terminal). The first models worked with TRS-80s and Apples. Today, the VET/2 ($895) works with the Apple II+, and the Shadow VET ($595) works with the Apple II+ and IIe. The VET/2 comes with a software program that enables teachers to write lessons that students can give spoken answers to. The VBLS (voice-based learning system) package costs $99.95 if you buy it separately. VBLS lets nonprogrammers get into the computer-aided instruction business in a convincing way.

Newer in the marketplace is the Voice Input Module (reviewed on page 40) from Voice Machine Communications. It is designed for the Apple II series of computers.

Tecmar's voice-recognition board is available to software manufacturers who want to make use of the technology with the IBM PC. For example, SuperSoft's ScratchPad with Voice-Drive uses the Tecmar board. Currently under development at Tecmar is a stand-alone voice-recognition product that can be used with commercial software for the IBM PC.

A speech-recognition system introduced just recently is the Speech Command system from Texas Instruments (also reviewed in the following pages). The product is for use with the Texas Instruments Personal Computer. You can add ears to a variety of computer terminals also. The C. Itoh, DEC, and Plessey terminals can accept plug-in boards to add voice input to the usual keyboard input. And all the host computer ever sees is ASCII characters from the terminal, so using the terminals doesn't require any special software. Plessey sells its terminal with the speech recognition option and has had great success in using it for "hands-free" programming. Programmers write COBOL programs by dictating the code to the computer.

Votan packages its hardware and software products in attractive boxes for use as stand-alone peripherals as well as selling them as individual boards. And the firm has done considerable work on making its products useful even over the telephone. With a recognizer designed for use with telephones, you can call a computer and use it from a remote location without any terminal at all.

The Texas Instruments 99/4A, when enhanced with the Milton Bradley MBX Expansion system, is the only low-cost home computer to offer speech recognition. The unit has a limited vocabulary, but it is sufficient for entering commands for games or educational programs.

Conclusion. In the future, you can expect to see speech capability built right into computers, instead of added on later. After all, semiconductor technology is making voice recognition practical and inexpensive, so it's inevitable that entire recognition systems will someday be available in chip form. And remember, it's not magic, it's just a pattern-matching system. ◇

SUPPLIERS

CompuPro
3506 Breakwater Ct.
Hayward, CA 94545

General Instrument
Microelectronics Div.
600 West John St.
Hicksville, NY 11802

Intel Corp.
3065 Bowers Ave.
Santa Clara, CA 95051

Interstate Electronics Corp.
1001 E. Ball Rd.
Anaheim, CA 92803

Plessey Peripheral Systems
17466 Daimler
Irvine, CA 92714

Scott Instruments
815 Elm
Denton, TX 76201

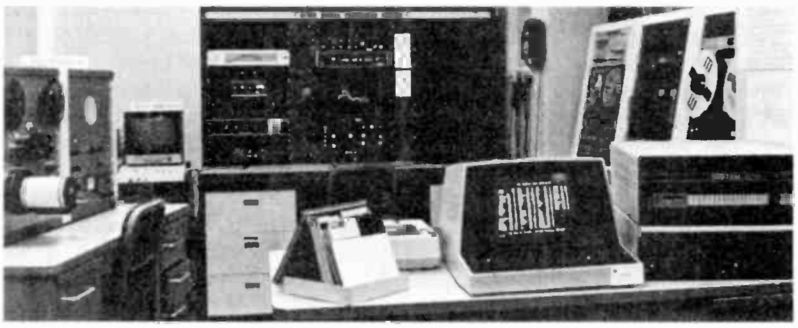
Tecmar
6225 Cochran Rd.
Cleveland, OH 44139

Texas Instruments Inc.
Box 10508
Lubbock, TX 79408

Voice Machine Communications
1000 South Grand Ave.
Santa Ana, CA 92705

Votan
4487 Technology Dr.
Fremont, CA 94538

WHO GOES THERE: SPEAKER IDENTIFICATION



Not all voice input systems are designed to respond to what is said to them. Some provide a quite different service—they determine if the speaker is someone who is allowed to use the system. This application can give a system some protection from intrusion. In such a system, the operator types in an identifier (the operator's name or a password, perhaps). The identifier tells the computer which set of vocabulary patterns to use. The computer can then look up the voice template for that person. It selects one of the vocabulary words and asks the operator to say it. When the operator speaks, the computer compares the input pattern to the one stored in memory for that operator.

A particular person will usually say each word in a reasonably similar manner each time. This strategy is called *speaker verification* because, while it doesn't identify a speaker, it can go a long way toward verifying that a speaker is who he says he is. The technique isn't foolproof; some speakers will produce the same or similar patterns, but it makes it a little harder for someone to use your computer or read your files without your permission.

Another way to use the same hardware is to identify a particular speaker from among a number of speakers. Suppose that you record someone saying a particular word. You might know that one of five people said the word, but not know which person. The computer can compare the recorded word against the patterns it has stored for all five people and tell you the person who *probably* said the word. In this case, the same hardware that might provide speech recognition is giving you speaker recognition.

This is one of the ways that law enforcement agencies are using voice input. The Los Angeles Sheriff's Department uses the CompuPro computer pictured above (donated for the purpose by Bill Godbout) to perform acoustic analysis of recordings, such as bomb threats and harassing telephone calls to determine whether or not a particular individual could be the one who made the call. But, according to Forensic Voice and Tape Investigator Craig Melvin, the computer's function is primarily to eliminate suspects. It doesn't point the finger of guilt at anyone as much as it proves that a certain person couldn't have made the phone call. If there is no match at all between the accused's voice and that of the tape-recorded voice, the officers will look for other suspects. Technology can acquit but can seldom convict. Not without other, supportive, evidence. ◇

Voice-Recognition Boards for Apple/ Franklin and Texas Instruments Professional Computers

By Joe Desposito

THE two voice-recognition products examined here are the "Voice Input Module" from Voice Machine Communications, Inc. and Texas Instruments' "Speech Command System." These devices are not reviewed so much for comparison as to give you insight into the advanced technology that is available for personal computers today.

Voice Input Module

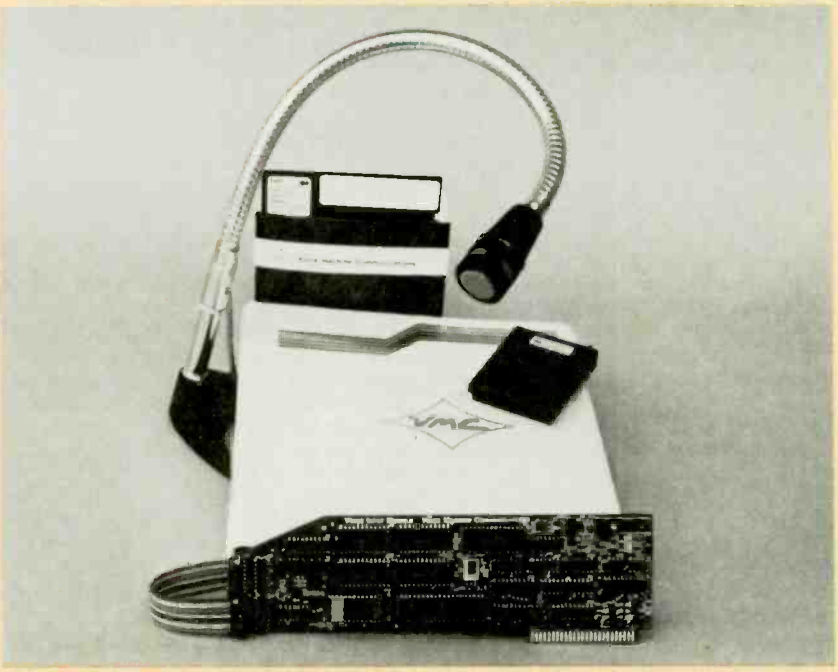
The Voice Input Module (VIM) is designed for use on the Apple II series of microcomputers or the Franklin ACE 1000. VIM can be integrated with most off-the-shelf Apple applications packages, which means that you can substitute voice input for keyboard entry (as desired) in programs such as VisiCalc, Pie Writer, and many others. And VIM works with languages, too! For example, you can use it when programming in BASIC, Logo, etc. Suggested retail price is $845 ($920 with a special noise-cancelling microphone and on/off footpedal), which includes the Magic Window II word-processing package and the MagiCalc financial applications software.

VIM Hardware. The VIM hardware consists of a circuit board that connects to an I/O slot at the rear of the Apple motherboard, and cables that interface the VIM to the Apple keyboard. There is a jack on the board that connects to a microphone.

On the circuit board are a 16-channel audio spectrum analyzer (a proprietary chip designed by Voice Machine Communications, Inc.), 8K RAM, 4K ROM, and Motorola's 68V03 microprocessor.

To install VIM, you must detach the Apple enclosure from its baseplate. The VIM printed-circuit board can be inserted in any unused Apple I/O slot. Then disconnect the keyboard encoder ribbon from the Apple main board and insert it into the VIM board. An additional ribbon connects from the VIM board to the now vacant connector on the Apple board. When this is done, the VIM is completely installed. Owing to the connection to the keyboard, this procedure is not as simple as inserting other types of boards into an Apple.

The Voice Input Module can be used with a variety of microphones. Supplied with the product is one of three different types: a hand-held microphone with on/off switch; a high-quality noise-cancelling microphone with an 18" gooseneck, a desktop stand, and footpedal switch; a high-quality noise-cancelling headset boom microphone with in-line on/off/momentary switch and plug.



Voice Machine Communications' Voice Input Module

VIM Software. The software (on one diskette) is called the Voice Utility Program (VUP) and is completely menu driven. Also included on the system disk are 10 vocabulary files for specific (such as VisiCalc) and general (such as a calculator command set) applications.

VUP enables you to build vocabulary files and voice-pattern files. If you have an applications package whose vocabulary file is not included on the system disk, you must build one for it before establishing a corresponding voice-pattern file. After creating voice-patterns, you can test the computer's ability to recognize them. When you're satisfied that the computer understands what you have entered, the voice commands can be integrated into your applications package.

Using the Voice Input Module. The first step in using VIM is to load a vocabulary file into the computer. If none exists on the system disk for your application, you must build the file from scratch. The procedure consists of entering a vocabulary word, and then entering the keystrokes for it. It may be simple, such as keying "1" for "one," or complex, such as keying "BLOAD INTBASIC, A$D000 <0D> for "load integer." The <0D> is a hexadecimal code that represents RETURN, which is a nondisplayable character. There are also codes for other characters of this type such as cursor right or left, escape, control characters, etc. A maximum of 80 words can be entered into a single vocabulary file.

Once you have built a vocabulary file, you're ready to "train" the computer to recognize those words or phrases. When a vocabulary word is displayed on the screen, you speak it into the microphone. After one pass through the vocabulary, the words appear again. This time around the computer may or may not accept your spoken input. If the

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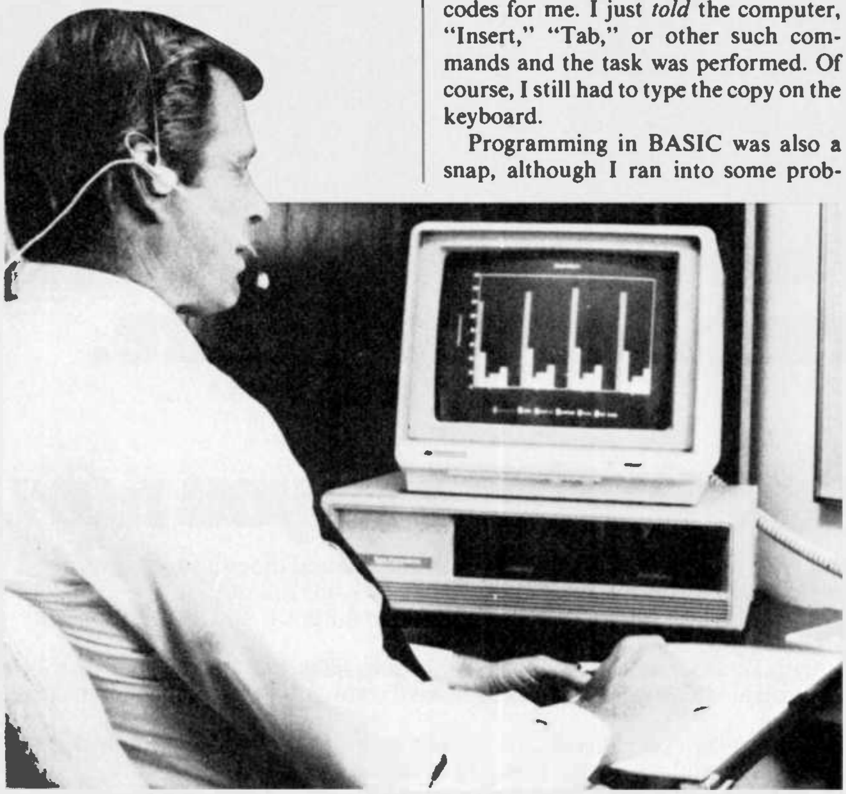
word is spoken in a similar way each time, there is no problem; otherwise the computer waits for you to give it another input. This procedure concludes after three passes.

At this point, after establishing a vocabulary file and associated voice-pattern file, the computer is ready to listen to you. However, before loading an applications program into the computer, it's a good idea to run some tests just to make sure that the computer really does understand you.

There are two tests available with the VIM system: a separability test and a recognition test. The separability test identifies any words that are likely to be mixed up, such as "or" and "for." In the recognition test, the computer prompts you to say the words in your vocabulary file (from a printout); and it prints the appropriate word on the display. Along with the input word, the computer prints the "nearest neighbor" and a numerical difference between them. If the difference is small, there is a good probability that the computer might mix up the input word with the nearest neighbor in the future. Sometimes the computer does not recognize the word, which means it will not respond at all or else print the wrong word.

Small difference values and unrecognized words indicate that additional training is called for. This process adds more information to the templates stored in the computer, and thus increases the probability of correct recognition. Voice Machine Communications, Inc. states that a 98% recognition factor is achievable.



Texas Instruments' Speech Command System

User Comments. Using the Voice Input Module is certainly an experience. The reward for setting up a vocabulary file and voice-pattern file is that your applications software suddenly becomes a joy to use! The first software I tried was Pie Writer, since I felt that word processing would be one of the major uses for a voice-input system. After enrolling the vocabulary that was included on the system disk (which took about 10 minutes), I began to do some word processing. No more control or escape codes for me. I just *told* the computer, "Insert," "Tab," or other such commands and the task was performed. Of course, I still had to type the copy on the keyboard.

Programming in BASIC was also a snap, although I ran into some problems. The computer was confused by some commands. Words like "or" and "for"; "six" and "text"; "oh" and "poke"; and "eight," "delete," and "peek" were constantly misunderstood. There are two ways to get around this. Either retrain your vocabulary or substitute different words for those that are being confused. For example, I substituted "letter" for "text," "erase" for "delete," and "look" for "peek."

I tried building a vocabulary and voice-pattern file for a video game and got some surprises. There were just four commands to the game: right, left, stop, and jump. After enrolling this small vocabulary, I played the game at the lowest level. Everything worked fine. Then I tried the highest level, where the game was much faster and more complicated to play. To avoid disaster I yelled, "Jump!" but nothing happened and my player was wiped off the screen. I kept trying to play the game, but the computer refused to respond to my voice commands at the expert level of play. Then I realized what the problem was. At the expert level, I was speaking excitedly into the microphone due to the fast-paced action of the game. But when I had enrolled the vocabulary, I did so with dull, monotone commands. Lesson one on enrollment: Try to envision the emotional state you'll be in when you use your applications program, and *then* enroll the vocabulary. In this case, I should have enrolled two sets of commands, one for the lower game levels and another, in a more excited tone, for the higher ones.

To test the speaker dependency of the system, I had a few other people try to use VIM after I had enrolled the vocabulary. I found that a female voice got no response, but a male voice got about a 50% response. The same held true in reverse when a female enrolled the vocabulary.

Conclusions. I think this product has great potential, but also limitations. Being able to use it with off-the-shelf applications packages is a big plus. The VIM can make the computer very accessible to noncomputerists or special groups of people, such as the handicapped. However, someone is needed who can set up the system for maximum proficiency. Installation is not a simple process, and setting up files must be done carefully and creatively. It's a big help, too, to know the applications package well.

I found the separability test lacking. For instance, after enrolling the BASIC vocabulary, I ran the separability test and it pointed out that "for" and "or" would be a potential source of confusion. However, in actual use, many more word pairs were confused.

Another shortcoming I found was that a word could easily be deleted from the vocabulary list, but there was no way to easily delete its corresponding voice pattern. To do this it was necessary to retrain the entire vocabulary! (According to a company spokesman, there is a new "merge file" feature that allows deleting a particular voice pattern without retraining the entire vocabulary.)

Weighing all factors (including cost) my feeling is that a person who purchases the Voice Input Module must have a serious need for it. It takes knowledge and patience to get VIM to the point where it's working at an optimum level. However, once there, using VIM is a most pleasant experience.

Speech Command System

The Speech Command System (SCS) from Texas Instruments is designed specifically for the TI Professional Computer with MS-DOS and at least 256K of memory. Voice recognition can be integrated with any MS-DOS-based applications software.

The suggested retail price of the Speech Command System is $2600, and you may wonder why. It's because the system also includes a sophisticated telephone management system (not reviewed here) that uses speech synthesis and digital voice recording.

SCS Hardware. The hardware for the Speech Control System consists of two circuit boards, one piggybacked onto the other that connects into one of the expansion slots of the computer. A microphone headset, included with the system, plugs into a jack at the rear of the board (accessible from the outside). Alternately, you may use a different type of microphone or even a telephone handset.

Other than sliding the board into the slot, the only connection is to the internal speaker, which is a simple matter. Once the unit is installed, a diagnostic test disk can be run to make sure that everything is working properly.

On the SCS circuit board is a Texas Instruments 32010 digital signal processor (DSP), an A/D and D/A converter, a programmable low-pass filter, an eight-word FIFO, and 16 × 16K-word RAM. All signal processing on the board is done by the TMS32010, while the FIFO acts as a buffer for input data, and the RAM is used to store vocabulary templates. When the TMS32010 has to process a template, it reads the template into its on-chip RAM.

SCS Software. There are two disks included with the Speech Command System. One is the Speech Command disk, and the other is the Transparent Keyboard disk. The latter is used solely for the speech-recognition functions, although both disks are needed to run the system (remember that a telephone manager is also part of the system).

The software includes vocabulary files for the following: MS-DOS, Multiplan, Easywriter II, NLX Dow Jones, Easyspeller II, MS-BASIC, PFS: REPORT, PFS: FILE, and Lotus 1-2-3. If you have an application not on this list, you may build a file to suit your needs. Also, you may add commands to existing files. Vocabulary files accommodate a maximum of 50 words. However, if this is too restrictive, you can build additional vocabularies, and the software can "switch" among them.

Using the Speech Command System. SCS is completely menu driven. However, depending on your TI-PC hardware configuration, there are different steps to follow to bring the voice-recognition menu up. I used SCS on a system with one floppy disk drive and one hard disk (a single floppy drive or dual floppy drives are other possibilities).

Before entering the main menu for the first time, you are expected to do a simple calibration routine. This assures optimum system performance for your specific voice and input device. What actually happens is that the computer determines the correct level or "gain" for the combination of your voice and input device. You needn't calibrate again unless you change your input device or environment, or if you think your voice has changed.

When the main menu appears, it includes choices for the telephone manager, calendar manager, and dictation file utility, as well as the transparent-keyboard vocabulary utility that we are concerned with here. Simply pressing function key F4 gets you into the voice-recognition mode. You now enter a command to bring up one of the disk-based vocabularies and begin the enrollment procedure.

When the vocabulary appears, the word that you're enrolling appears highlighted in inverse mode. After you say the word, the next one on the list is highlighted. In this manner, the computer steps you through the enrollment process. After enrolling the vocabulary, it is recommended that you "update" at least three times. In effect, you have created a template with the enrollment procedure, and updating serves to add more information to the stored template.

The next step is to test the vocabulary you've just entered. Here the TI-PC makes good use of its color properties. When the vocabulary appears for test, you say the word and the computer highlights it. On a scale from 1 to 10, you are given an indication of the "closeness of fit" of the current word to the stored template. High numbers indicate the best recognition. Visually, the computer shows words with low numbers in red, high numbers in yellow, and numbers in the middle in green. For numbers in red, you should go back and do further updates on them.

The Speech Command System has one important capability that hasn't been touched on yet. It not only recognizes individual words and short phrases, but also strings of words spoken in an ordinary way. For proper recognition, you have to enroll the desired word in the string context.

User Comments. I used the Speech Command System with the EasyWriter II word processor. The vocabulary file for this software is included on the disk, so I just needed to enroll my voice. Enrollment, updating, and testing were fairly easy once I became accustomed to the menu choices, which are listed in four columns near the bottom of the screen.

The system showed excellent response to my commands without confusing any of them. However, there were just 31 words in the vocabulary. One word caused a problem. Background noise was interpreted by the computer to be the word "ruler," which was one of the vocabulary words. This was no problem to correct, however, because the system has a "delete" option that allows you to delete a voiceprint, its associated phrase, and equivalent keystrokes form a vocabulary file. I changed the word to "margins."

Another option would have been for me to enroll ruler again. This would have deleted the previous voiceprint and stored a new one. Other options available are add and modify. The former permits you to add a new word to the vocabulary; while modify allows you to change the phrase and equivalent keystrokes associated with a voiceprint.

I also tried the connected-speech capability using MS-DOS commands. I went through the necessary procedures of creating the file, enrolling it, etc. However, the phrases that I entered included "Show me the directory," "of the disk in drive A," "of the Winchester," etc. Thus, when the MS-DOS prompt appeared later on, I was able to say, "Show me the directory of the Winchester," and it was done. Quite impressive!

Conclusions: The speech-recognition feature of Texas Instruments' Speech Command System is an excellent enhancement for its Professional Computer. However, to use it effectively, a skilled operator is needed to set it up. I don't think the vocabulary files offered with the system really exploit its full power.

