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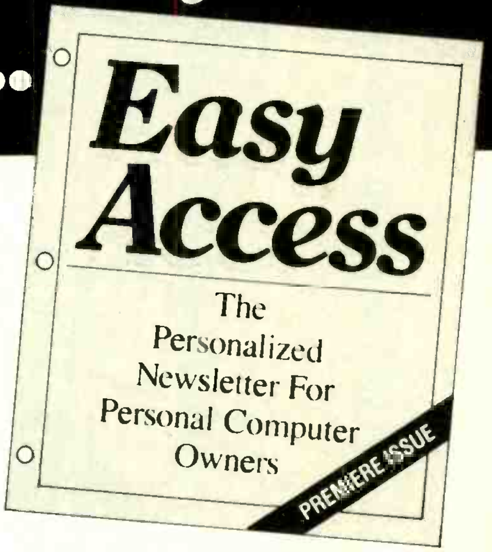
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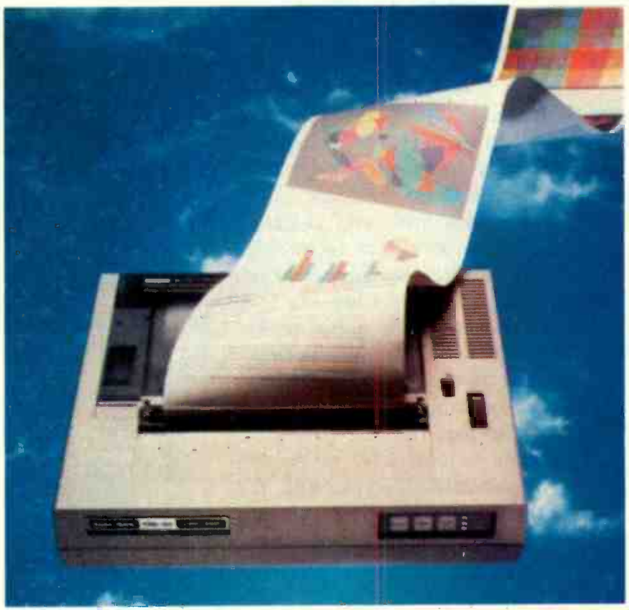

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EDITORIAL

THE SHOT HEARD 'ROUND THE WORLD

By SETH R. ALPERT

IN January, 1975, this magazine published a cover article that captured the imaginations of thousands of people across America.

It sparked new ideas and visions, it heralded a new world of technology, and it inspired a new technological subculture that now touches—or will soon—nearly every person in America.

That article revealed to the world the Altair 8800. It was the very first successful microcomputer.

The Altair and the microcomputer concept were so innovative, so resplendent with possibilities, so exciting, that some of the best and brightest of America's electronically oriented community saw the profound implications. Dreams were spawned in fertile minds. Lights burned late in garages and basements from Boston to San Francisco and a multi-billion-dollar a year industry was launched.

The revolution had begun.

The Minutemen. Now, I am new here, so it will not be immodest for me to boast a bit. Over the years, this magazine and its staff were more than mere reporters, chroniclers, or observers, for they, too, had a "vision." They were more than Paul Reveres of the microcomputer revolution, riding the countryside by horseback heralding the coming of a new and important force. They were also the Minutemen of the age, pushing aside their typewriters to experiment, innovate, and implement new ideas.

In the few short years that followed, the staff and contributors to this magazine (then *Popular Electronics*) introduced low-cost versions for the personal computer marketplace of nearly a dozen major innovations in the microcomputer field, including modems, color graphics, speech I/O, remote control, logic analysis, and the cassette interface.

The results of this ongoing revolution are familiar to us all. The computational power available 10 years ago only to large, highly capitalized corporations and government is now within the grasp of anyone who can afford a fancy color TV or used Volkswagen Beetle.

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Edmund Scientific "Kirlian" Photo Kit
Hewlett-Packard 5381 Frequency Counter

Microcomputers are now a product for the masses. Within years everyone who wants one will have his own.

Exciting New Direction. With this issue, *Computers & Electronics* assumes a new emphasis and direction, signalled by our new logo and format. You might well ask why?

The reason is simple. Alvin Toffler was right—the world is changing fast, very fast. And we must change, too, to keep pace with the needs of our readers. As a matter of fact, this change merely continues a process that has been part of the magazine's evolution since its inception in 1954.

Over the years, we have followed the currents of electronic technology. As the scope of microcomputing grew in the '70s and '80s, so did our coverage.

Since 1982, when we changed our name from *Popular Electronics* to *Computers & Electronics*, we have given our readers what we were always best at—and relied upon for—in-depth explanations and detailed descriptions of the latest advances in electronic technology, with an increased emphasis on microcomputers.

But now, new developments, technology, hardware, software, and new applications are bursting forth with ever-increasing speed.