The menu system is complete and offers all the options you need to prepare SCS for use with a particular application. And the connected speech feature is really a cherry on the ice-cream sundae. Overall, computer voice recognition with the Speech Command System made me feel as if I had entered a new era of computing. ◇

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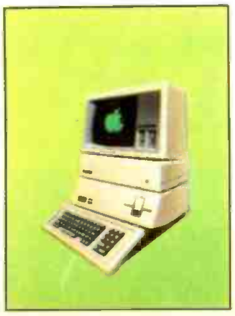

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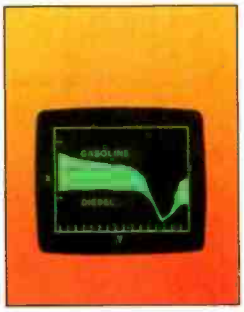

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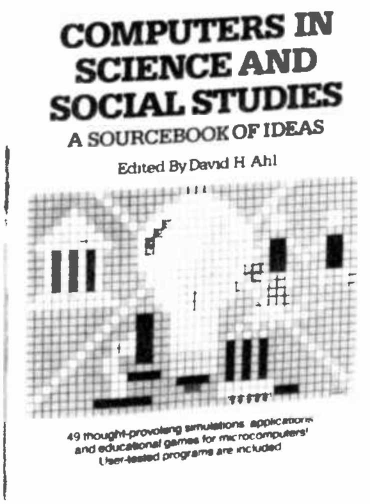

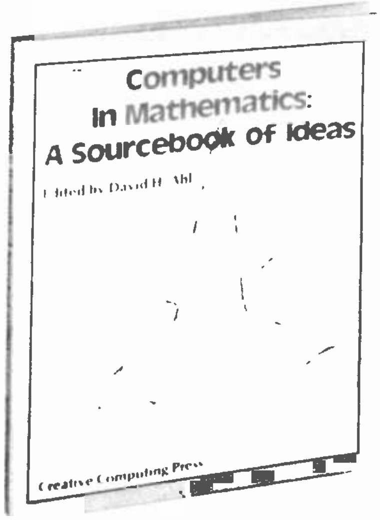

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Number Systems for Microcomputers

How binary, decimal, octal, and hexadecimal systems work in relation to your computer

By Randy Carlstrom

ALMOST 800 years ago, the *Arabic number system* was introduced in Europe. Ten symbols were used since man has 10 fingers that he can use for counting purposes. In fact, each symbol is called a *digit* (from the Latin *digitus,* for finger); and because there are 10 digits, the Arabic system is also called the *decimal number system* (from the Latin *decem,* for 10).

When counting in the decimal system, we begin with the digit having the least value, zero. When the count reaches 9, a limit has been reached because 9 is the digit of greatest value and there are no fingers left. An additional count produces a carry, which is equal to 10. The 1 occupies the 10s (10^1) position, whereas the 0 occupies the units (10^0) position. This process continues each time 9 is reached in the units position. When a 9 appears in the 10s position, the next carry into the 10s position will produce a carry into the 100s (10^2) position.

Note that a number in the 10s position possesses a value (*weight*) 10 times that of the same number in the units position. A number in the 100s position possesses a weight 10 times that of the same number in the 10s position. The same is true for each position of greater weight. Because of this relationship, the decimal numbering system is called a *place value system* and its *base* or radix is 10. When dealing with other place value number systems, as we shall be shortly, keep these four relationships in mind: (1) each place position multiplies the value of the digit by the base; (2) a carry from one position to the next increases its weight by a factor of the base; (3) the number of digits used in the system is equal to the base; and (4) the largest digit is one less than the base.

Let's examine a number in the decimal system, for example, the number 634. The 4 is the *least significant digit* (LSD) and occupies the units position. The 3 occupies the 10s position, while 6, the *most significant digit* (MSD), occupies the 100s position. The number 634 in base 10 implies that there are six 100s, three 10s and four 1s. This may be expressed as $(6\times 100) + (3\times 10) + (4\times 1)$, or in scientific notation as $(6\times 10^2) + (3\times 10^1) + (4\times 10^0)$.

Octal. Now let's look at another number system, the *octal* (base-8) system. It has eight digits, the one of greatest value being 7, which is one less than the base. When counting, the sequence is 0 to 7. A carry of 1 from the units position has a weight of 8 because the base is 8. The positional values of the first five positions for the octal number system are shown in Fig. 1.

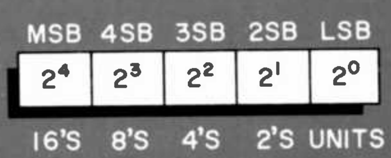


Fig. 1. Positional values of first five positions for the octal number system.

Now let's convert the octal number 1405 to decimal (base 10). Reading this as "one-thousand-four-hundred-five" implies base 10; therefore, this number should be read "one-four-zero-five," which does not imply any base. There are one 512s, which equals 512; four 64s, which equals 256; zero 8s, which equals 0; and five 1s, which equals 5. Summing these subtotals yields $512 + 256 + 0 + 5 = 773$; hence $1405_8 = (1\times 8^3) + (4\times 8^2) + (0\times 8^1) + (5\times 8^0) = 773_{10}$.

As another example, using Fig. 1 as a guide, let's convert octal 71834 to decimal. There are seven 2048s, which equals 14,336; one 512; eight 64s, which equals 512; but hold on a minute! We can't have "8" in the octal number system because the digit of greatest value is 7; 8 doesn't even exist in octal. Therefore 71834 is an *invalid* octal number!

Let's reverse the process and convert decimal 79 to octal. Since we are converting to base 8, we will want to repeatedly divide the decimal number by 8 until the quotient is reduced to zero, as follows:

$$79/8 = 9 + 7 \text{ remainder}$$
$$9/8 = 1 + 1 \text{ remainder}$$
$$1/8 = 0 + 1 \text{ remainder}$$

The correct octal number is obtained by reading the remainder column from bottom to top, or 117. Hence $79_{10} = 117_8$. The reader should verify this result for himself by converting 117_8 to decimal using the method previously described.

To make sure we understand the process of octal-to-decimal conversion, let's go through one more example and convert decimal 100 to octal:

$$100/8 = 12 + 4 \text{ remainder}$$
$$12/8 = 1 + 4 \text{ remainder}$$
$$1/8 = 0 + 1 \text{ remainder}$$

And, after reading the remainders from bottom to top, we have $100_{10} = 144_8$.

Octal is an important numbering system used in computers, as will be explained later.

Hex. *Hexadecimal* (base 16) is another important number system in dealing with computers. Recalling the basic relationships of number systems, how many digits exist in hexadecimal? What is the value of the largest digit? If you guessed 16 and 15, you're right. However, 15 is a decimal number and requires two digits—a 1 and a 5. In the hexadecimal number system, 16 *different* symbols must be used. The conventional zero through 9 are used for the first 10, and A through F are used for the remaining 6, as shown in Fig. 2, with Fig. 3 showing the positional value of a four-digit hexadecimal number.

Conversion from hexadecimal to decimal is done in the same manner as was done with octal-to-decimal conversion. As an example, let's convert the hexadecimal number 7B3F to decimal. There are seven 4096s, which equals 28,672; eleven 256s, which equals 2,816; three 16s, which equals 48; and fifteen 1s, which equals 15. Summing, we obtain 31,551 as our result. Or, in "base-16 scientific notation," 7B3F $= (7\times 16^3) +$

Decimal	Hexadecimal	Octal	Binary
0	0	0	0000
1	1	1	0001
2	2	2	0010
3	3	3	0011
4	4	4	0100
5	5	5	0101
6	6	6	0110
7	7	7	0111
8	8	10	1000
9	9	11	1001
10	A	12	1010
11	B	13	1011
12	C	14	1100
13	D	15	1101
14	E	16	1110
15	F	17	1111

Fig. 2. Equivalent values for the number systems.

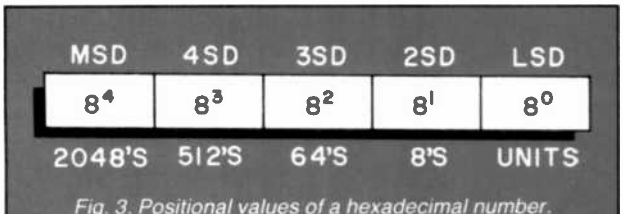


Fig. 3. Positional values of a hexadecimal number.

$(11\times 16^2) + (3\times 16^1) + (15\times 16^0) = 31{,}551_{10}$.

The conversion of decimal numbers to hexadecimal is the same as decimal-to-octal conversion, except division is by 16 rather than by 8 because the base is 16. What is the hexadecimal for decimal 3,720?

$$
\begin{aligned}
3720/16 &= 232 + 8\\
232/16 &= 14 + 8\\
14/16 &= 0 + 14(E)
\end{aligned}
$$

Reading the remainders from bottom to top as usual, and substituting the characters A through F for remainders greater than 9 as required yields $E88_{16}$. Again, the result may be verified by converting it back to decimal to see if it in fact equals 3,720.

Binary. The last number system we'll investigate is the binary (base 2) number system. There are only two digits used in the binary system: 0 and 1. All digital computers employ this number system for internal operations because only two signal levels are required. Binary digits are usually referred to as *bits*; therefore the least significant digit is called the *least significant bit* (LSB) and the most significant digit is called the *most significant bit* (MSB). The positional values of the first five positions of the binary number system are shown in Fig. 4.

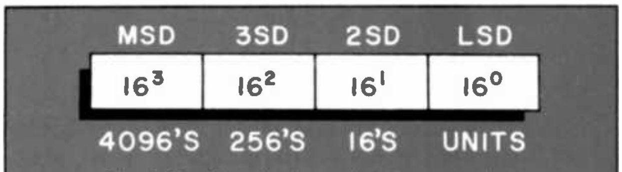


Fig. 4. Positional values of a binary number.

Binary-to-decimal conversion is very easy. If a 1 is present in a given position, the weight of that bit is added. If a 0 is present, the weight of that bit is not added. For example, the binary number $10110 = 16 + 0 + 4 + 2 + 0 = 22_{10}$.

Decimal-to-binary conversion is similar to that of conversion from decimal to other bases. Let's convert 94_{10} to binary:

$$
\begin{aligned}
94/2 &= 47 + 0\\
47/2 &= 23 + 1\\
23/2 &= 11 + 1\\
11/2 &= 5 + 1\\
5/2 &= 2 + 1\\
2/2 &= 1 + 0\\
1/2 &= 0 + 1
\end{aligned}
$$

Therefore $94_{10} = 1011110_2$. Let's verify this result: There is one 64, one 16, one 8, one 4, and one 2, which, after summing, yields 94.

Data Representation. Large numbers in a computer tend to become very long and difficult to work with, since many ones and zeros are required to represent the number. For instance, an 8080 memory address is represented by a binary number 16 bits in length, while larger computers may require up to 32 bits. Other number systems may be used as a shorthand notation of representing binary numbers. If only groups of three bits are considered, 2^3 (eight) combinations are possible, namely 000 through 111. The octal number system lends itself nicely to direct substitution of three-bit binary numbers. Let's convert an 8080 memory address for example, 1101000010111100, to octal. We will first want to separate this binary number into groups of three bits each, and then substitute octal digits for each of these groups.

```
001 101 000 010 111 100 (binary)
  1   5   0   2   7   4 (octal)
```

Therefore our "lengthy" memory address may also be written as octal 150274. When separating the binary numbers into three-bit groups, we begin at the right (LSB position). Because of this, two zeros were added to fill the most significant octal position. It is important to remember that the number, regardless of the form written, is still in binary form in the computer. The above procedure can be reversed to convert from octal to binary:

1	7	4	6	3	0	(octal)
001	111	100	110	011	000	(binary)

Another (and the most common) base used for writing binary numbers in shorthand notation is hexadecimal. If we separate the binary number into groups of four bits, 2^4 (16) combinations are possible (0000 through 1111). Since there are also 16 digits in hexadecimal, one hexadecimal digit is substituted for each group of four bits. The conversion process from binary to hexadecimal is similar to that of binary to octal, except that the binary number to be converted is broken up into groups of four bits instead of groups of three bits. Let's convert the same memory address used in the example above into hexadecimal.

1101	0000	1011	1100	(binary)
D	0	B	C	(hexadecimal)

So now our memory address may be represented either by octal 150274 or hexadecimal D0BC. Notice that the hexadecimal representation requires the least number of digits; this and the fact that "filler bits" need not be added to the binary number account for the popularity of this system.

The above procedure of course may be reversed to convert from hexadecimal to binary:

3	A	4	F	(hexadecimal)
0011	1010	0100	1111	(binary)

Addition and Subtraction. Now that we have mastered number system conversion, let's go on and find out how addition and subtraction are performed in various number systems. Add the decimal numbers 14 and 35:

1	4
3	5
4	9

When numbers are added, they are added in columns—one number is placed below the other. Either number may be placed first. The digits were separated in the example to emphasize positional differences. The answer is 49 (four 10s and nine 1s).

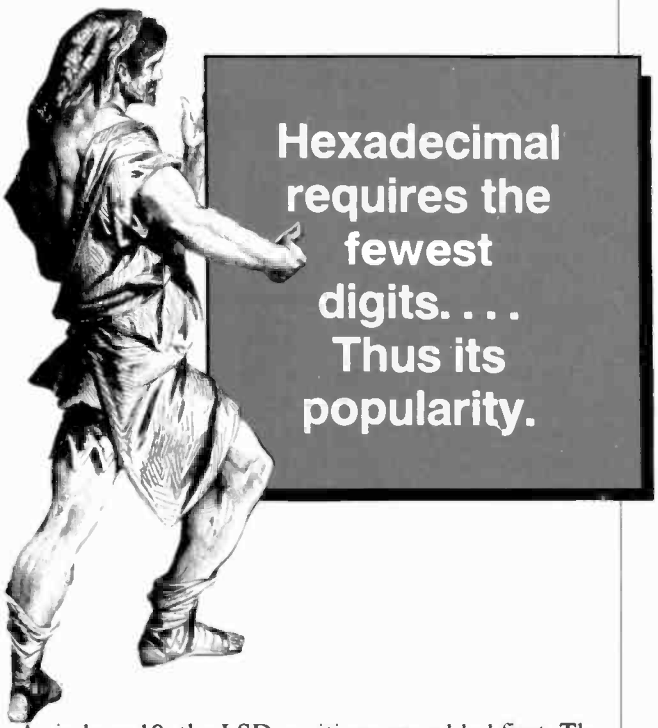
Now let's add the numbers 85 and 47 in base 10.

1	1		(carry)
	8	5	
	4	7	
1	(13)	(12)	
	10	10	(subtract value of carry)
1	3	2	

In this example there is a 12 in the units position. This number is greater than 9, which tells us there must be a carry (10). The digit remaining in the units position will be the difference of 12 and the value of a carry (10), or 2. The 10s position now contains 8 + 4 + a carry of 1, or 13. A carry is again indicated by a number greater than 9. Subtracting 10 from 13, we get 3 with a carry of 1. The third position (100s) contains only the carry. Note that the value of a carry is equal to the base of the number system being used.

Now let's add two octal numbers, say 137 and 461.

1	1		(carry)
1	3	7	
4	6	1	
6	(10)	(8)	(decimal sum)
	8	8	(subtract value of carry)
6	2	0	$= 620_8$



As in base 10, the LSD positions are added first. The sum of 7 and 1 is decimal 8. This number is greater than 7 (remember that 7 is the largest digit in base 8), which tells us there must be a carry. Subtracting 8 (the value of a carry) leaves 0 with a carry of 1. The 8^1 position now contains 3 + 6 + a carry of 1, or decimal 10. A carry is again indicated by a number greater than 7. Subtracting the value of a carry from 10 leaves a remainder of 2 with a carry into the next position (8^2). This position now contains 1 + 4 + a carry of 1, or 6. No carry is generated since the number is less than 8, so 8 is not subtracted. There are six 64s, two 8s and no 1s in our answer.

How about hexadecimal addition? No different! Let's add the hexadecimal numbers 2A4 and 97F.

1	1		(carry)
2	A	4	
9	7	F	
12	(18)	(19)	(decimal sum)
	16	16	(subtract value of carry)
C	2	3	$=C23_{16}$

Adding the units column results in decimal 19. Since 19 is greater than the largest hexadecimal digit (F), a carry exists. Subtracting the value of a carry (16) leaves a remainder of 3 with a carry of 1. In the next (16^1) position, the sum of A and 7 plus a carry of 1 is decimal 18. Again a carry is generated, leaving a remainder of 2 with a carry of 1 into the 16^2 position. Two + 9 + a carry of 1 in the MSD position yields decimal 12, which is C in hexadecimal. The final answer is $C23_{16}$, indicating that there are twelve 256s, two 16s, and three 1s.

For our last addition problem let's add two binary numbers, say 1010 and 1110.

1	1	1			(carry)
	1	0	1	0	
	1	1	1	0	
1	(3)	(2)	(2)	0	(decimal sum)
	2	2	2		(subtract value of carry)
1	1	0	0	0	$= 11000_2$

The method of binary addition is the same as that used with other bases. Any time an addition results in a number greater than 1 (the largest binary digit), a carry is generated. The remainder is then obtained by subtracting the value of a carry (2) from the decimal sum. From this example note that 0+0 always equals 0; 0+1 always equals 1; 1+1 always equals 0 and a carry; 1+1 + a carry always equals 1 and a carry. There is one 16 and one 8 in the answer of the above example.

Let us now examine the process of subtraction in various number systems. Since we are so familiar with base 10 subtraction and the rules involved are the same as those used for other bases, let's review the process of subtraction in base 10. Subtract 24 from 53:

4	borrow 1	
~~5~~	(1)3	(minuend)
2	4	(subtrahend)
2	9	(difference)

As in addition, we start the subtraction process in the LSD position. Since 4 cannot be subtracted from 3, we must "borrow" from the next significant position of the minuend. We may now interpret the 3 as 13 and find the difference, which is 9. Moving to the next position, we must reduce the minuend by 1 because of the borrow. We then subtract the number in the subtrahend from the new minuend, yielding a difference of 2. Remember that the borrow carries with it a weight equal to that of the base.

Keeping these rules in mind, let's subtract two octal numbers.

4	(1)0		
~~5~~	~~1~~	(1)6	
4	3	7	
0	5	7	$=57_8$

In this example 437_8 is subtracted from 516_8. A borrow is necessary in the first position since 7 is greater than 6. The borrow creates a new number in the minuend LSD position, 16. (This number is read "one-six," *not* "sixteen," since 16 is a decimal number. One-six in base 8 means 8+6 in base 10). One-six minus 7 equals 7 (if you think in base 10, then (8+6)−7 equals 7). In the next position, 1 was borrowed from the number in the minuend, making its value 0. A borrow is again required; it makes the value of the minuend 10 (or 8+0 in base 10). Subtracting 3 from 10 yields a difference of 5. In the last position, 1 was borrowed from the minuend, making its value 4. The difference in this position is 0.

Applying the same rules as in base 8, let's subtract the hexadecimal number 9AE from the number D96.

C	(1)8		
~~D~~	~~9~~	(1)6	
9	A	E	
3	E	8	$=3E8_{16}$

A borrow is required in the first position since E is greater than 6. One-six minus E equals 8, or, in base 10, (16+6)−14 equals 8. In the next position A is subtracted from 18 (one-eight), which equals E. Or, in base 10, it would be (16+8)−10 = 14. In the last position we subtract 9 from C (remember that the D became a C because of the borrow), yielding 3.

Finally let's turn our attention to binary subtraction.

As an example, let's subtract 01101 from 11010:

$$
\begin{array}{ccccc}
0 & \rightarrow(1)0 & & 0 & \\
\cancel{1} & \cancel{1}\rightarrow(1)0 & & \cancel{1}\rightarrow(1)0 & \\
0 & 1 & 1 & 0 & 1 \\
\hline
0 & 1 & 1 & 0 & 1
\end{array} = 1101_2
$$

A borrow is necessary in the LSB (2^0) position since the minuend is 0. The borrow has a weight of 2 since we are working in base 2. In the 2^1 position, 0 from 0 equals 0. A borrow is again required in the 2^2 position since 1 cannot be subtracted from 0. The minuend in the 2^3 position is 0 due to the borrow, so 1 must be borrowed from the 2^4 position. Both MSBs are 0, yielding a difference of 0.

In order to simplify the *ALU* (Arithmetic Logic Unit—an internal part of the CPU) design, subtraction in a computer is usually performed by addition of the complement of the subtrahend. As an example, subtract 137 from 421:

$$
\begin{array}{r}
421 \\
\underline{-137} \\
284
\end{array}
$$

This same operation may be performed by adding the *ten's complement* of 137 to 421. The ten's complement of a decimal number is the difference between that number and the next higher power of 10. Since the highest power 137 occupies is the hundreds (10^2) position, 10^3 (thousands) would be the next higher power of 10. Therefore, the ten's complement of 137 equals 1000 minus 137:

$$
\begin{array}{rl}
1000 & \\
\underline{-137} & \\
863 & \text{(ten's complement of 137)}
\end{array}
$$

Now perform the subtraction by adding the ten's complement:

$$
\begin{array}{r}
421 \\
\underline{+863} \\
1284
\end{array}
$$

The last step is to subtract the power of 10 used in finding the ten's complement:

$$
\begin{array}{rl}
1284 & \\
\underline{-1000} & \\
284 & \text{(difference)}
\end{array}
$$

Notice that this operation is just a matter of dropping the carry out of the most significant position.

Let's try subtracting 3247 from 9025 using the ten's complement method:

$$
\begin{array}{rl}
10000 & \\
\underline{-3247} & \\
6753 & \text{(ten's complement of subtrahend)}
\end{array}
$$

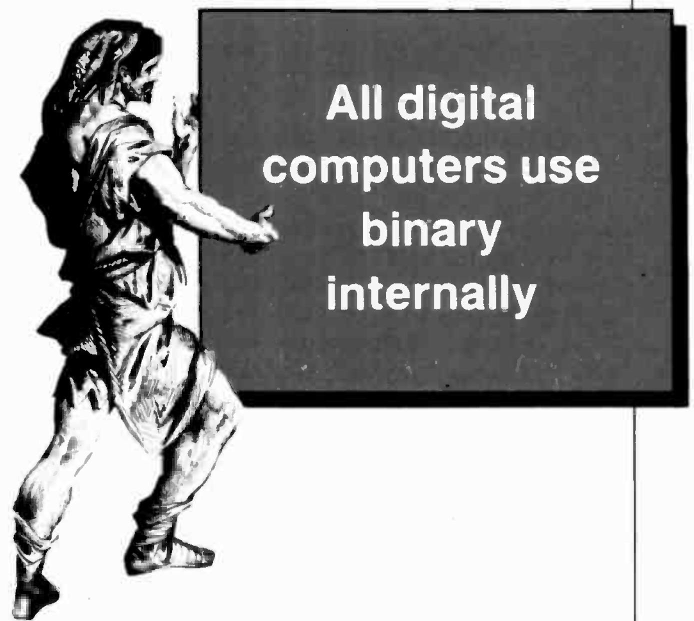
$$
\begin{array}{rl}
9025 & \\
\underline{+6753} & \\
5778 & \text{(difference) (ignore carry)}
\end{array}
$$

An easier way to obtain the ten's complement of a decimal number is to find the *nine's complement* of that number and then add 1. The nine's complement of a digit is the difference between 9 and the digit, which may be found by a simple inspection procedure. For instance, the nine's complement of 176 may be found as follows:

$$
\begin{array}{rl}
999 & \\
\underline{176} & \\
823 & \text{(nine's complement of 176)}
\end{array}
$$

By adding 1 to the nine's complement, we obtain the ten's complement, or 824.

The computer, of course, cannot perform the ten's or nine's complement directly since it works only in base 2. The computer instead uses what's called *two's complement arithmetic*, which is analogous to ten's complement arithmetic in the decimal system. First let's discuss what the *one's complement* of a binary number is.