In the months ahead, *C&E*'s "reason for being" will be to keep readers abreast of up-to-the-minute developments in microcomputer technology, and inform them of the most significant advances in hardware, software, and applications affecting the field.

World's Largest Computer Magazine. Today, *Computers & Electronics* has a paid circulation of over 600,000, the largest of any computer magazine in the world!

The reason more people read us than any other computer magazine is simply because of our long and rich heritage. Over time, this publication has attracted an ever-growing number of individuals keenly—and viscerally—involved in the growing field of electronics. As that field has grown and changed, so have we.

Today, over 432,000 of our readers use microcomputers in their day-to-day lives. On average, our readers—*you*—use a microcomputer 16 hours a week. 390,000 of you use microcomputers on the job. And 306,000 of you personally own one or more microcomputers.

In our business, those are staggering numbers. In fact, more of our readers actually own and use microcomputers than the total circulations of many other magazines in the field.

The revolution continues.

If there is one thing we can all count on it is change. And as it happens we will bring to you authoritative, thorough, and exciting explanations about what is going on, why, its direct applications, and its meaning to you. Whether it be in new chip technology, or a new significant hardware introduction, a breakthrough in software or a novel application, *Computers & Electronics* will be at the forefront of the important innovations.

Join us for the ride to the exciting frontiers of microcomputer technology.

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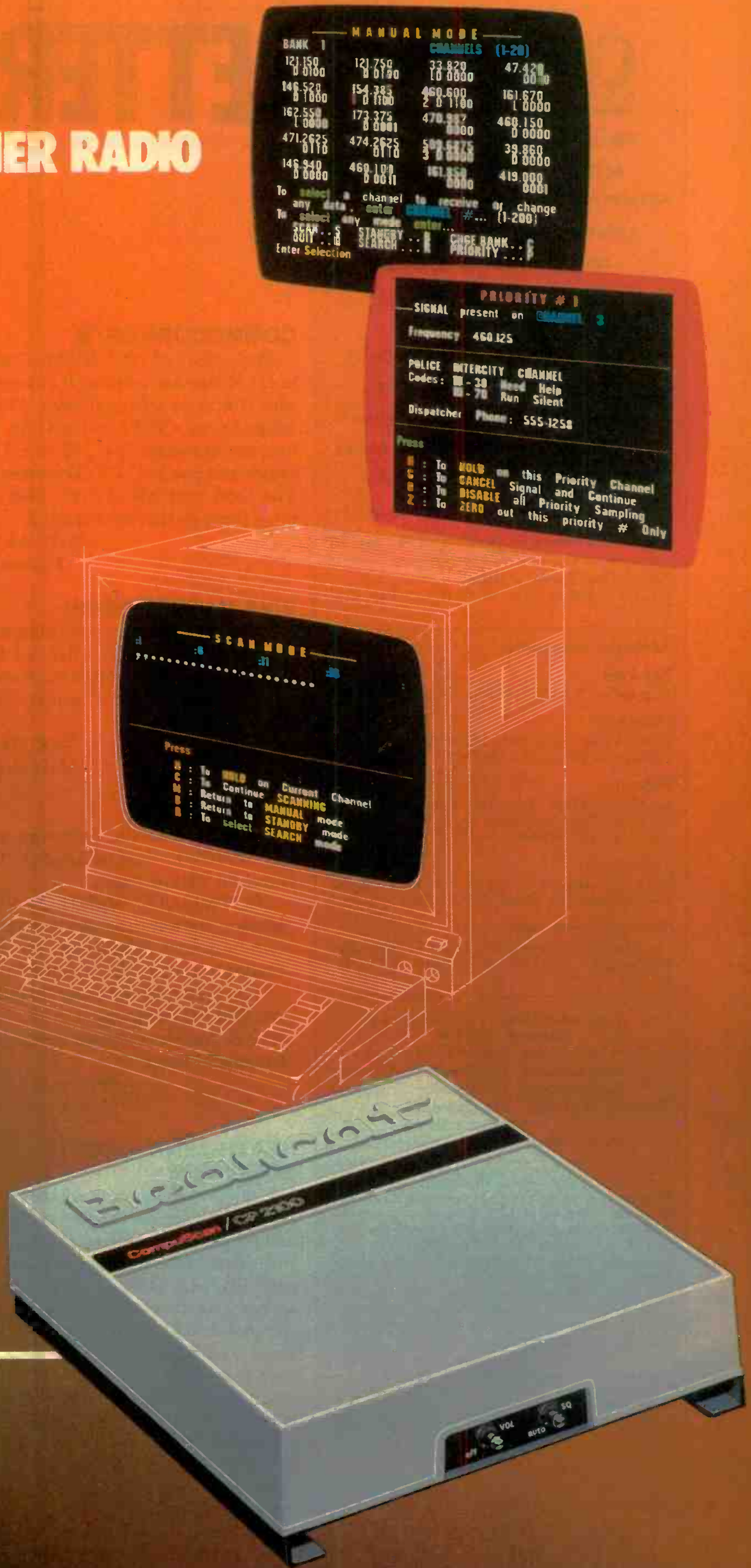
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LETTERS

COMMODORE CP/M

The author of "Bits & Bytes" asked, in his November column, if anyone had seen (for sale) a Commodore Z80 cartridge to run CP/M on the C-64. I got one, accompanied by a 240-page User's Guide and one 5¼" CP/M system disk. The total cost was $59.99, plus shipping, through the Sears catalog.