The one's complement of a binary number is similar to the nine's complement of a decimal number. The one's complement of a bit is the difference between 1 and the bit, which may also be found by a simple inspection procedure. The following example illustrates how the one's complement of 11010110 is found.

$$
\begin{array}{r}
1\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \\
\underline{-1\ 1\ 0\ 1\ 0\ 1\ 1\ 0} \\
0\ 0\ 1\ 0\ 1\ 0\ 0\ 1
\end{array}
$$

Notice that no carries or borrows are involved in this operation (as no carries or borrows were involved in finding the nine's complement of a decimal number). Inspection reveals that the one's complement of a binary number may be found by changing all the zeros in the number to ones and changing all of the ones to zeros. The ALU of the CPU is able to perform this operation very simply with an inverter circuit.

To subtract two binary numbers using the one's complement method, the one's complement of the subtrahend is added to the minuend. The carry out of the MSB position is then added to the LSB position. This process is called *end-around carry*. Let's find the difference between 10010111 and 01101010 using the one's complement.

$$\begin{array}{r} 1\,0\,0\,1\,0\,1\,1\,1 \\ -0\,1\,1\,0\,1\,0\,1\,0 \\ \hline \end{array}$$

becomes

$$\begin{array}{rl} 1\,0\,0\,1\,0\,1\,1\,1 & \\ +1\,0\,0\,1\,0\,1\,0\,1 & \text{(one's complement)} \\ \hline 1\,0\,0\,1\,0\,1\,1\,0\,0 & \\ (+)\qquad\qquad 1 & \text{(end-around carry)} \\ \hline 0\,0\,1\,0\,1\,1\,0\,1 = 101101_2 & \end{array}$$

The two's complement is obtained by adding 1 to the one's complement, just as 1 was added to the nine's complement to obtain the ten's complement. When using two's complement subtraction, the carry out of the MSB position is ignored—the end-around carry is not performed as with the one's complement method. When performing a subtraction, the ALU effectively obtains the two's complement of the subtrahend by first obtaining the one's complement (with an inverter), and then starting the addition process with a carry as the following example illustrates:

$$\begin{array}{r} 1\,0\,1\,1\,0\,1\,0\,0 \\ -0\,0\,1\,0\,1\,1\,1\,1 \\ \hline \end{array}$$

becomes

$$\begin{array}{rl} 1\,0\,1\,1\,0\,1\,0\,0 & \\ +1\,1\,0\,1\,0\,0\,0\,0 & \text{(one's complement)} \\ \hline (+)\qquad\qquad 1 & \text{(adding a carry produces two's complement)} \\ \hline 1\,1\,0\,0\,0\,0\,1\,0\,1 = 10000101_2 & \text{(difference)} \end{array}$$

The carryout of the MSB is ignored.

Notice that adding a carry with the subtrahend is the same as performing an end-around carry with the one's complement method. The carry to "complete" the two's complement conversion is simply added at an earlier time as shown in this example.

We can find the two's complement by taking the one's complement and then adding 1, but a faster method exists that enables us to obtain the two's complement by pure inspection. The method is to simply copy down the number to be complemented starting in the LSB position, working left (toward the MSB). Copy all the bits just as they appear up through the first 1. After the appearance of the first 1, all succeeding bits should be written in their one's complement form (1s written as 0s and 0s written as 1s). Consider binary 01001100 for example. We copy this number starting in the LSB (2^0) position, and stop after writing down the 1 in the 3SB (2^2) position. From this point on we invert each bit before writing it down. This process yields 10110 100, where we have separated the "inversion point" for clarity. We may check our result by adding to it the original number to be complemented. The result should be 0 (remember that the carry out of the MSB position is ignored) since we are actually subtracting the number from itself.

By now you may have asked yourself, "How does the computer store negative numbers?" To see how negative numbers are stored let us consider a mechanical register, such as a car's mileage indicator, being rotated backwards. A five-digit indicator approaching and passing through zero would read as follows:

00004
00003
00002
00001
00000
99999
99998
99997
etc.

It should be clear that the number 99997 may also correspond to -3. If we add

$$\begin{array}{r} 00004 \\ +99997 \\ \hline 1\ 00001 \end{array}$$

and ignore the carry out of the MSD position, we have effectively performed the operation of subtraction, which was described previously.

If a system of complements were to be employed for representing negative numbers, the minus sign could be omitted in negative numbers. Use of such a system, however, requires that a convention be established as to what is and what is not a negative number. For example, if the mileage indicator is turned back to 41768, is it

a negative 58232 or a positive 41768? With an ability to represent 100,000 different numbers (0-99999), it would seem reasonable to use half for positive numbers and half for negative numbers. Thus, we could define 0-49999 as positive numbers and 50000-99999 as negative numbers. This is exactly what is done in a computer. Assuming the computer is byte-oriented, each memory location has an ability to represent 256 different numbers (0-255). It is very convenient to reserve the MSB of the byte for what is known as the *sign bit*. When the MSB is 0, it is understood that the remaining (seven) bits represent a positive number. When the MSB has a value of 1, it is understood that the remaining bits represent a negative number *in the two's complement form*. This convention suggests that the largest (most positive) number that may be represented is 01111111_2, or $+127_{10}$. The smallest (most negative) number that may be represented is 10000000_2, or -128_{10}.

Fig. 5A illustrates how the decimal number 57 would be stored in a byte-oriented system, while Fig. 5B illustrates how negative 57 would be stored. Try taking the two's complement (the negative) of Fig. 5B and see if in fact the result is positive 57. Note that the inversion process used in producing the two's complement automatically produces a 1 in the MSB position, indicating a negative number. To demonstrate the advantages of us-

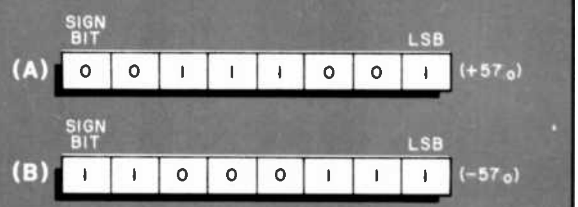


Fig. 5. How +57 and −57 are stored in bytes.

ing the two's complement, let's go through some examples. As our first example, find the sum of positive 5 and positive 9.

+5	00000101
(+)+9	+00001001
+14	00001110

Note that the positive numbers are stored in true form and the sum is positive and in true form.

Find the sum of negative 5 and negative 9.

−5	11111011
(+)−9	+11110111
−14	11110010

In this case the negative numbers are stored in two's complement form and the sum is negative and already in two's complement form. Remember that the MSB is the sign bit.

Now let's add positive 5 and negative 9.

+5	00000101
(+)−9	+11110111
−4	11111100

Again, the sign bit reveals a negative number (−4) in the two's complement form.

Subtract positive 5 from positive 9.

+9	00001001	00001001
(−)+5	−00000101	+11111011
+4		00000100

It was necessary first to complement the subtrahend and then add. The answer is the true form of 4.

Subtract positive 9 from positive 5.

+5	00000101	00000101
(−)+9	−00001001	+11110111
−4		11111100

In this case, the difference is negative and appears in the two's complement form.

As a final example, subtract negative 9 from positive 5.

+5	00000101	00000101
(−)−9	−11110111	+00001001
+14		00001110

Remember that negative 9 is stored in its two's complement form. To perform the subtraction, the negative 9 is complemented, which puts it in its positive true form, and is added to the minuend (positive 5).

When performing addition and subtraction using the two's complement method, the computer's ALU needs only circuitry to perform the add operation and the two's complementation. Multiplication and division are performed by routines of repeated addition and subtraction. ◇

HEWLETT-PACKARD'S

NEW TOUCH-SCREEN COMPUTER

Several unique features distinguish the Model HP-150 from other 16-bit microcomputers

By George Mitchell

WHILE some computer manufacturers have been creating systems that resemble the IBM PC, Hewlett-Packard's personal computer division has been working to design the first "intuitive" personal computer. Called the Model HP-150, or HP Touch, this new computer is unlike any system introduced to date. Although it does use an Intel 8088 and Microsoft's MS-DOS 2.0, that's about as far as the Model 150 goes toward being an IBM look-alike.

The differences are enormous and they begin with a basic form-factor that fits in 1.7 sq ft of desk space. Its 8-MHz 8088 microprocessor, 256K of user memory that's expandable to 650K bytes of RAM, 160K bytes of system ROM, 9" green-phosphor monochrome CRT, two expansion slots, three I/O ports, and optional thermal printer are all housed in a single enclosure designed to sit atop the disk subsystem. When equipped with an optional mounting frame, this versatile box of electronics can be tilted and swiveled to accommodate the user's convenience.

A Touching Moment. There is more to the system enclosure than its compact size. Taking its lead from the interest in Apple's Lisa-like screens and the use of outboard mouse pointing systems, HP incorporated a touch-screen technique for use on the Model 150.

The touch mechanism, based on a design previously used by Xerox in its 5500 series of terminals, utilizes a series of LEDs and photoreceptors to form a 14-by-21-line grid across the screen as shown in Fig. 1. Using individual and multiple grid intersections, a resolution of 1080 points is obtained. The 24 × 80 display actually supports 27 lines, but the three lowest are reserved for identifying the function keys, system status messages, and function blocks for the touch screen where necessary.

The touch screen has fingertip resolution, and therefore is inadequate for applications requiring high resolution (which, on a business machine, can be handled by business graphics software, rather than a mouse or other drawing devices).

By using the touch-screen technique, applications can be written that use "icons" (pictures of objects that represent a task) or standard menu examples. It's necessary, of course, to ensure that the selection item falls in a box in the grid so that the software is aware of the location. This task is easy both in HP and Microsoft BASIC since the POINT verb can be used to specify screen coordinates.

Though the Model 150 allows an easy way of using applications, the keyboard has eight function keys that correspond to screen labels. This permits the combination of touch-screen zones and function keys that enables the user to select a function quickly.

He is not always forced to use the touch-screen function. By simply entering a keyboard control sequence, the touch functions can be turned off, thus permitting the use of non-touch-oriented software with the Model 150 system.

Surprisingly, HP didn't make provisions for color, but the 9" screen does support a bit resolution of 390 x 512 pixels. This is sufficient for most business applications, and, by using dithering (changing individual dot intensity) techniques, various depths of shading can be created.

If you're an IBM PC owner, you may think the color issue important and that HP should consider an add-on color board. Right now, however, HP has no plans to do so, nor does it appear necessary. It's likely that numerous peripheral manufacturers will hop on the bandwagon and offer the option, though.

Two expansion slots are tucked away inside the CRT enclosure. These are for expanding memory and a soon-to-be-released 212A-compatible (300 to 1200 baud) "intelligent" modem.

The built-in interfaces allow the addition of peripherals or attachment of the Model 150 to another 150 or some other system. HP provides two RS-232C ports and HP-IB (IEEE-488) bus. The HP-IB bus is extremely versatile and lets you add an almost unlimited number of devices, including printers, plotters, and more disk drives.

More Hardware Attributes. Although the touch-sensitive CRT seems to be the hot button on the Model 150, HP didn't stop there. The storage systems offered range from dual 256K-byte, 3½" Sony drives (see the box entitled "Small Disks Catch Up") to a 15M-byte Winchester. Unlike previous HP personal computers (such as the HP 80 series), the disk transfer rates are fast and they're based on special in-

Instructions are entered by pointing to the appropriate symbol.

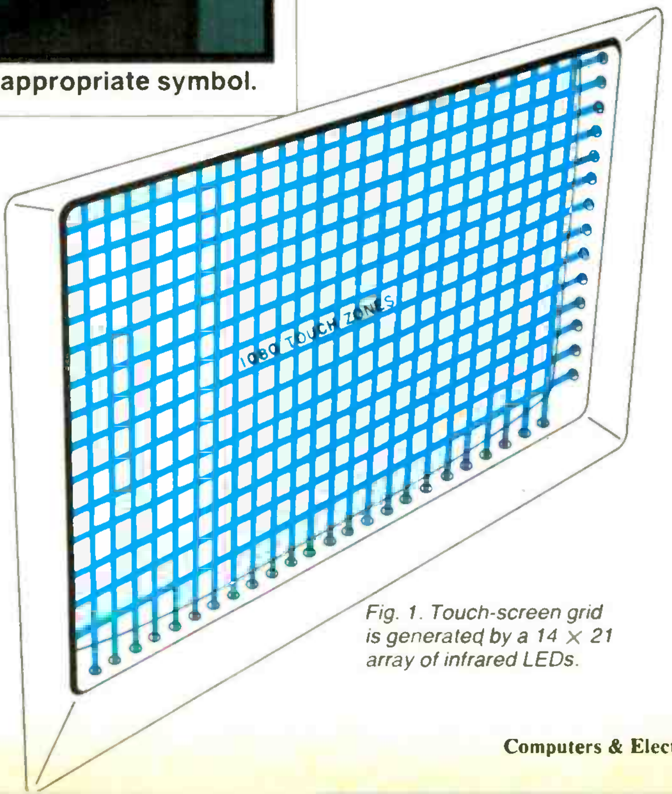


Fig. 1. Touch-screen grid is generated by a 14 × 21 array of infrared LEDs.

Free Post-it™ Note tray from 3M diskettes.

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The unit has an extremely small footprint. Floppy disks at right are only 3½".

terfaces and protocols developed for much larger systems.

Afforded an early showing of the system at HP's Sunnyvale headquarters, I was unable to benchmark the drives or overall system operation. I do believe, however, that because full-track buffering is used, the system should match the speed of other 16-bit machines.

Although the Model 150 supports the serial and 488 ports without additional hardware, an optional IBM 3270 plug-in emulator card is also available. This gives the Model 150 a direct, high-speed coaxial-cable connector to an IBM host computer, and allows the Model 150 to operate as an intelligent work station.

By using the RS-232 ports, the Model 150 can be connected to an HP 3000 minicomputer, and communications can be established through the 100 DSN/Link software. Further, you can attach any of the popular intelligent RS-232C modems for telephone communications. You might do well to wait for the board-level versions and keep your serial options open, however.

If you really want to keep your desk clutter-free, consider adding the thermal printer (for an extra $500). This printer can be installed (by you) in the CRT enclosure and it provides an inexpensive way to generate quick notes or dump screen graphics. A graphics example is shown in Fig. 2. The thermal printer provides a one-to-one relationship to every dot on the screen, so nothing is lost in the translation.

Intuitive Software. Since HP went to the trouble of developing a touch-screen display system, it felt it necessary to create an equally sophisticated software system. With MS-DOS needing some support to ease the user into it, HP developed Personal Applications Manager (P.A.M.). Don't be misled into assuming that P.A.M. is a down-and-dirty front end to MS-DOS. It isn't! In fact, P.A.M. is a sophisticated systems supervisor that surrounds both the operating system and the applications.

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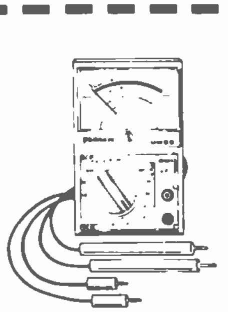

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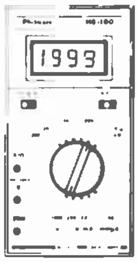

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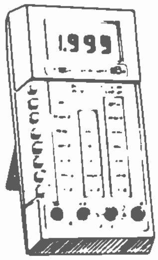

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More features for this price than you would imagine: 10 amp range, AC and DC, extended 2,000 hour battery life, 250 mV for in-circuit resistance measurement, 2.8 Volts for diode testing on "Ohms." Heavy-duty test leads and carrying case included.

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Here's the new low-cost Simpson 470 meter you've heard so much about! With 0.15% DCV accuracy and full measurement capability — 100 mV to 1000 VDC, 100 mV to 750 VAC, 0.1Ω to 19.99 MΩ, AC/DC current up to 10A, plus a full line of available accessories. Battery, test leads and manual included. Made in U.S.A.

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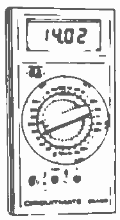

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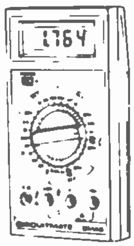

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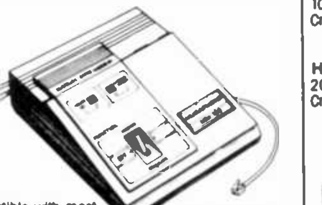

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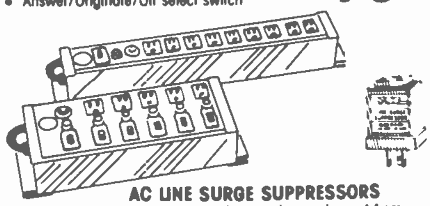

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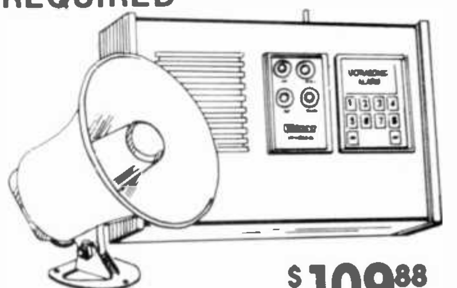

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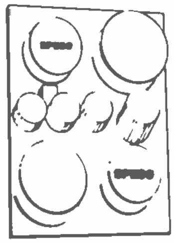

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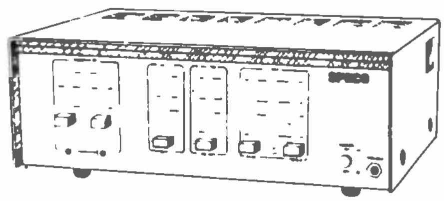

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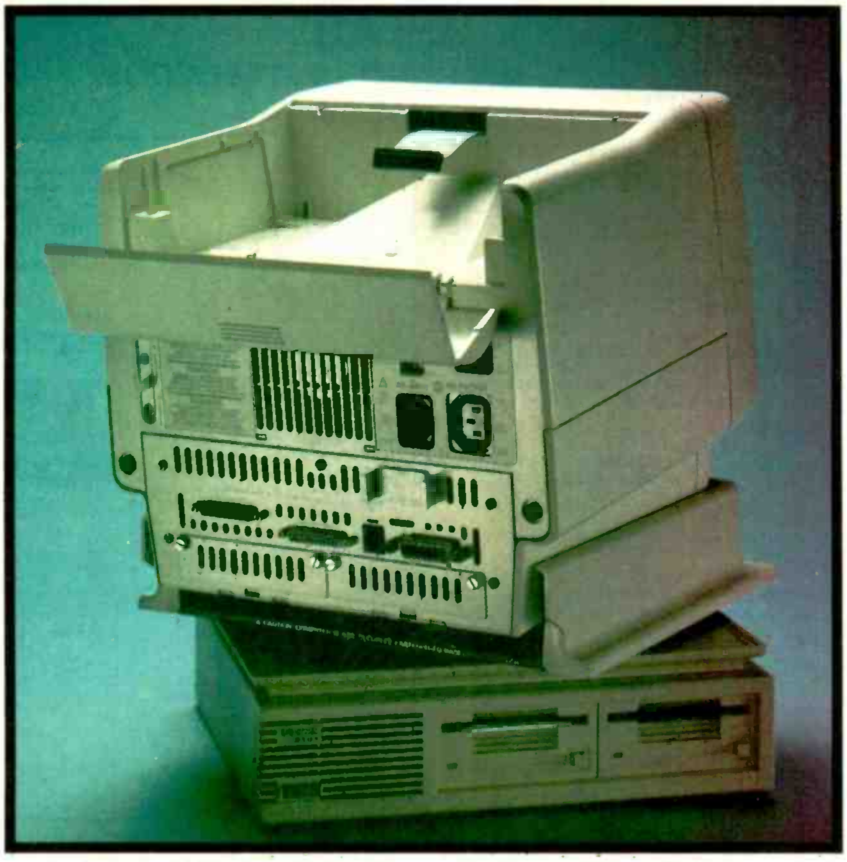


Recess in top of unit accommodates thermal printer.

from the operating system, but you can go to the DOS command level via a series of touch zones with the various applications displayed. To activate one, you touch the correct zone on the screen.

Besides allowing the execution of an application, P.A.M. also handles all the utility functions. For example, if you want to TYPE a file, touching that function on the status row and then the desired file name is all that's required. The same holds true for making backups, formatting diskettes, or listing to the hardcopy device.

If this were all that P.A.M. offered, it would be excellent. But it does still more. Unlike other front ends that only insulate you from the operating system, P.A.M. also serves as a file translator. For example, if you wish to use files created in the touch version of WordStar with dBase II or Condor files, you can do so without any special conversion. The files are automatically converted by P.A.M. in a transparent fashion, thus avoiding the need for separate file manipulation.

Other Software. Working in concert with the P.A.M. concept are two additional HP-supported applications. (When this was written, HP was unsure whether they would be offered separately or bundled.) These include Personal Card File and MemoMaker. The latter is a simple word processor for those who just want to type and print with basic cut-and-paste, as well as on-screen correction capabilities. The files are fully WordStar-compatible and can also be used in conjunction with other applications. Like all of these, MemoMaker uses the touch-screen functions or, if you like, standard WordStar control-key directives.

The Personal Card File was the application we found the most fascinating. The screen display for entering information looks exactly like a typical roll-type desktop card file. You can, as with the paper card, decide exactly how the information will be entered. All indexing is automatic, making use of the cards easier. Moreover, cards can be linked so that more than one can contain information on the same subject.

In using the card file, the touch-screen functions roll the cards up or down just like a desktop file. Getting the right card is easy. You just touch it, and the screen responds by showing the information on that particular card. Of course, you can print it by simply touching the PRINT SCREEN button. Or, you can print the entire file with a simple touch command.

Although HP software is quite significant, it doesn't stop there. A special version of MicroPro's WordStar takes advantage of all of the touch attributes, and there is a touch version of VisiCalc, a graphics package for creating pie, bar, line, and text charts.

For data communications, HP supplies the DSN/Link. This may be one of the more sophisticated (but basically uncomplicated) communications packages currently

(Text continues on p. 66)

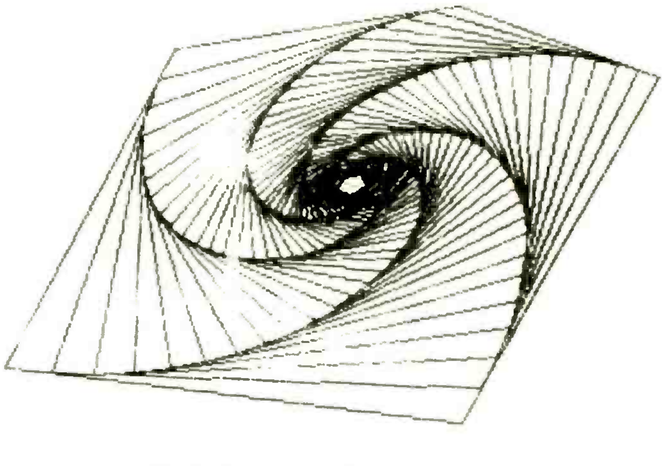


Fig. 2. An example of a screen dump generated by the thermal printer.

Counterpoint Views

THE editors of C&E had the opportunity of spending several days with a preproduction model of the HP Model 150. The remarks that follow are first impressions only, on a unit that wasn't fine-tuned for careful examination. Even so, you will observe the diversity of views that comes from subjective analyses.

Josef Bernard: The unit is compact. The disk drive box, with the display *cum* computer sitting atop it, covers not much more than a square foot of desktop area. The full-size keyboard is not small, though. So, although it can be separated from the rest of the system by a coiled telephone-type cable, be prepared to devote a fair amount of desk space to it. Bear in mind also that you will want both the keyboard and the display within arm's reach to use the touch-screen feature.

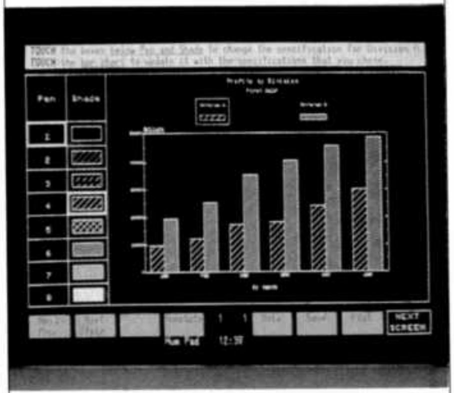
The display screen is a bit too small for my taste (8½" effective diagonal) and sometimes requires a little peering at. But the display itself is very sharp and the character sets are well defined. On the unit we had, I thought the brightness of the display could have been a little higher. Because of the size of the keyboard and the need to be able to get at the disk drives over the top of the keyboard, the display must, of necessity, be located farther away from the user than might be desirable.

The Model 150 uses an 8088 microprocessor running at a claimed speed of 8 MHz. I was therefore somewhat disappointed by the apparent sluggishness of the system.

Although I did not run benchmark tests on disk-access times, they seemed to be reasonable considering the size of the disks and the files they contained. However, the system appeared to pause for unreasonably long periods of time *after* disk accesses, as if trying to decide what to do with the data it has just read. This annoyed me after a while, especially when I sat with a finger held in the air awaiting the arrival of the next menu on the touch screen.

We did run several benchmark tests from BASIC (Microsoft Version 5.28). The results there were again not as good as we would have expected from an 8-MHz 16-bit CPU. In particular, the popular sieve of Eratosthenes program for finding the first 1437 prime numbers required two minutes and 20 seconds to run to completion. That is just a little faster than the same program has been run on some 4-MHz Z-80 systems. Take heart, though. The same program took 2 minutes and 57 seconds on an IBM PC.

My first thought was that the overhead of maintaining the touch-screen system was slowing things down, but then I realized that that part of the system was not used (or, at least, did not appear to be used) within BASIC. (Upon questioning Hewlett-Packard about the speed question, I was told that, because of the ROMs used in the preproduction model, the system speed had been reduced.)



Barchart shown on an HP-150

One of the most intriguing features of the Model 150 is its touch screen. As explained in the review, the front of the screen is crisscrossed by a grid of infrared light beams spaced less than a finger's width apart. Breaking a pair of beams with a finger or pencil indicates to the computer a set of coordinates and, depending on the software in use, causes a command to be carried out.

In theory, the touch-screen principle is a good one, especially for those who are not familiar with working from a keyboard. The screen displays an array of boxes or pictures, each of which is labeled with a command. All that has to be done to have that command carried out is to touch the appropriate screen area.

In practice, I found it to be a mixed blessing in several senses. Although I must qualify my comments by noting that the WordStar release used was marked "Preliminary," it appears that a few of the word processor's commands—like cursor movement by line and character—could not be carried out using the touch function, but had to be given from the keyboard. Some, like changing the logged disk drive, required the use of both the screen and the keyboard.

Perhaps there is a reason for the way the commands are divided between the keyboard and the screen, but I have not been able to figure it out. Futhermore, it seems rather silly, in a program devoted to keyboard use, to have to keep moving one's finger(s) between the keyboard and the screen. (I concede, though, that all the WordStar functions can still be carried out from the keyboard alone, without resorting to the touch screen.)

The RPN (Reverse Polish Notation) calculator program supplied us by HP makes a much more sensible use of the touch screen. A full calculator keyboard, including financial functions, is displayed, and all you have to do is touch the appropriate keys on the screen to perform your calculations.

Which brings us to another point about the touch-screen feature. With the system set up so the display unit sits in its swivel mount atop the disk drive unit, and the keyboard far enough in front of them to allow access to the disk-eject buttons on the front of the disk drive box, the screen is elevated rather far above the work surface. This means that, to touch it, you have to extend your arm straight out, or even up at an angle. Over an extended period this can become quite fatiguing, particularly if you have to wait for menus to change and decide to keep your finger at screen level to make the next selection. If the screen were not so far away or were located so that you could point down at it instead of out or up, it would be much more convenient to use.

This is not to say that the touch-screen concept is a bad one, just that it could have been better implemented in this system. Certainly, for simple data-retrieval, as typified by HP's Personal Card File (seen only in demo form), once the data has been entered, the touch method is a convenient way to select and view it. Getting data into the system, however, is a matter better suited to someone with 10 agile fingers than with one finger extended.

Art Salsberg: What a neat little package this is! It's certainly a space-saver on a desk. I'm favorably impressed by the handling ease and apparent ruggedness of the 3½" disk, too. They kept sliding out of a plastic pocket onto the floor again and again without harm.

The touch screen? I love it! In particular, I found HP's Memomaker program very amenable to such operation. I could block out an entire section of copy for deletion or transfer by simply moving my finger about the screen instead of using the keyboard to move the cursor and mark appropriate locations. It performed as though my finger was a magnet that an opposite-pole cursor followed around. Better than a mouse. And you don't have to memorize commands with either, but the touch screen doesn't take up extra desk space and control is easier. In fairness, though, a cursor can pinpoint a screen object more finely than any finger can. Also, using a touch screen for long time periods may be tiring as well as break the rhythm of a proficient typist.

I found the positioning of the monitor just perfect for this work, contrary to Bernard's feelings. I was also extremely comfortable with viewing the display. Resolution was truly excellent. But then, I've done most of my computing with transportables and all-in-one machines. The keyboard's clustering of keys and touch were really fine.

The one area that was a bit bothersome to me was the slower-than-anticipated data loading speed. Irksome, too, was a rather lengthy screen output delay at times. The computer acted as if it was searching for one of a variety of options, much as one experiences with a higher level on a computer chess program. The HP people advised that production models will be speedier.

If you've got an IBM mainframe in an office, HP's plug-in emulator card links it locally or remotely. This is an obvious asset.

All this telegraph's Hewlett-Packard's intention to widen its customer base. So does its plan to triple the number of dealers who sell its products, give them better profit margins, higher credit limits, and so on. ◇

SMALL DISKS CATCH UP

If you're a regular reader of this magazine, you may remember the article on disk storage systems in the July 1983 issue (page 36). As mentioned there, disk systems are getting more capable and, in most cases, smaller.

The Sony 3½" 256K-byte, single-density disk drive is just one of the marvels in storage systems to become available in the last two years. It is the one that Hewlett-Packard has chosen to supply with its Model 150.

The tiny diskettes, which are housed in a plastic cartridge with an automatic shutter to protect the magnetic surface, are capable of storing about 256K bytes of formatted data. To ensure integrity of the data, HP developed a Media Monitor system that automatically tracks the disk's age by counting the number of times it rotates and tells you when to replace it.

The small diskettes are laid out with 66 tracks/surface broken up into 16 sectors of 256 bytes each. The drives spin at 600 rpm, transfer data at 17.8K baud, and provide a 415-ms average access time.

Although 256K bytes doesn't sound like much storage, especially when you can buy 5¼" drives that offer as much as 1M byte per drive, don't despair. Currently, Sony is offering a double-sided, double-density version of the tiny drive that delivers 500K bytes/side and yields 1M byte of storage. These aren't available yet; and, reportedly, some problems still exist in reliability. The drives may, however, begin showing up as early as mid-1984.

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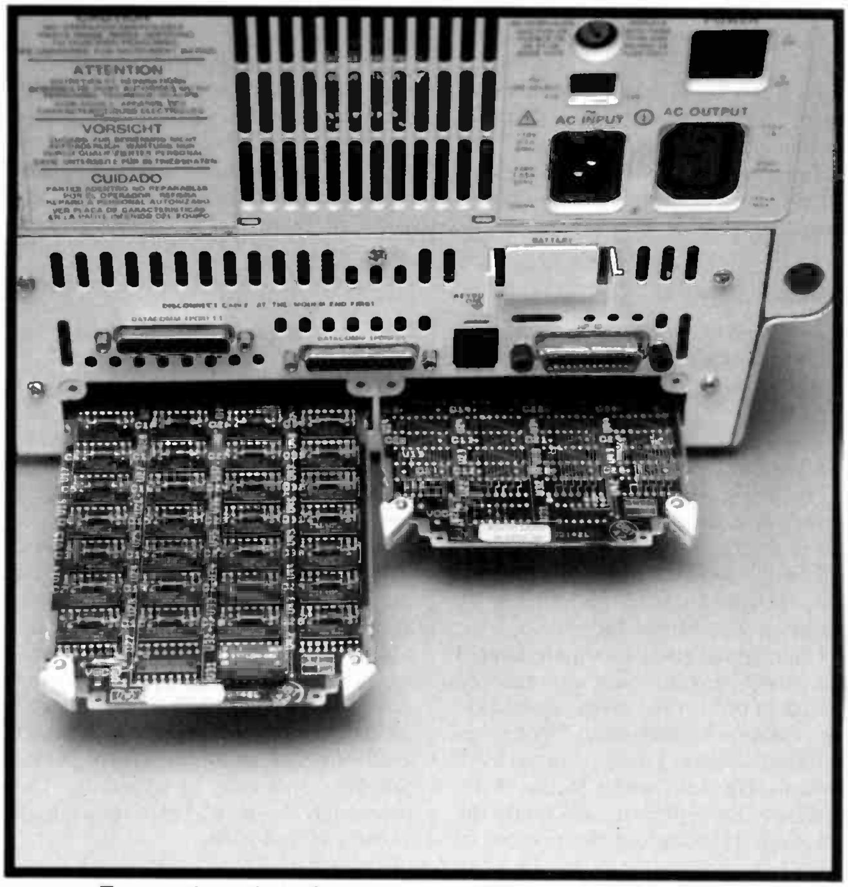

Expansion slots for extra memory and peripherals.

available for micros. It allows the passing of files from one Model 150 to another; from a Model 150 to a mainframe; or, via a modem, to Micronet, The Source, or your favorite bulletin board.

Although DSN/Link is quite good, we were surprised that HP didn't include provisions for background operation. We would have liked to have had the communications functions operating while being able to use another program. This would permit the grabbing of data from a remote system when needed or, if necessary, sending other messages via a spooling mechanism while performing other work. The HP spokesman said that the intent was to provide a single-task work station and that multiple tasks were something that could come later.

Notably, the Model 150 architecture supports task segmentation, and MS-DOS 2.0 seems to have all the necessary links to implement such functions. A number of packages for the IBM PC purport to support such functions already.

An interesting aspect of the Model 150 software philosophy is that no ROM BASIC is provided, nor is there the HP-BASIC normally offered by HP. Instead, they are offering the standard Microsoft BASIC. (GW BASIC is planned for a later date, as is Pascal.)

Multiple Formats. Even though Hewlett-Packard has settled on 3½" Sony disk drives and has established methods for third-party software vendors to provide software in this format, they are aware that 5¼" double-sided, double-density drives are here to stay for a long time. As a result, you can choose the type of drive you want without stretching the size of the system. Half-height drives are used to keep the space requirements unchanged and you can expect the same for a Winchester.

Although IBM PC compatibility wasn't high on the HP list, you can use software written for the PC. Be aware, however, that the screen presentation won't be the same, and in most cases you probably won't be able to change the screen display attributes easily.

A Top-Notch Selection. Overall, I was impressed by the Model 150's operation and the attention that has been paid to the user's needs. I'd like to see HP bundle the MemoMaker and Personal Card File as part of the basic purchase price. Possibly, they could also consider adding color display later, and I'd like to see the optional printer made to work with plain paper, rather than special thermal paper. This can be done, as in printers from

"I was impressed by the operation and attention to user's needs."

Brother Ltd., by adding a ribbon carriage. Even color functions can be added by this method.

Though the ability to slide in a printer for $500 impressed me, not everyone I talked to thought it was that important, or even necessary. Nevertheless, I believe that, for the creation of the fast internal memo or roughing out graphics for a special presentation, it seems to be a low-cost viable solution to diminishing the amount of space usurped on one's desk.

Regarding the paucity of expansion slots, HP feels that it is solving the problem by including the interfaces as standard equipment. The PC and compatibles generally require that you add on those interfaces. We think that the idea isn't all that bad. The Model 150 doesn't require the addition of a multifunction card to supply a continuous clock—it's also built in—and for machine or test equipment control you have the HP-IB. It's doubtful you really need more. And you get all that for under $4000. A similarly priced IBM PC comes with 64K of RAM, two disk drives, and only a parallel and CRT interface. To get the rest requires anywhere from an additional $1000 to $2000.

The only thing I could see that would be beneficial to add to the Model 150 would be voice I/O, and somehow I think that may just be in the wind. ◇

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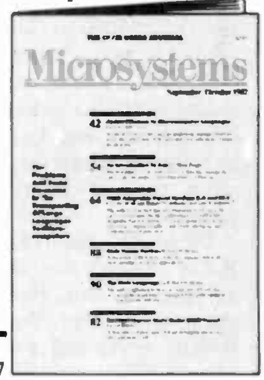

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'ARTIFICIAL' EXPANSION OF TIMEX-1000 MEMORY

Programming techniques that will help you make the best possible use of available memory • By William Largent, Jr.

IF you're into programming your Timex 1000 or Sinclair ZX81 computer, you are probably constantly trimming, altering, or scrapping programs due to the lack of sufficient memory to hold them. As a result, you may be spending a quarter of your programming time in fighting the memory problem.

Of course, the 16K, 32K, and 64K RAM add-ons that are available offer an easy way out. However, an understanding of how the Timex/Sinclair BASIC works and is stored in memory can aid you in making the best possible use of whatever amount of memory you have available. Memory conservation will then become an integral part of program design, rather than an afterthought when memory space runs out.

RAM Organization. The built-in RAM of the Timex 1000 consists of 2048 bytes. Since each 1024-byte segment of memory is referred to as a "K," the size of the Timex's memory would be called 2K. But everything that's been written about the computer says that it has only 1K of usable storage!

The discrepancy is resolved when you realize that the computer's BASIC needs 1K of RAM to store a program and another 1K to execute it. That means that there's 1K for you, the programmer (and that's the amount referred to in the literature), and 1K for the computer.

For the purposes of this article, we'll break the 1K of memory available to the programmer into two segments. The first segment contains the actual text of the BASIC program, such as:

```
100 FOR A=1 TO 100
110 LET B=1+1
120 NEXT A
```

The second segment is broken down into six types of areas, which contain the values of different variables used in the program. In the program excerpt above, the values of variables A and B would reside in this segment.

By understanding how these two segments are used by the computer, a programmer can make the most efficient use of the memory available to him. That allows larger, more complex, programs to be written in a memory space where less efficient techniques would have prohibited them.

Memory Requirements. A BASIC program statement, as shown in Fig. 1, consists of four components. The LINE component is two bytes long, and contains a numeric value that represents the line number of the statement.

The LENGTH component uses another two bytes of memory, and contains a numeric value representing the length of the TEXT and ENTER components.

The TEXT component contains the text of the actual program statement, excluding the line number. Its length can be from 1 to *n* bytes. Finally, the ENTER component contains the ENTER code (118 decimal), and is used to denote the end of a program statement.

Consider the following example:

```
100 IF A=1 THEN PRINT "HI"
```

This statement consumes 21 bytes of memory. However, the actual logic or text of the statement is only 16 bytes in length. *Every statement contains five bytes of overhead that serve only to help BASIC execute the program.* Therefore it is important to keep the number of statements needed to perform a particular task to a minimum. Each additional statement wastes five bytes of memory! In the following program excerpt, 63 bytes of memory are used to write a program to test three variables producing identical results:

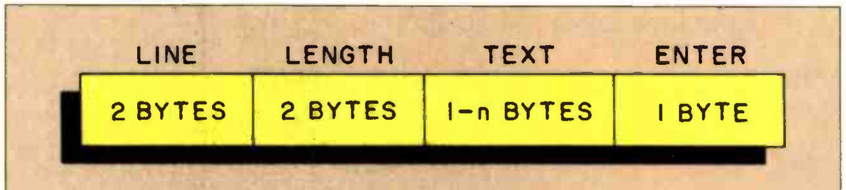
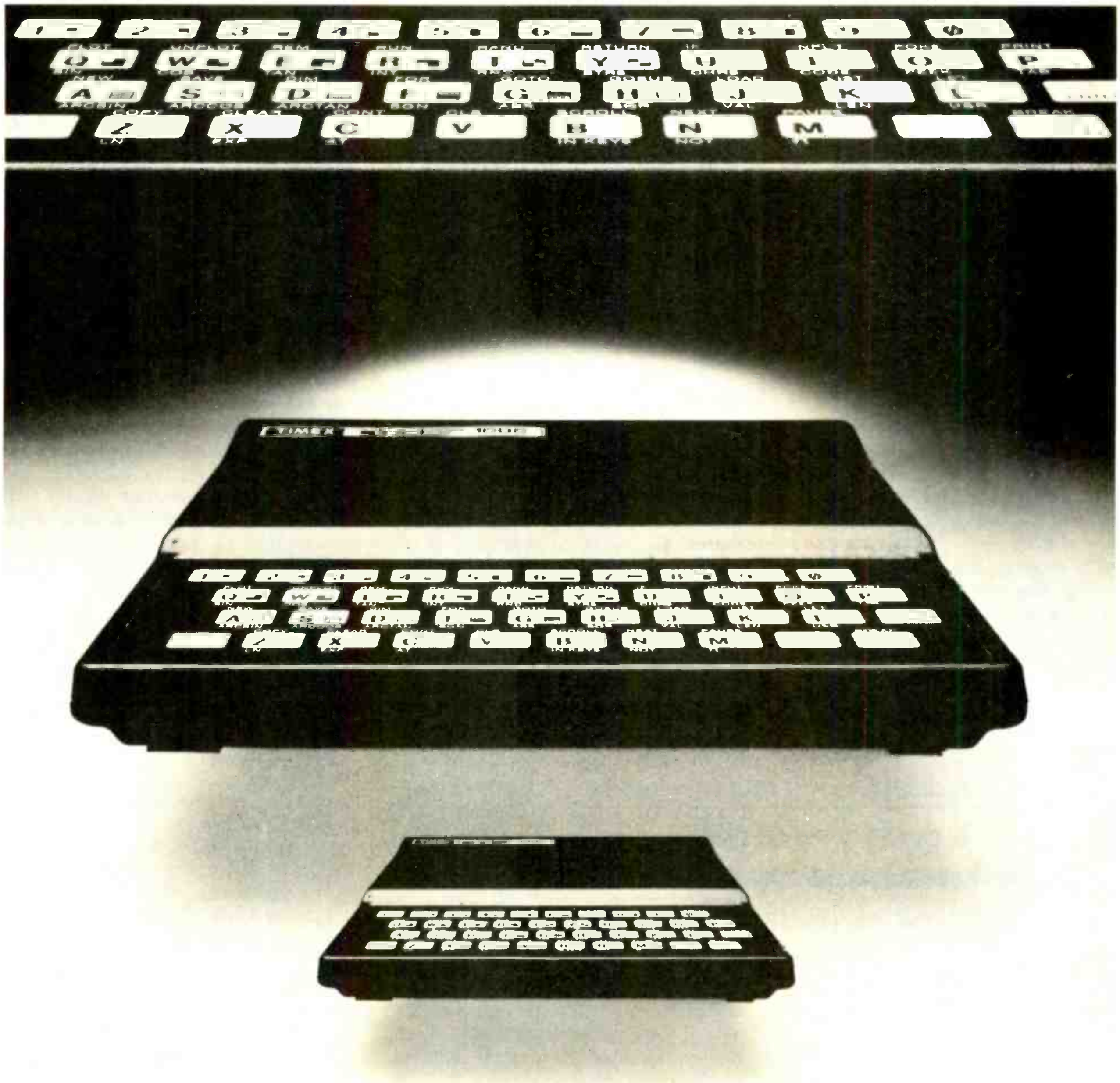


Fig. 1. A BASIC program statement consists of four components.



```
100 IF A=1 THEN PRINT "HI"
110 IF B=1 THEN PRINT "HI"
120 IF C=1 THEN PRINT "HI"
```

This could have been coded more efficiently as shown below, and would have used only 41 bytes of memory:

```
100 IF A=1 OR B=1 OR C=1 THEN
    PRINT "HI"
```

Remember, not only do extra program statements carry five bytes of overhead, they also consume memory with duplicated code that should be combined with like logic.

As mentioned above, the second—or variable—segment of memory contains six different types of areas. There are three that are important to us. The first two are used for numeric or character arrays. These arrays are normally associated with the storage of large amounts of data, which is a fact of life in modern computing. In our case, only the data needed from one execution of a program to the next should be stored.

The third area is used to contain numeric variables that are identified in the program by names longer than a single character: i.e., SALES as opposed to S. This convention of using full names is good from the standpoint of being able to identify what is going on in a program and is fine for computers that have an abundance of memory; but on smaller computers, it should be avoided in the interest of conserving memory.

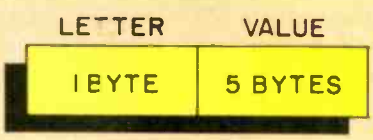


Fig. 2. A single-letter numeric variable.

The variables that are of particular interest to us are single-letter numeric variables, single-letter character variables, and the control variables used in FOR/NEXT loops.

A single-letter numeric variable is created and/or referenced when BASIC encounters a LET or INPUT statement while executing a program. Such a variable is shown in Fig. 2. The LETTER component is one byte in length and contains the unique character that identifies the variable. The VALUE component uses five bytes of memory to contain a representation of the actual numeric value for the variable.

As in the case of a single-letter numeric variable, a single-letter *character* variable is created and/or referenced by BASIC when it encounters a LET or INPUT statement. Its three components are shown in Fig. 3. The LETTER component, which requires one byte, contains the character that represents the variable.

Fig. 3. A single-letter character variable.

The LENGTH component uses two bytes of memory to hold a numeric representation of the length, in bytes, of the actual text represented by the variable LETTER, and can occupy from one to *n* bytes of memory.

The FOR/NEXT loop-control variable is created and/or referenced when BASIC encounters a FOR or NEXT statement while executing a program. Its storage requirements are shown in Fig. 4.

The LETTER component is one byte long, and serves to identify the variable. VALUE is the component that contains a numeric representation of the initial value of the FOR/NEXT loop. Similarly, LIMIT contains the upper limit of the loop. Both VALUE and LIMIT require five bytes of memory. The STEP component is also five bytes long, and represents the increment by which VALUE will be brought up to LIMIT. (This is set to one, unless a different step value is specified.) Finally, LOOP LINE contains a numeric representation of the line number of the first program statement that is to be executed by the loop. It takes up two bytes of memory.

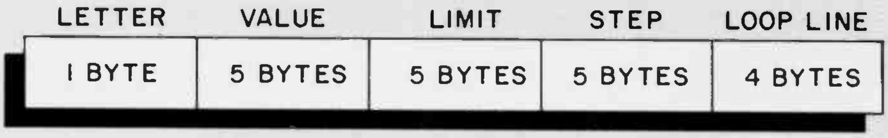


Fig. 4. The FOR/NEXT loop-control variable.

By realizing how to use these three variable types most efficiently, a programmer can make the most of the memory available to him. By the same token, a "full steam ahead" approach to programming, with no consideration given to conserving memory space, can lead to unwanted results. Let's now examine each type of variable in greater detail.

Numeric Literals or Variables. It would be safe to say that 90% of all BASIC programs contain at least one numeric literal or variable. (A literal is a fixed value, as in "LET X=255".) It is frequently more efficient to use a variable than it is to use a literal. Consider the following program excerpt:

```
100 LET A=(RND*100)
110 IF A<100 THEN GOTO 100
120 IF A=100 THEN GOTO 200
130 IF A>100 THEN GOTO 300
```

Here, after generating a random number, that number is tested to determine which line the program should branch. This sequence of statements requires 111 bytes of memory. What would happen if the same program excerpt were coded as follows?

```
95 LET B=100
100 LET A=(RND*B)
110 IF A<B THEN GOTO B
120 IF A=B THEN GOTO 200
130 IF A>B THEN GOTO 300
```

We added a LET statement assigning a value of 100 to a variable, B. That action created a single-letter numeric variable of the type discussed earlier. Each numeric literal of 100 was then replaced by the single numeric-variable B. That resulted in a saving of 17 bytes.

Where did we steal that extra memory from? Each numeric literal of "100" in the original program used three bytes, while the representation of that number in memory took up six bytes, for a total of nine. Since "100" was replaced by "B," which required only one byte, five times, the initial saving was $(9 \times 5) - (1 \times 5) = 45 - 5$, or 40 bytes. Part of that was used by the new LET statement (17 bytes), and the single-letter numeric variable in that statement (6 bytes). Subtracting $(17 + 6)$, or 23, from 40 gives a total of 17 bytes saved.

Furthermore, if the numeric literal "100" were replaced elsewhere in the program by "B," another eight bytes would be saved each time. Table I shows when it is most efficient to use a numeric literal or single-letter variable.

A normally overlooked feature of Timex/Sinclair BASIC is the fact that a numeric literal can be replaced by a single-letter numeric variable in GOTO, GOSUB and PAUSE statements. Keep that in mind when determining whether to use literals or variables for particular values in a program. Remember, a few minutes spent setting up variables can save hours of grief later.

Character Literals, Variables, and VAL. Character (as opposed to numeric) literals and variables are typically used to make communication between the computer and the individual using it easier (on the individual). They behave within the computer in much the same way as their numeric counterparts, and large character-variables and -literals should be avoided in the interest of keeping memory use to a minimum.

One aspect of character literals and single-letter character variables that should not be overlooked is their ability—at the expense of a sacrifice in execution speed—to substitute as numeric literals or single-letter numeric variables. That is accomplished by using the VAL function.

The 94-byte program excerpt that evolved from the original 111-byte one can be further simplified by rewriting it to use the VAL function as follows:

```
100 LET A= (RND*VAL "100")
110 IF A<VAL "100" THEN
    GOTO VAL "100"
120 IF A=VAL "100" THEN
    GOTO VAL "200"
130 IF A>VAL "100" THEN
    GOTO VAL "300"
```

By removing line 95, which contained the LET statement, and replacing the single-letter numeric variable "B" with VAL functions, another four bytes can be saved. The total memory space required for this program segment has now gone from the original 111 bytes to 90 bytes. And, an even more efficient version is possible. By reinserting the LET statement and replacing the numerical literals "100" with the single-letter numeric variable "B," the total memory space required for the program segment can be reduced to 85 bytes. Compared to the original 111-byte version, this is shorter by 26 bytes. That represents a 23% reduction in program length, and realizes a greater than 2.5% increase in the amount of total memory available when the program is run.

VAL is a very powerful function, but bear in mind that a program using it, while it will be more memory-efficient, will run more slowly than if numeric variables or single-numeric variables were used.

FOR/NEXT Loops. FOR/NEXT loops

are useful and powerful when applied to a task for which they were intended. However, because of the 18 bytes that a FOR/NEXT loop-control variable requires, its use should be carefully weighed. For programming infinite loops, usually used in games, a FOR/NEXT loop can be somewhat less than efficient. Consider the following program excerpt:

```
100 FOR A=VAL "1" TO VAL
  · "9999"
110 IF INKEY$="F" THEN
     GOSUB VAL "500"
120 NEXT A
```

Here, the program will go into an "infinite loop," testing INKEY$ for the character "F." (This is presumably part of a game program.) These three lines take up 64 bytes of memory. Let's look at a more efficient way of obtaining the same result:

```
100 IF INKEY$="F" THEN
     GOSUB VAL "500"
110 GOTO VAL "100"
```

These two lines, which accomplish the same thing as the three above, now use only 31 bytes, a saving of 33 bytes. In addition, the routine executes more quickly.

If a set of program statements must be executed a specific number of times, use a FOR/NEXT loop. If, on the other hand, an infinite loop that can be halted by the BREAK key is desired, use a GOTO statement.

Subroutines. The use—or lack of use—of subroutines can have a profound effect on the amount of memory consumed by a program. Subroutines should not be used indiscriminately, though. There are certain guidelines that should be applied. Consider this:

```
100 INPUT A$
```

Just because this line may occur twice in a program does not mean that it should be treated as a subroutine. To do so would cost you 12 bytes of memory. To be eligible for subroutine status, a program statement (or group of statements) should occur more than once in a program, and *should have a collective length greater than 20 bytes.* Anything smaller will waste, not conserve, memory.

Space Available. As you've read this, you've been bombarded with quotes as to how much memory one sequence of statements would use as opposed to another. Programmers soon learn that to be proficient in memory conservation they must have a tool available that shows how much memory any component of a program consumes. Table II shows just such a program written for the Timex/Sinclair with 1K of usable memory. The program can be entered into the computer as shown and can then be executed during program design, or even while the program is being entered. Here's how it works.

The program monitors the size of the program and variable segments of memory. The size of the system variables has been accounted for, as well as a full display screen. (Remember, the characters displayed on the video screen are stored in memory.) It's necessary to take the video display into account because, even though a program, when run, may not use the screen much, *listing* the program does. Therefore, a full video memory should always be assumed.

What the program does is subtract the value of the system variable STKEND (the bottom of the stack area) from RAMTOP, the top of memory, and also compensates for the area used for the video display. STKEND is situated at memory locations 16412 and 16413, and RAMTOP at 16388 and 16389. The video memory area occupies 793 bytes, and the program itself takes up 76 bytes. The figure obtained by running the program is accurate to within 25 bytes.

This program can be used in several ways. The first mode of operation measures the number of bytes used by the program statements under consideration. During this phase, variables are not counted. The program statements are entered into the computer, followed by the RUN command. Since line 2 of the program is a STOP command, BASIC will not get the opportunity to allocate space to any of the variables. If the number that appears in the upper-left-hand corner of the display is subtracted from 977, the result will be the amount of memory, in bytes, used by the statements in question.

To determine the amount of memory needed for both statements and variables, use this program, but do not run it! Instead, enter GOTO 1. That will preserve the variable area so that an accurate determination of the amount of memory it uses can be made. If your program uses LET statements, you will have to reenter them in the command mode to initialize the variables since that is normally done when the program is run.

Finally, only the variable portion of memory can be analyzed by deleting the program statements prior to issuing a GOTO 1 command. Just make sure that the variable space has been initialized, as previously described. Since the RUN statement was not used, the variable portion of RAM will still be intact.

Note that if the memory size of your computer differs from that of the standard Timex 1000, the locations of the variable areas in the program will have to be changed. They can be found in your User Manual. (The figures used here for STKEND and RAMTOP are found in chapters 26 and 27 of the Timex manual.)

Despite their limited memories, the Timex/Sinclair computers can be put to a number of entertaining and practical uses. To get the most out of them and make the best use of the RAM that's available, use the techniques described here. ◇

MEMORY EFFICIENT VERSIONS OF FAMILIAR STATEMENTS

```
FOR L=VAR "n" TO VAR "n" STEP
    VAR "n"
FOR L=variable TO variable
    STEP variable
GOSUB VAR "n"
GOSUB variable
GOTO VAR "n"
GOTO variable
LET L=VAR "n"
LET L=variable
PAUSE VAR "n"
PAUSE variable
PLOT VAR "n"
PLOT variable
RAND VAR "n"
RAND variable
UNPLOT VAR "n"
UNPLOT variable
```

TABLE I—NUMERIC LITERALS VS. SINGLE-LETTER VARIABLES

For 1- or 2-byte literals:
  Used less than 3 times, use literal.
  Used more than 2 times, use variable.
For 3- to 10-byte literals:
  Used less than 3 times, use literal.
  Used more than 2 times, use variable.

TABLE II—PROGRAM FOR SIZE MONITORING

```
1  PRINT (PEEK VAL"16388"
   +VAL "256" * PEEK VAL
   "16389") - (PEEK VAL
   "16412"+VAL"256" * PEEK
   VAL "16413"-VAL"798")
2  STOP
```

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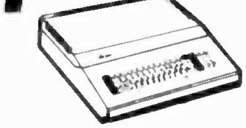

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C&E Reviews Spectravideo's SV-318 Personal Computer

By Its Joystick Ye Shall Know It

WITH the low-end computer war inflicting monumental casualties on even powerful companies, new computer makers have to have an appealing mousetrap to stay alive, let alone prosper. It appears that Spectravideo has striven to achieve this by joining with software giant Microsoft and 15 Japanese computer hardware makers (who are just itching to get a toehold in the U.S. market) to develop a universally compatible software standard.

Spectravideo's $299 (suggested retail price) SV-318 personal computer has apparently been chosen as the group's front-line hardware standard for compatible software called "MSX" (based on Microsoft's super-extended BASIC). A special adapter to use such software is not yet available. Regardless of whether MSX ever sees daylight—and we think

"Typing on the SV-318 is not a total joy. . . . The overall value of the computer appears to be good."

that the so-called standard is doomed before it begins—let's examine this modestly priced machine for what it is without MSX.

Description. The Spectravideo SV-318 personal computer is easily recognized by its colorful integrated joystick, which looks like a red golf ball on a tee on the right-hand side of the white plastic enclosure. The machine has a host of features that include CPM "compatability," top-loading cartridge port, built-in Microsoft BASIC, 16 colors, graphic sprites, extended sound capability, 32K user memory expandable to 256K, and more.

The internal structure includes a Z80A microprocessor, a TI9918A graphics chip, GI8910A sound chip, and Intel's 8255 programmable peripheral interface (PPI). There are ports for expansion and interface purposes, cassette input/output, extra joysticks, and video output.

The keyboard has 67 keys made from what feels like hard, black rubber (sometimes called "chiclet" keys). Each has a stark white identification. Five of them—F1 through F5—can be switched to other functions (F6 through F10) by using the SHIFT key. The bottom line of the video display constantly identifies just what these keys are, even when the user redefines them.

Three other keys, also double-function via the SHIFT key, are for text editing. The alphabet keys, besides providing upper and lower case, carry two graphic symbols each, selected by LEFT GRPH and RIGHT GRPH keys positioned beside the space bar. When held down, every key on the keyboard goes into auto-repeat.

The joystick consists of two elements. The first is a 2"-diameter black plastic disk called a "control pad" mounted on the upper surface of the computer just to the right of the keyboard. The top of the control pad has four fingertip indentations, each identified by a directional arrow to indicate cursor motion. The bright red joystick arm is usually plugged into the center hole of the control pad, but it can be removed if desired. The joystick can be used to place the cursor anywhere on the screen, for text editing as well as game playing and other purposes.

The only other item on the upper part of the computer is a small spring-loaded door that opens to accept plug-in cartridges. As mentioned before, a cartridge adapter must be plugged into this slot to run MSX cartridges. Although there is no keyway on the cartridge edge connector, a cartridge can be inserted in only one direction.

The rear apron supports a large and small card-edge connector and a DIN connector. The large edge connector is used primarily to connect the SV-601 Super Expander, which, in turn, allows increasing the memory to 256K of RAM and 96K of ROM and the connection of other peripherals. The small edge connector permits the use of the special Spectravideo cassette recorder for storage of data. The DIN connector allows hooking to a video monitor (color if desired), or to an r-f modulator (provided in the basic system) for connection to a monochrome or color TV receiver.

On the right-end panel is a pair of joystick ports that accept most commercial joysticks, the main power on-off switch (power on is indicated by a red LED on the keyboard), and the power supply input. The actual power supply is housed in a separate metal box about 3" on a side and 2" high. This keeps heat from the power supply away from the computer.

On power-up, the Spectravideo logo appears. It remains for a few seconds, and then the display snaps to BASIC. When a game module is plugged in, the same logo appears, and then the system reverts to the game instructions.

Although there is no feedback from the keys, either audible or physical, you can "feel" when the key bottoms out. However, if you press the top or bottom edge of a key, it does not make proper contact. When using the TV as a video monitor, you can hear a slight "click" when a key is fully and correctly depressed.

SPECTRAVIDEO SV-318 SPECIFICATIONS AND FEATURES

Microprocessor: Z80A operating at 3.6 MHz.

Memory: 32K ROM holding BASIC, expandable to 96K; 32K dynamic RAM, expandable to 256K.

Keyboard: 67 keys, QWERTY style, u/lc; 52 graphics symbols, 10 user-definable keys.

Display: TV or video monitor, 40 char./24 lines using 5 × 9 matrix, 256 × 192 pixels in graphics. HiRes, 16 colors, 32 sprites, and three sound channels with eight octaves per channel.

I/O: Data cassette interface, built-in joystick, expander port, external joystick/graphic tablet port, and game cartridge port.

Software: Built-in 32K-byte Extended Microsoft BASIC with graphics and sound commands.

Peripherals: Data cassette, 300-baud modem, graphics tablet, 80-column printer, floppy disks, RAM and ROM expansion modules, Coleco game cartridge adapter, and an expansion unit for connecting multiple high- and low-power peripherals. Interface cartridges include floppy disk drive controller, Centronics and RS-232 interfaces, IEEE 488 interface, 80-column display card.

Dimensions: 16¼"L × 8¾"W × 3"H. Weight 8 lb.

SV-318 Software. Since no operating system is available with the basic system, only the BASIC interpreter PEEK, POKE, and USR functions allow access to machine language. The BASIC, from Microsoft, includes all of that company's excellent interpreter plus both graphic and sound commands.

The 52 built-in graphic symbols are accessed via the alphabet keys in conjunction with either the RIGHT GRPH or LEFT GRPH function keys. What shows up on-screen is a set of block graphics similar to those used on comparable systems. The graphic symbols can be concatenated to form any desired design.

Up to 32 "sprites" can be created using the BASIC graphic commands. Each sprite can be user-defined to any shape and color desired within an 8 × 8 array. Since each sprite can be given a name, it can be "called" on-screen and moved around. It is easy to include joystick positions to create various games, and begin to achieve arcade-like effects.

The BASIC graphics commands include such useful functions as drawing lines, boxes, circles, parts of a circle, etc.; and they can have any size and positioning desired. A PAINT command allows the use of color both within and without the sketched-in area. The high-resolution graphics of the machine produce 256 × 192 pixels.

The SV-318 can generate sounds when used with an external audio amplifier or a TV receiver. Up to eight octaves can be covered by the built-in sound capabilities of the GI 8910A

The joystick is used to place the cursor anywhere on the screen.

sound chip. A simple PLAY command followed by the appropriate coding produces the desired sounds. The octave, tempo, volume, and length of each note can be specified.

As the basic system is shipped, there is ROM (the BASIC) occupying the first 32K bytes of memory, with 32K bytes of RAM above it. Since page one has ROM, we questioned the advertising claim to CP/M compatibility. According to Spectravideo, when you add an expansion interface, a disk controller, and a disk drive, the software (which includes CP/M) performs a memory-map swap so that the RAM is at the bottom. This allows a 32K CP/M, which, with the addition of more RAM, can be increased in size.

A considerable amount of software, both in ROM and cassette, is said to be available. The software includes educational, personal interest and business, recreational, and programming aids.

We did receive three games. Two of these were in ROM plug-ins that booted up when system power was turned on. The third game was on cassette, which we found very easy to load. In all three cases, the games and their sound effects were of high quality.

We also received a Spectravideo SV-903 cassette recorder for data storage. Since it has no volume or tone controls, it is simple to load and save programs. At the time of writing, neither the SV-601 Super Expander nor the disk system were available for test. A brochure that came with the SV-318 illustrated a large number of peripherals soon to be made available, however. These include a printer, a graphics tablet, interface cards, modem, an 80-column card, various sizes of RAM cards, joysticks, and a Colecovision game adapter.

Conclusion. The Spectravideo SV-318 is an excellent starting system for the beginning computerist. Its broad range of features will satisfy a young student/game player as well as an adult who is interested in learning how to use a computer.

To use the machine with CP/M, however, would be an exercise in foolishness. Adding up all the expansion hardware to provide a single floppy drive and 64K more memory, the total system would "list" at more than $1600. Add a video display and software costs to this.

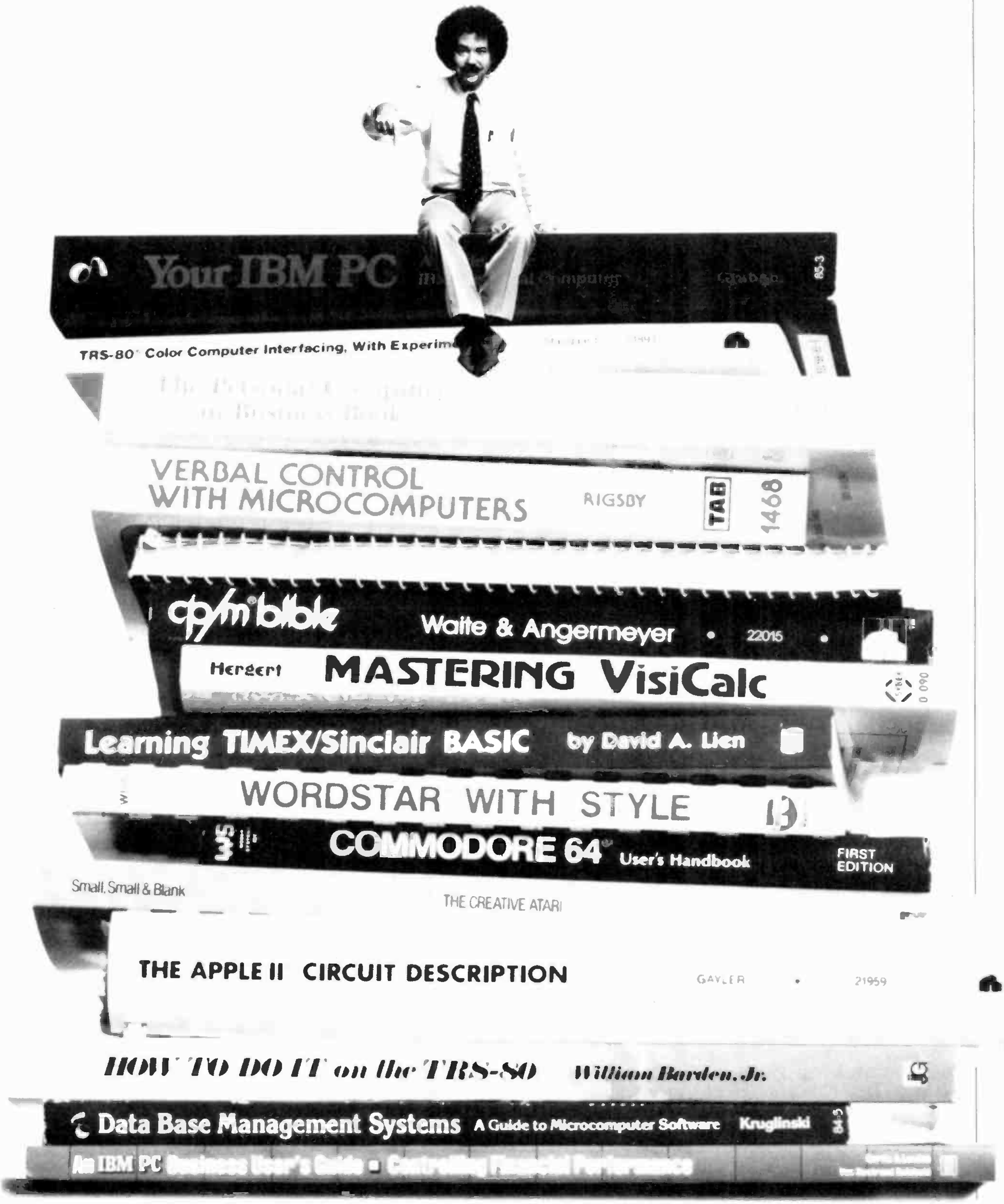
Typing on the SV-318 is not a total joy, owing to the type of keypad it incorporates. Moreover, keys have to be hit dead center to generate a character, which obviates serious touch-typing. But given the computer's price category, combined with the "extra" facilities offered, the overall value of the Spectravideo computer appears to be good.

Will all the promised peripherals be available for sure? How much third-party software support will be given this computer? What kind of price discounting will be practiced by dealers? These are among the cutting questions that come to mind at this time. The performance/price ratio itself is promising for recreational and educational applications. *—Leslie Solomon*

Circle No. 83 on Free Information Card

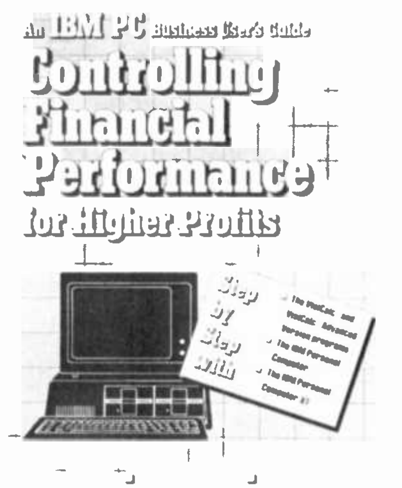
THIS year there were more books published about computers than there were works of fiction. Review copies pour into our office on a regular basis. Many of them treat their subjects with competence and sometimes with a humor that takes the "sting" out of what might otherwise be dry technical material.

Here is a potpourri of recent arrivals that appear to be noteworthy for one reason or another, whether to upgrade one's personal knowledge of a specific computer, a computer language or application, or personal computers in general. The sampling might serve you well during this season of gift-giving, too.

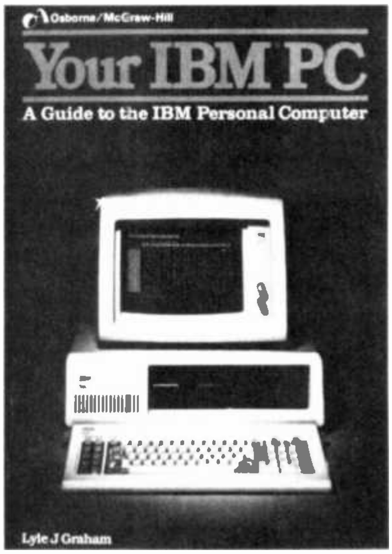


COMPUTER BOOKS

A sampling of interesting books on specific computers, applications software, and personal computing in general



Controlling Financial Performance for Higher Profits, subtitled "An IBM PC Business User's Guide," is a wonderful hands-on type of book that guides the reader through the many facets of the popular VisiCalc electronic spreadsheet as used in an IBM PC or XT computer. Detailed screen examples of what different inputs produce and a host of working tips make it easy for the user to start on the road quickly to financial planning and budgeting with an IBM desktop machine. Happily, the guide is written for managers and small business owners, rather than accountants and computerists. (*Published by Curtin & London, Inc. and Van Nostrand Reinhold Co., softcover, 170 pages, $15.50*)

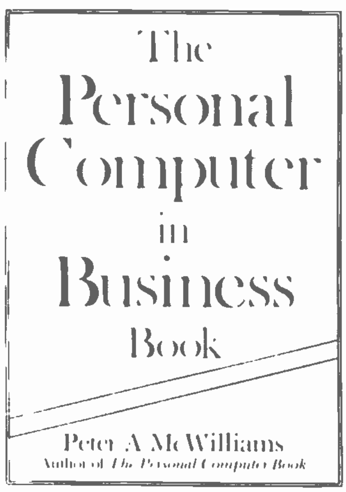


Your IBM PC: A Guide to the IBM Personal Computer, by Lyle J. Graham, offers something for everyone interested in the IBM Personal Computer. It brings into focus on two levels all the key elements that make up one of the most popular business-oriented personal computing systems. For the novice, it presents an overview of PC hardware and software, step-by-step operating instructions, and an introduction to IBM BASIC programming. For the experienced PC user, it goes into more technical detail, with discussions of PC DOS and CP/M-86 operating systems and IBM BASIC programming, color graphics, and sound. (*Published by Osborne/McGraw-Hill, softcover, 400 pages, $16.95*)

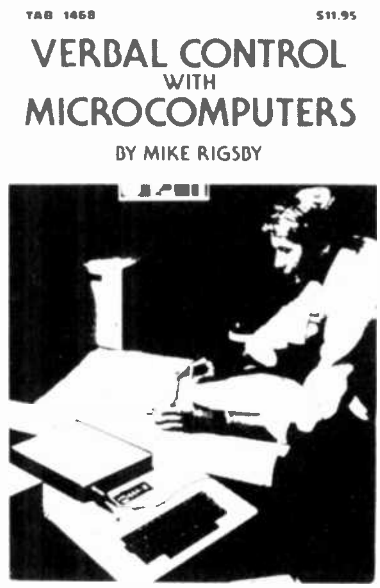
Learning Timex/Sinclair BASIC, by David A. Lien, offers a simplified, nonintimidating approach to learning how to use the Timex/Sinclair TS-1000's built-in language for programming. In his usual witty style, the author takes the reader through the ins and outs of BASIC programming and even includes a helpful tutorial on using the BASIC EDITor to rectify typing errors and to insert and delete material in a BASIC program. To benefit the greatest number of readers, the book is written for the T/S-1000 (as well as Sinclair ZX80 and ZX81) computers without any expansion memory modules. (*Published by CompuSoft Publishing, softcover, 331 pages, $14.95*)

The Creative Atari is an exciting compendium of informative articles for Atari home computers published in *Creative Computing* magazine, plus new material written just for this book. It is written for the nonexpert Atari user who has a limited knowledge of BASIC and simple programming. It shows in elementary terms how to get the most out of Atari computers in graphics, sound, memory, animation, disk storage, and dozens of other topics. In addition to the hardware discussed, a variety of ready-to-run program listings is included. (*Published by Creative Computing Press, softcover, 243 pages, $15.95*)

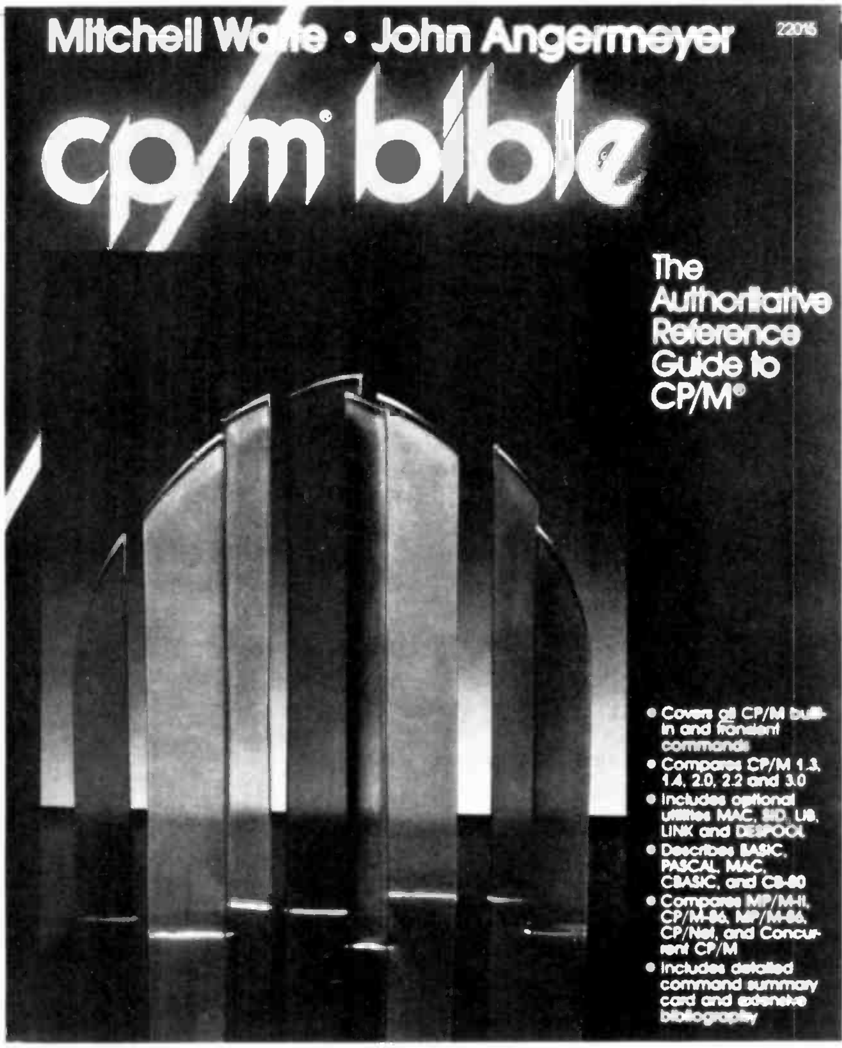
How To Do It on the TRS-80, by William Barden, Jr., is an encyclopedia of information on Radio Shack computers. It brings together in a single volume all the small details a TRS-80 Model I, II, III, 100, or Color Computer owner either can't find in his user's manual or the manual doesn't cover. Using an extensive four-character alphabetic coding system, with substantial cross-indexing, the book helps the reader to rapidly locate just about any information he may need on software, hardware, operating procedures, and computer-related topics like converting from binary to hexadecimal and inserting an IC in its socket. This is a book that any serious TRS-80 user should have handy. (*Published by IJG Inc., softcover, 339 pages, ($29.95*)



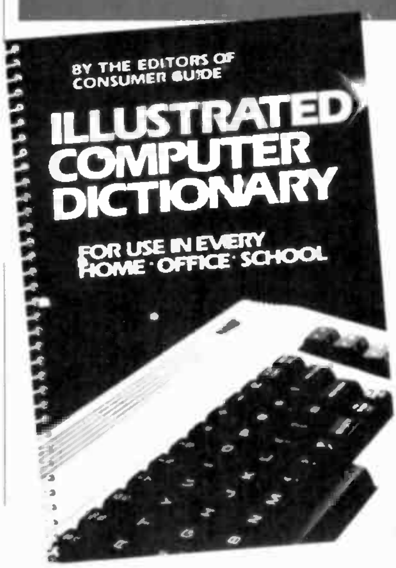
The Personal Computer In Business Book, by bestselling author Peter A. McWilliams, gives the reader a serious but lighthearted look at computers from the business point of view. Intended for the business person who knows nothing about computers but feels he must know something, the book describes what a computer is and what it can—and *can't*—do in the business environment. There is a comprehensive, if slightly opinionated, guide to the various systems available, as well as a section on how to go about purchasing a computer for business use. (*Published by Prelude Press, softcover, 287 pages, $9.95*)



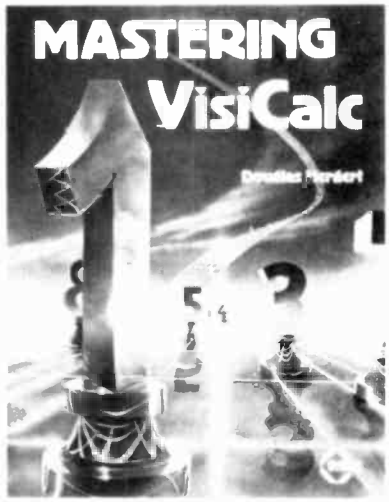
Verbal Control With Microcomputers, by Mike Rigsby, is a book for serious experimenters who want to use their computers to control external devices. It presents a variety of practical applications of sound (not specific voice) recognition technology for using a computer in some fascinating control applications. Using Radio Shack's TRS-80 Model I computer with 16K of RAM as the test bed, the author discusses concepts of sound recognition and explains, through diagrams and program listings, how to implement sound recognition with projects that can be built for less than $100. (*Published by TAB Books Inc., softcover, 404 pages, $11.95*)



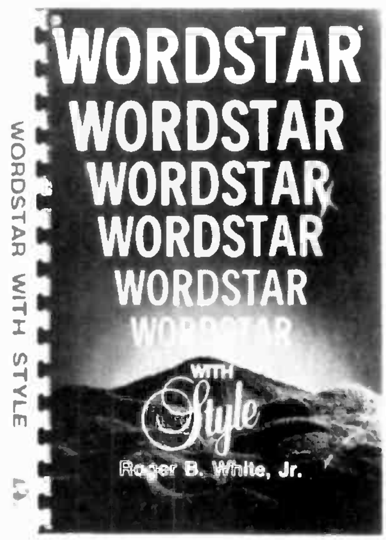
CP/M Bible, by Mitchell Waite and Howard Angermeyer, subtitled "The Authoritative Reference Guide to CP/M," is indeed authoritative. Rather than serving as a tutorial guide to this popular disk operating system, as so many CP/M books do, this one is more an encyclopedia of CP/M's built-in commands, transient commands, and operating procedures. Emphasis is on CP/M 2.2 and earlier versions, but CP/M 3.0 is given the once-over as well. Anyone who uses CP/M, whether beginner or experienced, should have the *CP/M Bible* within easy reach. (*Published by Howard W. Sams & Co., Inc., softcover, 429 pages, $19.95*)



Illustrated Computer Dictionary, by the editors of *Consumer Guide*, brings together the most popular (and some not so popular) terms in common usage among computerists and explains their meanings in lively, down-to-earth language. Beyond the fact that it contains lots of useful information, in bite-sized pieces, this handy spiral-bound book is notable for its airy layout and liberal sprinkling of informative line art. Unlike other dictionaries that present dry facts, this one invites casual reading. (*Published by Exeter Books, softcover, 180 pages, $4.98*)

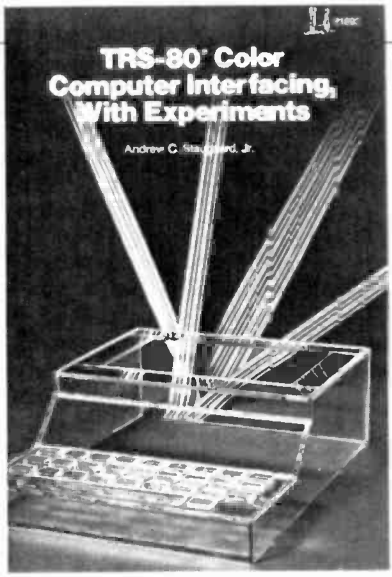


Mastering VisiCalc, by Douglas Hergert, is one of those rare books that brings to life the normally dry prose of a technical subject. Written in an easy-to-read format, it details most of what a user might wish to know about using the very flexible VisiCalc spreadsheet program. The book even provides a complete introduction to the use of the DIF function for communicating data between the VisiCalc spreadsheet and a BASIC program. This book by itself can serve as both a tutorial course in using VisiCalc and as a quick reference guide for people already familiar with the spreadsheet program. (*Published by Sybex Inc., softcover, 217 pages, $11.95*)

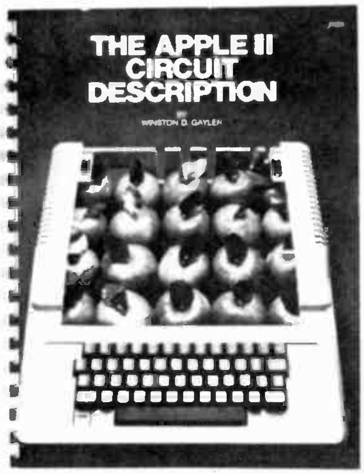


WordStar With Style, by Roger B. White, Jr., is another in a long list of books written for the only word processor that appears to need how-to guides owing to its enormous flexibility and great popularity. Written in a project demonstration format, the book is valuable to both the beginner and intermediate user of WordStar. By following the informal exercises presented, the reader learns how to use WordStar's functions and, equally important, why these functions work as they do. The reader is shown how to produce almost any document in a wide variety of print formats. In addition, some of the other software packages that work with WordStar are described. (*Published by Reston Publishing Co., Inc., softcover, 181 pages, $14.95*)

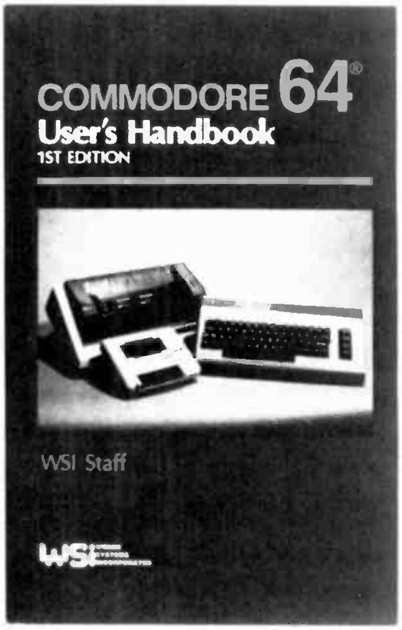
Data Base Management Systems, by David Kruglinski, is an interesting primer that can be used by the reader to choose a database management program that suits his particular needs. It gives an overview of DBMSs and microcomputers and smoothly eases the reader into use of specific types of programs available in the marketplace, using examples and actual screen displays. Detailed descriptions of the Condor Series, dBASE II, FMS-80, and MDBS III database management systems are used to familiarize the reader with the power of these productivity tools. (*Published by Osborne/McGraw-Hill, softcover, 260 pages, $16.95*)



TRS-80 Color Computer Interfacing With Experiments, by Andrew C. Stugaard, Jr., is an experimenter's delight because it gets the reader involved in both hardware and software in detailing how to connect useful devices to Radio Shack's popular Color Computer. Instead of describing how to add onto the computer specific devices, emphasis is on how to go about making interfaces. Only a working knowledge of Color BASIC programming and the binary number system are required to understand the procedures detailed. (*Published by Howard W. Sams & Co., Inc., softcover, 203 pages, $14.95*)



The Apple II Circuit Description, by Winston D. Gayler, is to the Apple II computer what shop manuals are to an automobile. It takes the reader right down to the nuts and bolts level of the computer through detailed technical descriptions of all versions of the main logic board and current two-piece and older single-piece keyboards. Written on two levels, the text provides an overview for beginners and a detailed circuit analysis for the more advanced. Full technical descriptions are backed up with fold-out logic, schematic, and timing diagrams to help in servicing the computer and successfully interfacing peripherals. This is one book every Apple II owner should have on his shelf. (*Published by Howard W. Sams & Co., Inc., softcover, 260 pages, $22.95*)



Commodore 64 User's Handbook takes the reader, even if he or she is a first-time computer user, far beyond the user's manual supplied with the versatile Commodore 64 home computer. In meeting its stated aim to serve as a setup, operating, and programming guide for the C-64, this hands-on instruction book makes extensive use of examples and even presents a mini-course in Commodore BASIC programming. Used as a supplement to the C-64 user's manual supplied by Commodore, the book will tell you just about anything most users want to know about this powerful home computer. (*Published by Weber Systems Inc., softcover, 307 pages, $14.95*)

Fail-Safe, Real-Time Clock for TRS-80

Low-cost accessory keeps time even when computer is turned off

By John C. Mein

A REAL-TIME clock accessory for a TRS-80 that will continue to keep time even when the computer is turned off could be a handy thing to have for many applications. Even if your set-up includes an expansion interface, you can add this useful function for about $30 worth of hardware and a little programming. Here's how: The circuit (below) is based on the MSM5832RS IC that functions as a real-time clock-calendar for use in a bus-oriented microprocessor application. The IC contains all the circuitry necessary to keep track of the seconds, minutes, hours, day of the week, day of the month, and year. It even keeps track of leap years.

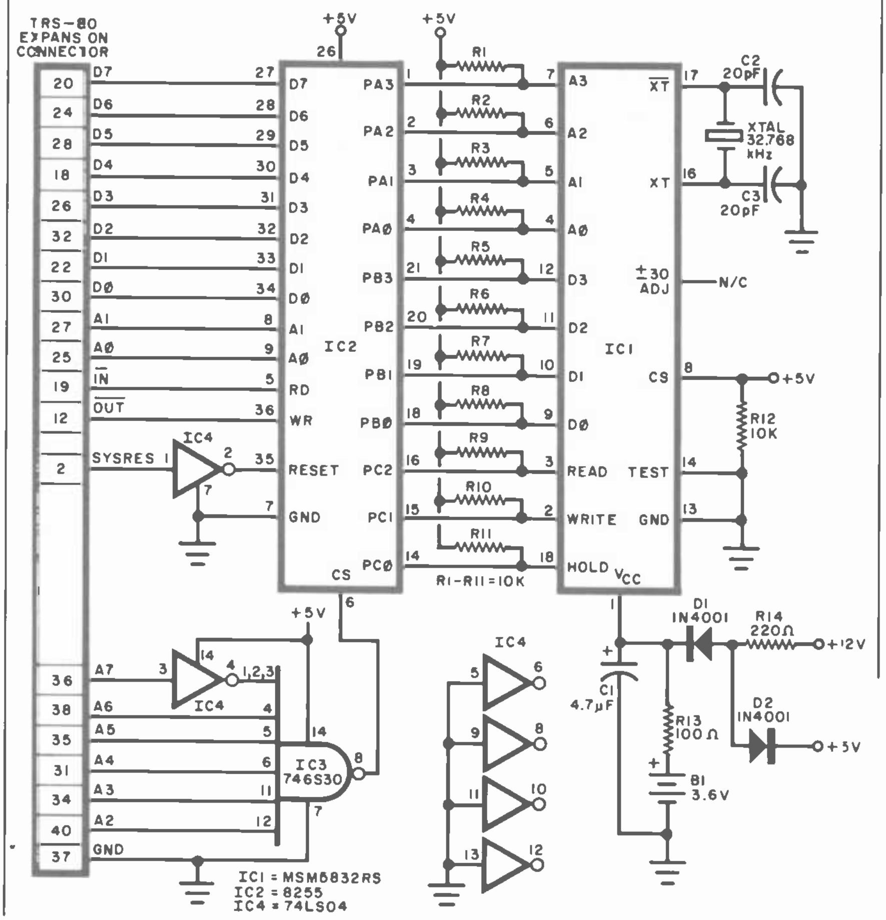
The MSM5832 normally requires a 5-volt ±5% supply, but will operate satisfactorily from as little as 2.2 volts. This allows a back-up battery to be used.

The chip select line of *IC1* (*CS*, pin 8) is connected to system power. When *CS* is high (power on), all chip inputs and outputs are enabled. Loss of system power lets *R12* pull *CS* to ground, disabling all inputs and outputs. The threshold voltage of *CS* is higher than all other inputs to insure correct operation of this function.

Three 1.2-volt NiCd cells connected in series *(B1)* are kept at full charge by the 12-volt supply through current-limiting resistors *R13* and *R14*. Diodes *D1* and *D2* prevent the batteries from discharging back through the supplies when power is turned off.

A standard 32.768-kHz clock crystal (*XTAL*) is used as a timing reference. (This crystal can be salvaged from a discarded digital wristwatch.) Resistors *R1* through *R11* insure proper source and sink currents between *IC1* and *IC2*.

Parts layout is not critical and any method of construction can be used in-



The heart of the clock is an MSM5832RS IC containing all the necessary circuitry to keep track of seconds, minutes, hours, days, months, and years.

PARTS LIST

B1—1.2 V NiCd cell (3)
C1—4.7 µF, 6-V tantalum capacitor
C2,C3—20-pF mica or polystyrene capacitor
D1,D2—1N4001 or similar diode
IC1—MSM5832RS clock (OKI Semiconductor)
IC2—8255 programmable peripheral interface
IC3—74LS30 8-input NAND gate
IC4—74LS04 hex inverter
R1 through R12—10kΩ, ⅛-W resistor
R13—100-Ω, ¼-W resistor
R14—220-Ω, ¼-W resistor
XTAL—32.768-kHz crystal
Misc.—40-pin connector to TRS-80, wire, prototype board or similar.

Note—The following are available from Appcomp, 8255 Jellison Ct., Arvada, CO 80005: MSM5832RS clock chip and 32.768-kHz crystal for $15.00 postpaid in USA. Colorado residents, add sales tax.

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cluding Wire Wrap or printed circuit. Power requirements are low, and any +12-V and +5-V supply capable of supplying 100 mA will do. The circuit is connected to the TRS-80 via the expansion interface connector as shown in the schematic.

The program used to set the clock to the proper time is shown in Table I. After entering all the time parameters, depressing the "ENTER" key starts the clock. This allows synchronization with an external time reference. The program that displays the contents of the clock on screen is shown in Table II. In operation, this program continually accesses the clock and displays the current time in the upper lefthand corner of the video display.

If you intend to use the clock to control timing functions, you need only occasionally access the clock to determine the time. For instance, when the time reaches a preset value, via external circuitry, the computer could turn various electrical loads on or off.

When accessing the clock chip for reading or writing purposes, make sure that the *IC1* HOLD line, (pin 18) is *not held high for more than one second*, otherwise, the clock timing is disturbed and a second or two may be lost. With the programs given, this should not be a problem. ◇

TABLE I—CLOCK SETUP ROUTINE

```
1000                'THIS PROGRAM ALLOWS US TO SET THE CLOCK.
1010 OUT 127,128  'FIRST WE SET UP THE PPI FOR ALL OUTPUTS.
1020 DIM A(20)
1030 INPUT"WHAT YEAR IS THIS (LAST TWO DIGITS)";A(15)
1040 INPUT"WHAT MONTH IS THIS (IN NUMBERS)";A(16)
1050 INPUT"WHAT DAY OF THE MONTH IS ThIS";A(17)
1060 INPUT"12 OR 24 HOUR FORMAT (ENTER 12 OR 24)";A(18)
1070 IF A(18)=12 OR  A(18)=24 THEN 1080 ELSE 1060
1080 IF A(18)=24 THEN 1110
1090 INPUT"AM OR PM";A$
1100 IF A$="AM" OR A$="PM" THEN 1110 ELSE 1090
1110 INPUT"WHAT HOUR WILL IT BE";A(19)
1120 INPUT"WHAT MINUTE WILL IT BE";A(20)
1130 INPUT"IS THIS A LEAP YEAR (YES OR NO)";Y$
1140 IF Y$="YES" OR Y$="NO" THEN GOTO 1150 ELSE 1130
1150 A(0)=A(1)=0           'ZERO OUT THE SECONDS REGISTERS.
1160 A(2)=10*(A(20)/10-FIX(A(20)/10))     'GET THE MIN 1'S
1170 A(3)=INT(A(20)/10)                   'GET THE MIN 10'S
1180 A(4)=10*(A(19)/10-FIX(A(19)/10))     'GET THE HRS 1'S
1190 A(5)=INT(A(19)/10)                   'GET THE HRS 10'S
1200 A(7)=10*(A(17)/10-FIX(A(17)/10))     'GET THE D.O.M. 1'S
1210 A(8)=INT(A(17)/10)                   'GET THE D.O.M. 10'S
1220 A(9)=10*(A(16)/10-FIX(A(16)/10))     'GET THE MONTHS 1'S
1230 A(10)=INT(A(16)/10)                  'GET THE MONTHS 10'S
1240 A(11)=10*(A(15)/10-FIX(A(15)/10))    'GET THE YRS 1'S
1250 A(12)=INT(A(15)/10)                  'GET THE YRS 10'S
1260 IF A(18)=24 THEN A(5)=A(5)+8         'ADJ FOR 24 HR FORMAT
1270 IF A$="PM" THEN A(5)=A(5)+4          'ADJ FOR PM
1280 IF Y$="YES" THEN A(8)=A(8)+4         'ADJ FOR LEAP YEAR
1290 INPUT"HIT ENTER TO START THE CLOCK";D$  'WAIT TO SYNCHRONIZE THE CLOCK.
1300 OUT 126,1                            'ASSERT HOLD TO STOP CLK
1310 FOR I=0 TO 12                        'ADDRESSING LOOP
1320 OUT 124,I                            'ADDRESS THE PROPER REGISTER.
1330 OUT 125,A(I) AND 255                'AND OUTPUT THE DATA
1340 OUT 126,3                            'TURN THE WRITE LINE ON
1350 OUT 126,1                            'AND OFF TO WRITE.
1360 NEXT                                 'DO ALL 12 REGISTERS.
1370 OUT 126,0                            'AND AWAY WE GO.
1380 END
```

TABLE II
CLOCK DISPLAY ROUTINE

```
10                        'THIS PROGRAM DISPLAYS THE CLK ON THE SCREEN.
20 CLS                   'START WITH A FRESH, CLEAN SCREEN.
30 DIM A(15)             'SET UP AN ARRAY TO READ THE CLK VALUES INTO.
40 OUT 127,130           'SET UP THE PPI FOR A,C IN AND B OUT.
50 OUT 126,1             'ASSERT HOLD TO PREVENT FALSE READINGS.
60 OUT 126,5             'ALSO ASSERT READ TO READ THE CLOCK
70 FOR I=0 TO 12        'ADDRESSING LOOP
80 OUT 124,I             'ADDRESS THE REGISTERS SEQUENTIALLY
90 A(I)=15 AND INP(125)    'INPUT ONE REGISTER AT A TIME AND
100 NEXT                    'MASK OFF UNWANTED BITS.
110 OUT 126,0           'RESUME REGULAR CLOCK TIMING
120 H=10*(3 AND A(5)) + A(4)    'PUT THE HRS INTO THE PROPER FORMAT.
130 IF H<=9 THEN PRINT @ 0,"0";H;":"; ELSE PRINT @ 0,H;":";    'AND PRINT THEM OUT.
140 M=10*A(3) + A(2)        'PUT THE MINUTES INTO THE PROPER FORMAT
150 IF M<=9 THEN PRINT "0";M; ELSE PRINT M;      'AND PRINT THEM OUT.
160 PRINT ":";        'PRINT THE COLON
170 S=10*A(1) +A(0)     'PUT THE SECONDS INTO THE PROPER FORMAT
180 IF S<=9 THEN PRINT "0";S; ELSE PRINT S;    'AND PRINT THEM OUT.
190 PRINT"          ";10*A(10) + A(9);  'PRINT THE MONTH
200 PRINT"/";10*A(8) + A(7);   'AND THE DAY OF THE MONTH
210 PRINT"/";10*A(12) + A(11);    'AND THE YEAR.
220 GOTO 40          'LOOP FOR CONTINUOUS DISPLAY.
```

The World's First 16-Bit CMOS Microprocessor
Experimenting with a Piezoelectric Speaker

By Forrest M. Mims, III

WITH the arrival of portable notebook computers such as Radio Shack's Model 100, Convergent Technologies' Workslate, and Epson's HX-20, the era of truly *personal* computing has finally arrived. Now all we need is a portable machine that will run software developed for IBM's Personal Computer.

Thanks to the development of the first commercial 16-bit CMOS microprocessor, the 80C86, the availability of such a machine may not be far away. This month we'll take a detailed look at this important new microprocessor and its applications.

Next, we'll cover a favorite subject of mine, ultrasonics, and experiment with low-cost piezoelectric tweeters. Then we'll build an ultrasonic siren that may stop the annoyance of barking dogs.

The 80C86 CMOS Microprocessor

In my opinion, the major microprocessor news of 1983 was the development by Harris Corporation of a CMOS version of Intel's popular 8086 microprocessor. The 8086 is software compatible with the 8088, the chip IBM uses in its phenomenally successful Personal Computer. Indeed, the 8086 and 8088 share the same basic set of 108 instructions.

The new chip is the world's first commercial 16-bit CMOS microprocessor. Designated the 80C86, it provides all the capabilities of the 8086 at considerably reduced operating power. Furthermore, unlike the NMOS 8086, which must be operated at a fixed clock frequency, the 80C86 can be operated over a clock frequency of dc to 5 MHz. Since the power consumption of a CMOS chip increases with the clock speed, the 80C86 can be operated at reduced clock rates to lower its power consumption.

Another important benefit of a variable clock speed is the ability to single-step the 80C86 through its programs for easier debugging. This capability is sure to make the new chip popular with programmers.

In operation, the 80C86 consumes only 500 μA in its dc standby mode. In this condition, the clock is stopped, but the contents of all internal registers are saved. When the clock is activated, the 80C86 consumes a maximum of 10 milliamperes per megahertz. Therefore, at its highest clock frequency of 5 MHz, the 80C86 consumes a maximum of 50 mA. This is substantially less than the 275 mA consumed by the NMOS 8086.

The 80C86 incorporates several unique design features, some of which were necessary due to important operating drawbacks of CMOS chips. For example, one of the most important CMOS problems is what to do with unconnected ("floating") inputs.

If you've assembled working CMOS circuits, you already know that a floating input acts like an antenna. It can pick up stray signals that can cause a CMOS gate to switch erratically and possibly consume excessive current. Consequently, a firm rule of CMOS circuit design is that all inputs *must* go somewhere.

This rule can be unintentionally but easily broken when applied to a CMOS microprocessor. In a working system a microprocessor often accesses external memory and other chips via a three-state bus. If one or more lines connected to any of the microprocessor's many ad-

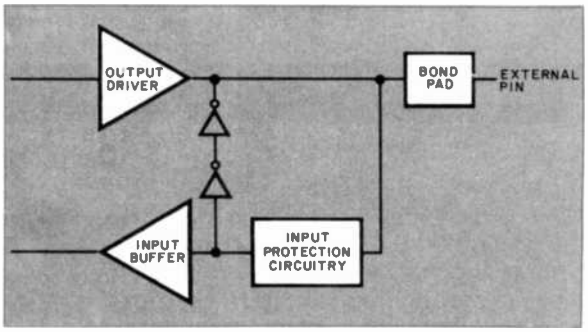

Fig. 1. Block diagram of a bus-hold circuit.

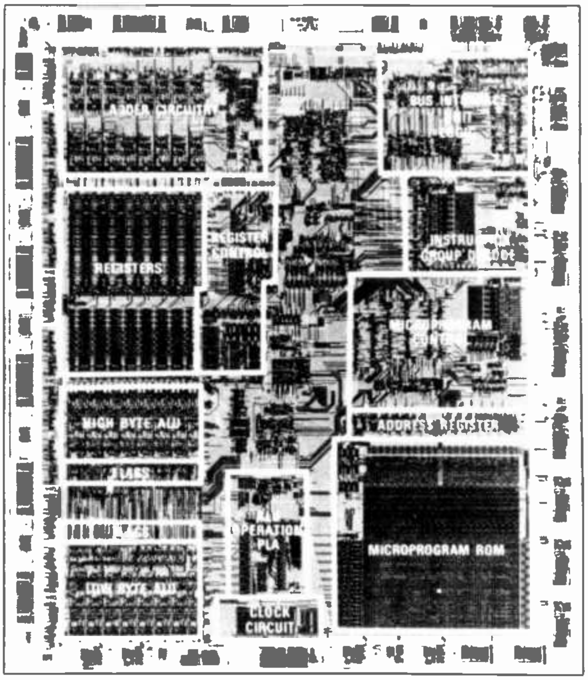

Fig. 2. Photo of an actual Harris 80C86 chip.

dress, data and control inputs assume the high-impedance state, then the affected inputs are essentially unconnected and in a floating state. The system may then behave erratically and serious errors or malfunctions may occur.

This problem can be alleviated by connecting all input pins to V_{cc} by means of pullup resistors. However, this imposes additional complexity and expense. It also requires additional space, a drawback for the portable, battery-powered systems for which CMOS microprocessors are ideally suited.

The 80C86 overcomes this problem entirely by means of "bus hold" circuits at each of its inputs. Should an input or bus line assume the high-impedance state, the bus-hold circuit maintains the input at its last defined logic state. When the input line is again active, the bus-hold circuit can be "overdriven" by an incoming logic signal.

Figure 1 is a simplified block diagram provided by Harris of a bus-hold circuit. However, the diagram doesn't adequately reveal the workings of the circuit. Apparently the two inverters form part of a bistable (two-state) feedback loop that keeps the input at the prior state so that it is not allowed to float.

Comparing the 8086/80C86 and the 8088. Since the 8088 is used in the IBM PC, it's important to understand why the 8086/80C86 can be used to make a so-called "IBM compatible" computer, that is, one that accepts software written for the PC.

Figure 2 is a photograph of an actual Harris 80C86 chip. The chip contains 38,000 transistors and measures only 0.243" × 0.284". From the photo, it's evident that a considerable percentage of the chip's surface is occupied by an extensive network of interconnecting bus and control lines.

The chief difference between the two microprocessors is that the 8086/80C86 has a 16-bit data bus, while the 8088 has only an 8-bit data bus. The 8088 overcomes this apparent disadvantage by accepting 16-bit data as two sequentially entered bytes.

Both the 8086/80C86 and the 8088 have a 20-bit address bus. This means each microprocessor can address up to a *megabyte* (1,048,576 bytes) of external RAM. The 16-bit program counter in each chip, however, allows direct access to only 65K (65,536) bytes of memory. The full address capability is made available by a method called *segmented addressing.*

The memory is organized into as many as sixteen 65K *segments.* Four 16-bit registers are used to store memory-segment addresses. All memory referrals are then made with reference to the addresses stored in the *segment registers.* The complete 20-bit address is obtained by shifting the address in the segment register four bits to the left and adding the result to the memory-referral address.

Segments can be located anywhere within a full megabyte of memory and can even overlap one another. However, all the information in a segment must be logically related (e.g. program code or data). Three of the four segment registers are designed for three specific categories of information: data (DS), stack contents (SS), and program code (CS). The fourth register (ES) is available for extra segments.

Figure 3 is a simplified block diagram of the 8086/80C86 that shows the location of the segment registers. You can find out much more about how the 8086/80C86 handles large memory addresses by studying the technical literature available from Intel and Harris.

Both the 8086/80C86 and 8088 are

supplied in 40-pin dual-in-line packages. Since both microprocessors have *more* than 40 input, output, and power-supply connections, it's necessary for some of the address pins to double as data pins. The status of a special memory/input-output (M/IO) pin determines whether a pin functions as an address or data pin.

Eight status and control pins also serve dual functions. Their functions are collectively changed by means of a logic signal at a special pin designated *MN/MX*.

80C86 Support Chips. Intel makes a complete family of support chips for the 8086. The 8086 can also be used with support chips designed for the 8080 and 8085 microprocessors.

Along with its introduction of the 80C86, Harris announced the availability of CMOS support chips. These include the 80C54 Programmable Interval Timer, the 82C55A Parallel Peripheral Interface, the 82C59A Priority Interrupt Controller, and the 82C59A Octal Latching Bus Driver. Other CMOS support chips include the 82C84A System Clock and 82C88 Bus Controller.

Figure 4 is a typical 80C86 system diagram that shows how these various support chips are used. Each of the support chips performs a range of functions beyond its primary purpose. For example, the 82C84A System Clock provides a power-on/reset signal. It also synchronizes other 82C84As (if used) and coordinates local and system bus synchronization.

The Harris-Intel Connection. Since the 8086 is an Intel chip, you may be wondering how Harris can make and sell a CMOS version of the same chip! It's very common for semiconductor companies to license the rights to their chip designs to one or more competitors. While licensing agreements can provide additional income, they serve an even more important purpose by guaranteeing a second source for the licensed chip.

Rarely will a major manufacturer commit to manufacture an electronic product if the circuitry uses chips available from only one supplier. Should the supplier not be able to deliver chips, a product may be cancelled. This, of course, is the real reason Intel was happy to permit Harris to make the 80C86.

Harris Semiconductor, a division of Harris Corporation, has produced special-function CMOS chips for years. Many of their chips are used in sophisticated military electronic systems.

Though Intel is, by comparison, a relative newcomer in the CMOS business, the company has already introduced such CMOS chips as the 80C51, 80C49 and 80C48 single-chip microcontrollers. Intel plans to introduce its own version of the 80C86, along with a family of CMOS support chips, by mid-1984.

What It All Means. Simply put, the 80C86 means that portable, battery-powered 16-bit microcomputers are on the way. Though their 16-bit capability will enhance the microprogramming of such machines, the real advantage to the end user will be massive memory.

It's easy to foresee a portable, notebook-sized computer similar to Radio Shack's Model 100 but with a full *megabyte* of internal RAM. With this kind of storage, *many* applications can be handled without the need for a floppy disk. If I can type this entire column into a 32K Model 100, imagine the capacity of a full megabyte!

Since the 80C86 is a U.S. chip, it's enticing to conclude that the new generation of 16-bit portable computers will be made in this country. IBM, for instance, now owns 14% of Intel's stock.

But IBM and other U.S. computer makers will have to keep a wary eye on Japan. According to a new report in *Electronics* magazine, both Oki Electric Industry and NEC Corporation, two

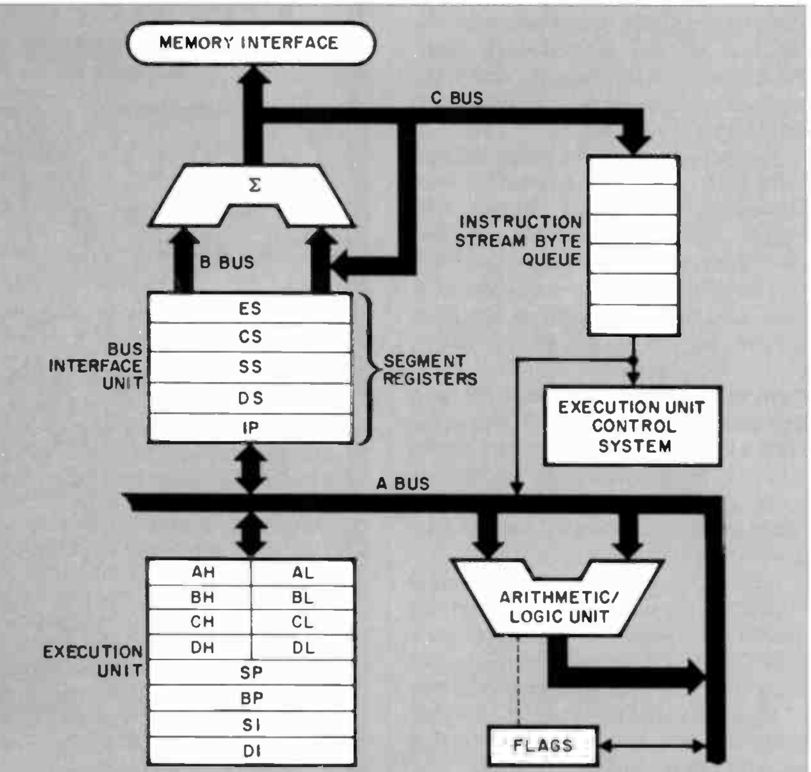

Fig. 3. Simplified block diagram of the 8086/80C86 showing segment registers.

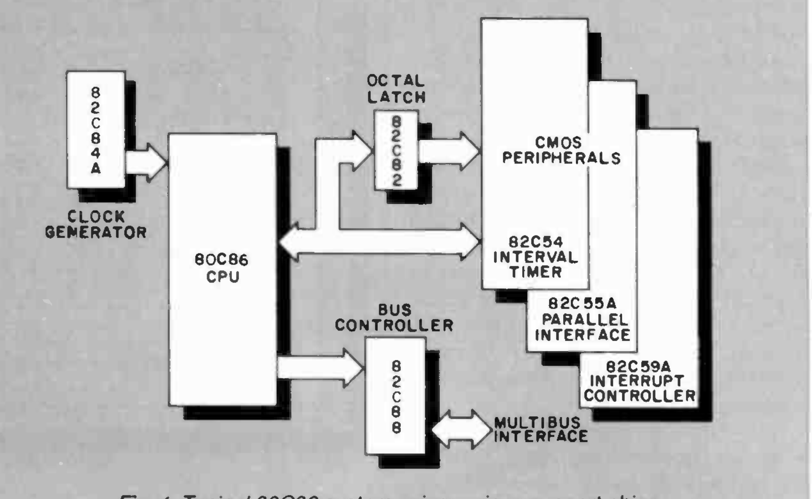

Fig. 4. Typical 80C86 system using various support chips.

major Japanese semiconductor companies, are working to develop CMOS versions of the 8086. The *Electronics* news item predicted that another Japanese company, Kyocera Limited, will be the first customer for the Oki CMOS 8086. The significance of this is that Kyocera Limited is the manufacturer of the 8-bit Model 100.

A Piezoelectric Speaker Siren

Piezoelectric speakers are commonly used as high-frequency tweeters in high-fidelity speaker systems. Since the moving surface of such speakers is comparatively small, sounds having a frequency approaching 40 kHz can be generated.

Figure 5, for example, is the frequency response curve for a typical piezoelectric tweeter, Radio Shack's Realistic® Super Horn (catalog number 40-1381). This tweeter has an impedance greater than 1 kilohm at 1 kHz and more than 20 ohms at 40 kHz. It has good transient response and faithfully reproduces single-frequency tones. It's also lightweight, sturdy, and vibration resistant.

Piezoelectric tweeters can be connected directly across conventional electromagnetic speaker terminals without a crossover network and with or without a level control. Figure 6 shows how to implement a straightforward level control to adjust the volume from the tweeter.

Applications for Piezoelectric Tweeters. Aside from their intended function as hi-fi tweeters, piezoelectric speakers have several additional applications. For instance, a piezoelectric tweeter can be used as a high-impedance microphone.

More significant, however, are appli-

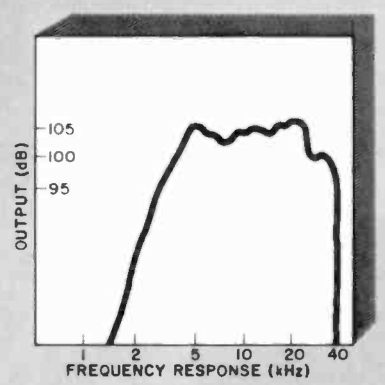

Fig. 5. Tweeter response curve.

cations in which the speaker serves as a sound-emitting source for a warning device or ultrasonic generator. I've experimented with several circuits that implement these functions. They're easy to assemble, and you may wish to try the two described here.

A Multi-Output Alarm. Figure 7 is a simple but very effective multiple-output alarm circuit made from both halves of a 556 dual-timer chip. When connected to a piezoelectric tweeter, this circuit emits three different attention-getting alarm signals.

In operation, the left timer is connected as a multivibrator that switches on and off at a rate of about 0.5 Hz. Let's refer to this circuit as the *autoswitcher*. The right timer is connected as a multivibrator that oscillates at a frequency of a few kilohertz. We'll refer to this portion of the circuit as the *audio oscillator*.

Switch *S1* permits three operating modes to be selected. When *S1* is in position 1, the audio oscillator operates independently of the autoswitcher and the speaker emits a steady, piercing tone. With *S1* in position 2, the output from the autoswitcher is connected to the trigger input of the audio oscillator through *R3*. The speaker then emits a distinctive alternating tone that resembles a "twee-dell" siren. When *S1* is in position 3, the output from the autoswitcher is connected directly to the audio oscillator's trigger input and the speaker emits a series of penetrating tone bursts.

The circuit in Fig. 7 can be used to drive a small 8-ohm electromagnetic speaker, but a piezoelectric tweeter provides much better results. The sound is very penetrating *and* very loud. The volume can be increased by raising the supply to 15 V. The various sound outputs can be altered by simply changing the various RC components.

A Sonic/Ultrasonic Siren. A piezoelectric tweeter makes a very effective sound source for a sonic/ultrasonic siren. I've designed and assembled an experimental version of such a siren to test its effectiveness as an alarm.

Figure 8 is a schematic of the siren. The SN76488 complex sound generator operates as a self-recycling, swept-frequency, up-down oscillator. The frequency range of the oscillator is determined by *R2* and *C2*. The sweep rate is determined by *R1* and *C1*.

With the values shown in Fig. 8, the oscillator can be adjusted via *R2* and *C2* to sweep from a lower range of a few hundred hertz to a few kilohertz and an upper range of about 15 kHz to 50 kHz.

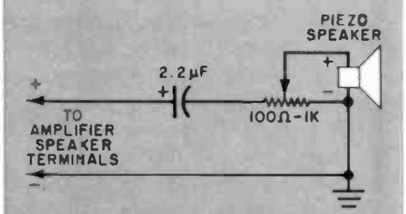

Fig. 6. Tweeter volume control.

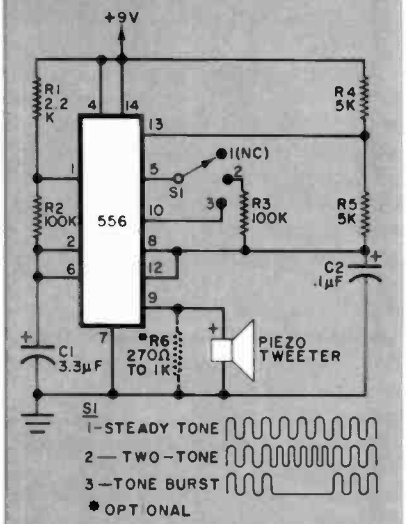

Fig. 7. Speaker driver circuit.

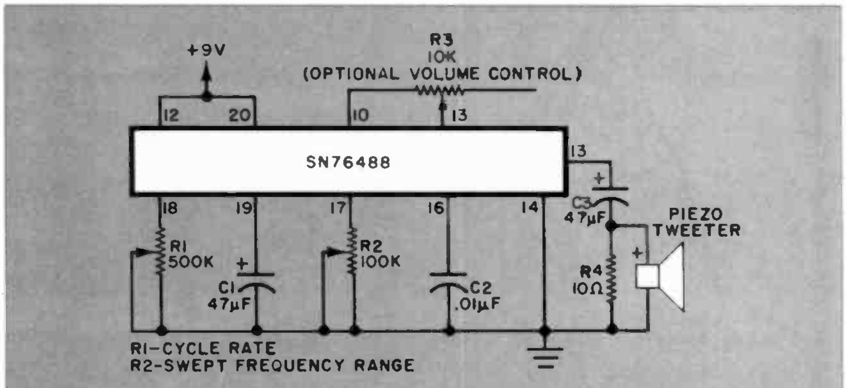

Fig. 8. Schematic sonic/ultrasonic siren circuit.

The cycle rate can be varied from a few tenths of a hertz to several hertz by altering *R1's* setting.

Testing the Siren. There's really no need to explain how to test the siren circuit when it's operated in the audible frequency mode. You simply adjust it for the sound you prefer. Caution: The sound can be very penetrating. You should cover the speaker while testing the siren indoors to protect your ears.

Operating the siren in its ultrasonic mode is trickier, since you cannot hear the output. I have used this operating mode in an experiment to silence barking dogs.

A young person with normal hearing can detect sounds having frequencies approaching 24 kHz. Animals such as dogs and, especially, bats can hear sounds having even higher frequencies. The upper limit for older people is usually much lower, perhaps 10 kHz or even considerably less. People whose hearing has been impaired by exposure to excessive sound or disease may have even lower frequency response levels. The siren in Fig. 8 can cover this entire range of frequencies and beyond.

While testing the siren circuit in my office, a neighbor's pack of four dogs began a chorus of yelping when a fifth dog wandered too close to their territory. I connected a Realistic® Super Horn to the siren, adjusted *R2* for ultrasonic operation, went outdoors and pointed the tweeter at the dogs. They immediately stopped barking! The worst offender repeatedly shook his head as he walked away.

While this brief experiment achieved the desired result, later the dogs completely ignored a second barrage of ultrasonic waves during another barking episode. I'm not sure why the second experiment was not successful. Perhaps the wind was blowing from the wrong direction. Or maybe the sound of their own barking blocked the effect of the ultrasonic waves.

In any event, I quickly stopped a third round of barking the next day with a few quick bursts of ultrasonic waves. Unfortunately, all subsequent attempts to discourage the dogs from barking have been unsuccessful. Indeed, the siren now causes the dogs to bark even more vigorously.

Though I've concluded my brief experiment aimed at curing barking dogs, I would be interested to hear from any readers who obtain better results. Of course you should be careful that your experiments do not offend the owners of the barking dogs or that, as in my case, they don't stimulate rather than eliminate barking spells.

I'm also curious to know if an ultrasonic source, as some companies claim, drives away insects, mice, rats, and other pests. While I cannot respond to individual letters, I'll be happy to pass along any interesting results in a future column. Be sure to send all the details of any experiment that might interest other readers. And indicate whether or not you would like your address used.

Assembling a Permanent Siren. The circuit in Fig. 8 uses so few parts you can assemble it *inside* the empty space in the plastic enclosure of a Realistic® Super Tweeter (Cat. No. 40-1380) or similar enclosed piezoelectric tweeter. This tweeter's enclosure can be opened by removing the screws inside the three recessed holes on the back panel of the enclosure. When the screws have been removed, place the enclosure on its back panel and remove the front portion of the enclosure. This will keep the fragile piezoelectric element and its paper cone from falling out of its receptacle and posssibly being damaged.

There's ample room in the enclosure for the necessary components, controls, and a 9-V battery. Figure 9 shows one way the components can be installed.

Begin assembly by *carefully* removing the piezoelectric speaker element from its plastic mounting cylinder. In the side of the cylinder, drill a hole for mounting a 9-V battery holding clip. Then drill holes for *R1* and *S1* as shown in the view of the back panel in Fig. 10.

I assembled the siren circuit on a 1.5" × 2" piece of perforated board with pre-etched copper foil patterns suitable for a DIP IC (Radio Shack 276-153 or similar). Figure 11 shows the parts layout.

You can mount the completed board directly to the speaker connection solder tabs inside the enclosure (back side of the back panel). First, unsolder the piezoelectric element's leads (careful, they're fragile). Then place (melt) some solder blobs on the back side of the board. Melt some more solder on the solder tabs. Then hold the board against the tabs (component side facing the speaker cylinder) while remelting the solder on one tab. When the solder hardens, heat the second tab. The board will then be anchored securely in place.

Next, *carefully* solder the speaker leads to the circuit board. Then solder the leads from a 9-V battery clip to the board and one pole of *S1*. Finally, connect leads between the board and the second pole of *S1* and the terminals of potentiometer *R1*.

You'll have to adjust the swept frequency range before replacing the back panel on the enclosure since *R2* is attached to the circuit board. If you want to make quick frequency changes, you can mount *R2* in the side of the enclosure. There isn't room to mount it on the back panel of the speaker I used.

Going Further. There are many ways to make sonic and ultrasonic sirens. Over the years many different transistorized and integrated circuit versions have been published, and you may want to experiment with some of them.

Of course, sound generator chips greatly simplify the design and construction of such circuits. In addition to the SN76488 I used for this circuit, you can use the SN76495, SN94281 and various other sound-synthesizing chips.

If you're troubled by barking dogs, you may want to consider adding a sound-activated trigger to the siren. Adjust the circuit to deliver a burst of ultrasonic waves each time it detects a bark. This approach may very well solve your problem.

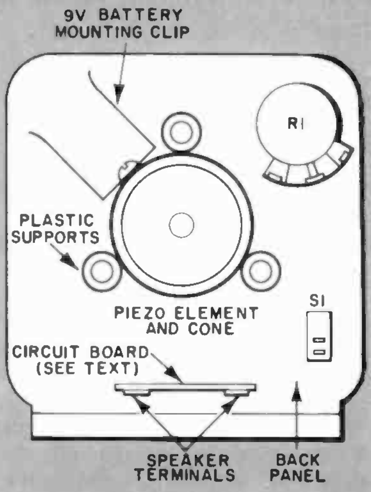

Fig. 9. Assembly of the siren.

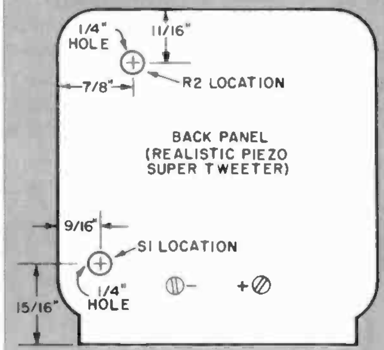

Fig. 10. Back panel of the tweeter.

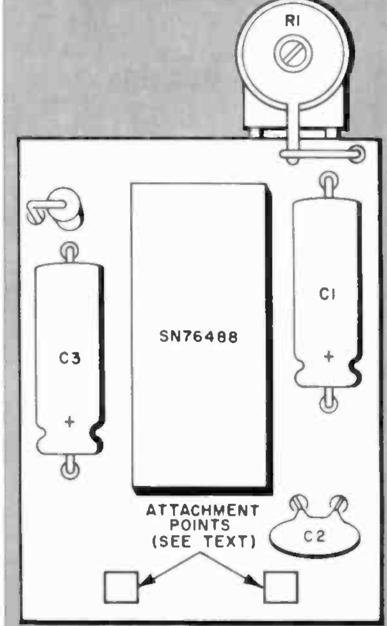

Fig. 11. Parts layout of the siren circuit board.

An Iso-Gate ™ SCR Driver. In "The Electronics Scientist" in the June 1983 issue of C & E, I described a novel line of optoisolators introduced by Dionics, Inc. (65 Rushmore St., Westbury, NY 11590). These optoisolators, which are called Iso-Gates™, employ an integral infrared emitting diode and one or two integrated photovoltaic diode arrays to directly drive the gates of power MOSFETs.

Recently, Dionics announced a new Iso-Gate that *directly* drives sensitive-gate SCRs. When the infrared LED is driven by an incoming 50-mA current pulse, the infrared that is then emitted causes the miniature photovoltaic array to generate a 4-V output pulse having a current of about 50 μA. This pulse is applied directly to the gate of the SCR being triggered.

Since the new Iso-Gate drives an SCR without the help of an external power source, Dionics believes it ". . . provides unprecedented immunity to the normal threats of false triggering and noise problems . . . ." Furthermore, the company notes, "Since the Iso-Gate output acts as its own power supply, it is truly floating and completely removed from the main terminals. Therefore, the output is totally immune to any power supply spikes, surges, or noise-related interference."

Of course, few, if any, electronic components are totally fail-safe. Even an Iso-Gate can be falsely triggered should the LED receive an unintended pulse of current. Nevertheless, it seems safe to assume the Iso-Gate offers considerably more noise immunity than previous SCR triggering methods.

Iso-Gates may have some interesting applications beyond straighforward optoisolation. For example, the Iso-Gate is a true optoelectronic analog of the transformer. It converts a low-voltage, high-current input into a high-voltage, low-current output. In actual practice, the device is not very efficient; but the fact that it multiplies the input voltage by a factor of three suggests possible applications worth exploring.

I'll try to get some sample Iso-Gates for evaluation. In the meantime, if you want more information about the latest Iso-Gate, mention its label, the DIG-11-OH-200F, when you write to the company. The new Iso-Gate is available in a standard miniDIP, TO-5 metal can, or ceramic chip carrier. The devices sell for $2.82 in quantities of 1000.

A High-Resolution LCD. I ave previously discussed liquid-crystal displays like the one used on the Radio Shack Model 100 Portable Computer. This display is capable of showing eight rows of 40 characters each.

While the Model 100 display is certainly impressive, it's only a hint of what's to come in portable, notebook-style computers. By the time you read this, Sharp Corporation will be manufacturing a liquid-crystal display with a remarkable capacity of 16 rows of 80 characters each! The display can also be used for graphics. Its 480-by-128-dot resolution exceeds that of some computers that use CRT readouts!

Sharp's new display has a viewing area that measures 230 by 61 millimeters. This means it will fit nicely in a space not much larger than that occupied by the display in my Model 100. It's obvious, therefore, that the second generation of notebook portables will have as much display capacity as today's desktop machines.

Incidentally, Sharp doesn't plan to slow its development of high-resolution liquid-crystal displays. They are now developing a display capable of showing a full page of text! ◇

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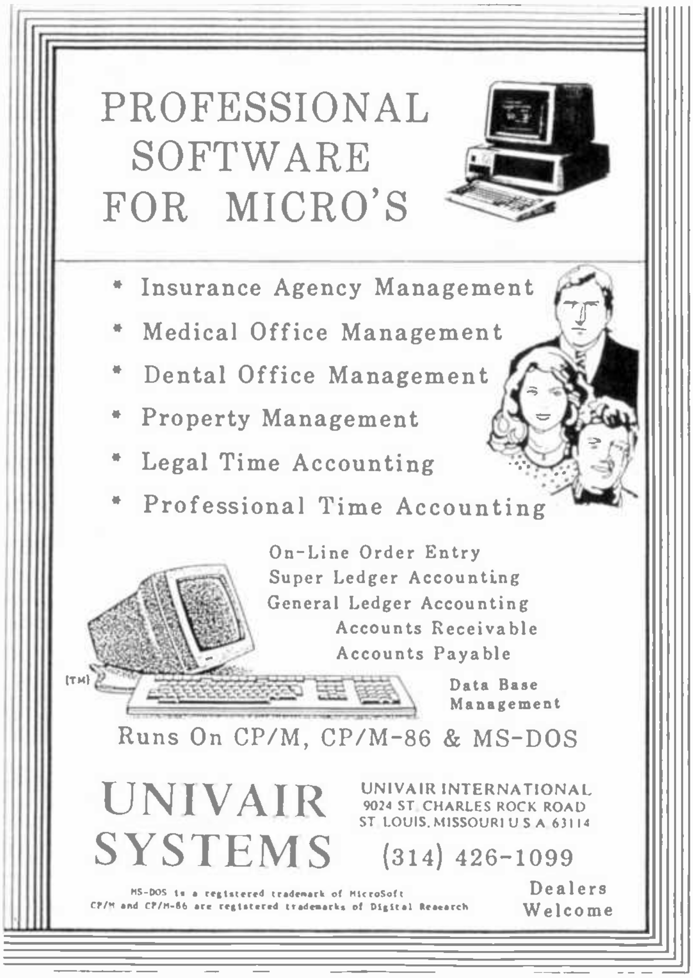

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OPERATION ASSIST

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

Supreme, Inc. Model 655 oscilloscope. Need .5 mfd-1500 VDC capacitor and schematic. George Karastas, 3701 Mt. Aladin Ave., San Diego, CA 92111.

Atari CS-2600. Need schematic and specific information on the I/O port. Paul Yoes, 245 Koy Rd., Bellville, TX 77418.

Crosley Radio Corp. U.S. Army radio receiver and transmitter #3C-654A, Serial #46716. Need repair manual, operations manual and schematic. Michael J. Cedeck, 2903 Gene Lane, Arlington, TX 76010.

Hallicrafters Model PC-210F radio. Need schematics. Narciso R. Villafane, Lemay 108 Ramey Base, Aguadilla, PR 00604.

Weston Model 983 oscilloscope. Need schematic and operation manual. Bill Allen, 35 Eagle St., Terryville, CT 06786.

Zenith Model G4541W Chromcolor II TV. Need schematic or service manual. C. G. Malseed, 331 Penny St., McKeesport, PA 15132.

General Electric Model #GEL-740 radio. Need schematic, instructions, alignment information and service manual. Richard R. Eggergs, 191 N. Park Victoria Dr., Milpitas, CA 95035.

Craig Model 6408 videotape receiver. Need manual, parts list and schematic. T. Langley, 52 Sarles Lane, Pleasantville, NY 10570.

Hammarlund Model HQ100 receiver. Need manual, parts list and schematic. T. Langley, 52 Sarles Lane, Plesantville, NY 10570.

Hickock Model OSK-4 teaching systems oscilloscope Model OSK-4. Need manual and schematic. Mark Abrams, 79 Nichol Ave., New Brunswick, NJ 08901.

Mercury Model 880 picture tube tester. Need instruction book. James E. Stewart, 1607R NE 15th Ave., Fort Lauderdale, FL 33305.

Precision Model ES-500A oscillograph. Need schematic and parts list and/or service manual. Jon M. Sobel, Box 7282, St. Petersburg, FL 33714.

Dumont Model TO-100 television camera. Need schematic and/or service manual. Gary Montgomery, 1011 Westwood Drive, Elkview, WV 25071.

Electrodata Co. Model AG-1 audio generator. Need schematic. R.H. Klapheke, 4113 Sunflower Dr., Louisville, KY 40216.

Conair Model 224 tube tester. Need CRT testing chart and adapter description(s). Jim Vassil, Box 4691, Redding, CA 96099.

Elco Model 625 tube tester. Need schematic and operating manual. John O. Tjebban, 5008 Will-O-Dean Rd., Raleigh, NC 27604.

Hallicrafters Model SX96 receiver. Need schematic, alignment data and operating manual. George Zintak, 8617 S. Karlov, Chicago, IL 60652.

Lafayette HA-800 Receiver. Need schematic and alignment manual. Robert W. Halcro, U.S. Army Element Alfsee, Box 2195, APO NY, NY 09224.

Telequipment oscilloscope Model D61A. Need service manual or schematic. M. Repouic, Box 403, Boston, MA 64080.

General Electric Model M-81 receiver. Need schematic. George Henley, 502 N. Armstrong, Pleasant Hill, MO 64080.

Texas Instruments Model PHP 1700. Need accessories interface. Rovert Fein, 48 Pratt St., Allston, MA 02134.

Educational microcomputer systems Model M68K. Need schematics and documentation. **Motorola** Macsbug monitor. Need assembly language source listing. Joseph R. Stewart, 586 Plain St., Stoughton, MA 02072.

RCA Model TMV-97-B, r.f. oscillator. Need schematic and other available information. Russ Sandman, 560 Forest Hills Blvd., Waverly, OH 45690.

Digicom Data Products Modem Model AC-312. Need manual and schematics. Harold Wright, 7144 Center St., Highland, CA 92346.

EMC Model 502. Need schematic and NTS construction manual and parts list. M.M. Zamir, Box 1253, NY, NY 10451.

Philco Model 37-640 multiband radio and **Lear** model G511 phono and wire-recorder with model WC311A radio. Need schematics, service manuals and source of replacement parts. Mike Miller, Box 105, Bethel CT 06801.

Tennelec memory scan Model MS-1 monitor. Need schematic. Ernest Clark, R.D. 3, Box 426, Homer City, PA 15748.

Hallcrafters SX-4Z. Need schematic, parts list and operating manual. William F. Chapman, Lakeside Village, Wales, MA 01081.

Scott Model 99-C amplifier and **Sinclair** Model X-20 Class-D hi-fi amplifier. Need schematics. Patrick E. Chung, 11 Faulkner Avenue, Duhaney Park, P.A. Washington Blvd. Jamaica, West Indies.

YORX Model M2601 stereo. Need technical manual, schematic, or owner's manual. Roman Budek, 65 Dover Dr., Des Plaines, IL 60018.

Advent VB225 projection T.V. Need schematics and parts list. Waldo Senechal, 2727 Pacific 141, Highland, CA 92346.

Video Systems Corp. Model 2000 video terminal. Need schematic, operating manual and service data. Don Morar, 3663 Hipsley Mill Road, Woodbine, MD 21797.

Mercury Model 204 tube tester. Need meter, charts and schematic. **Philco** 10L43 T.V. Need schematic and picture tube 17DRP4. Tom Schenk, c/o Ed Knapstein, 105 Bradford LN, Madison, WI 53714.

Realistic Model 150-A receiver. Need service manual and schematic. Jesus Pulgar, Box 11243, Santurce, PR 00910.

Precision Apparatus ES 500A oscilloscope. Power transformer needed. Vincent Werdein, 2517 Wehrle Dr., Williamsville, NY 14221.

Automatic Radio Phone Secretary Model TPS-3173. Need instruction manual and schematic. Gary Cook, Box 5, Centerville, MO 63633.

RCA Model 96K2 radio. Need schematic and parts list B. Murray, Route 1, Box 658, Capshaw Road, Harvest, AL 35749.

Analab dual trace scope Type 1120. Need any available information. Peter J. McManus, Box 38, Porter, ME 04068.

Micro-Q Z-80 based controller. Need schematic and operating manual. K.W. Keck, 9201 Hooker, Westminster, CO 80030.

Elco VTVM Model 221. Waterman Products industrial and television pocketscope Model S-11-A. **Precision Apparatus Co. Inc.** tube tester Model 912, Serial No. 16479. Need owners or service manuals and tube charts. Edward Skirel, Wickham Ave., Box 339, Mattituck, NY 11952.

Precision Apparatus Co. Series E-200 C signal generator. Need schematic, operating instructions and service manual. Rustan R. Crespo, 440 59th St., West New York, NJ 07093.

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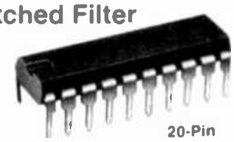

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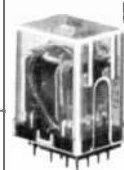

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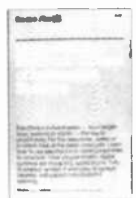

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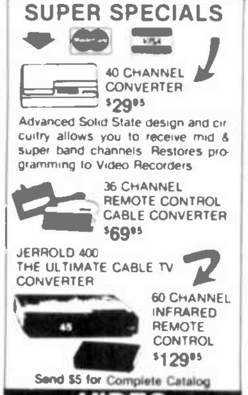

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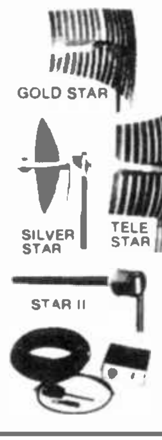

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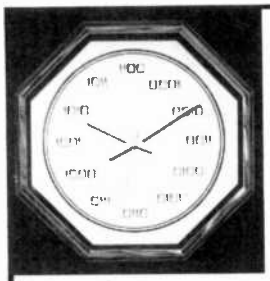

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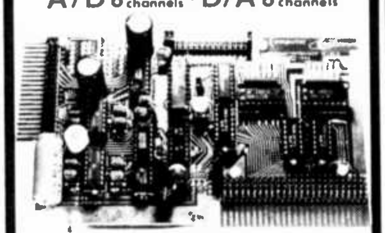

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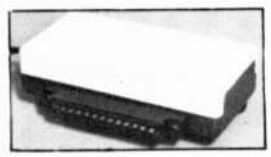

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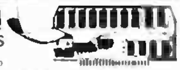

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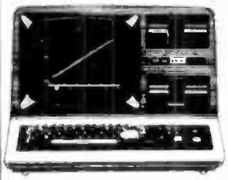

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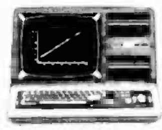

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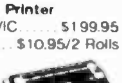

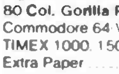

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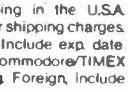

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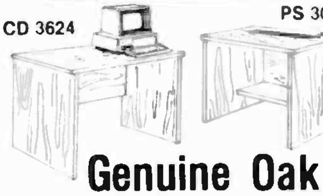

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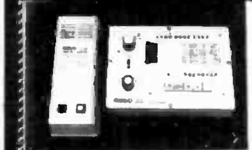

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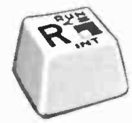

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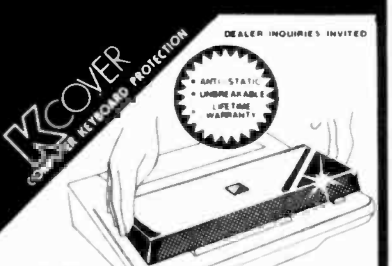

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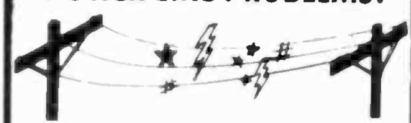

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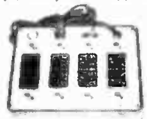

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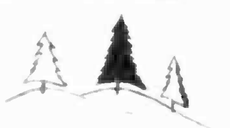

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