—W.H. ANTRIM
Tucson, AZ.

VIVA MATCHMAKER!

The story "Matchmaker, Matchmaker; Interfacing with Parallel and Serial Ports," in your November issue was excellent. How about a sequel on the IEEE-488 GPIB.

—R. REITER
McHenry, IL.

BAUDY HOUSE

I recently saw the following ad on BUY-PHONE, the Los Angeles "Computerized Yellow Pages."

> ROOMMATE WANTED: I am looking for a roommate to share a two-bedroom apartment in San Gabriel. Rent is $225/month.
>
> You also may have partial use of my IBM PC computer. . . .

Is Los Angeles setting a trend toward "Room and Baud"?

—WILLIAM LAPPEN
Los Angeles, CA.

HEATH-ZENITH AND IBM SOFTWARE

I enjoyed the review of the Heath/Zenith 120 microcomputer in your October issue, but would like to take issue with some of the statements about compatibility with IBM PC software. The author said that IBM software is not compatible with the 100 series and vice-versa. This is not completely true. Here are a few points.

Zenith's ZDOS and IBM's PC-DOS are both customized versions of Microsoft's MS-DOS. They share a common set of BIOS calls that are accessed by software interrupt #21. In addition to these standard BIOS calls, both machines have advanced features that can be accessed through other interrupts or calls to routines in ROM. The point is that programs that stick to the standard operating system calls will run on both machines.

With regard to disk formats, the Z-100 machines use the same disk format as the IBM PC. This is a double-density, 8-sector per track, 40 tracks per side, single- or double-density format. The IBM allows the user to extend the normal 8 sectors per track to 9. This boosts formatted capacity on double-sided disks from 320K to 360K. I think the Z-100 supports only the 320K format.

Regarding BASIC, the Zenith version, Z-BASIC, has a great deal in common with IBM's BASIC-A. Like ZDOS and PC-DOS, the BASIC systems were customized by Microsoft starting with the same source. The main difference is in the handling of graphics. The Zenith machines have a much higher degree of color resolution than IBM. Most BASIC-A programs can be converted to Z-BASIC without too much effort. One may have to store programs in ASCII if they are being moved via disk.

—G. F. ROBERTS
Knoxville, TN.

A POX ON HEX, ETC.

"Math with binary, octal, and hex.
Sometimes, the best of us will vex.
Especially when we are taught.
From pix with errors that are fraught."

—R. I. RUBY
Beverly Hills, CA.

Yes, in the December issue, in the article "Number Systems for Microcomputers," the illustrations wound up with the wrong captions. Obviously, Fig. 1 (octal) should have been the diagram based on 8's; Fig. 3 (hex) should have been based on 16's; and Fig. 4 (binary) should have had the 2's.—ED.

FAIL-SAFE, REAL-TIME CLOCK

In my article "Fail-Safe, Real-Time Clock for TRS-80" (December, p. 82), *IC3* is incorrectly labelled on the schematic. It should be 74LS30, as given in the Parts List. Also, the address given for ordering parts from Appcomp, in the Parts List, should be 8578 W. 67th Pl., Arvada, CO 80004.

—JOHN C. MEIN
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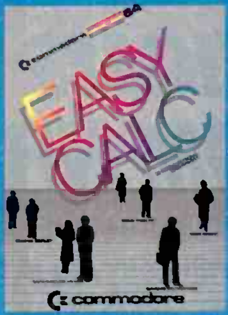
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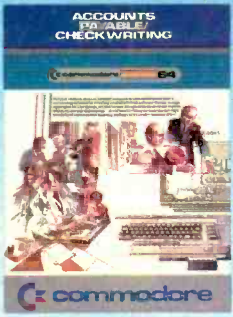
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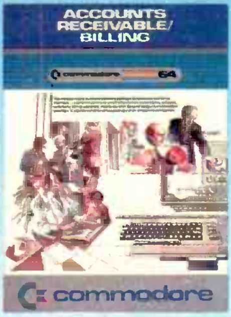
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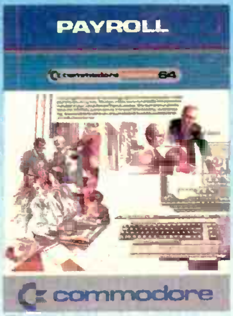
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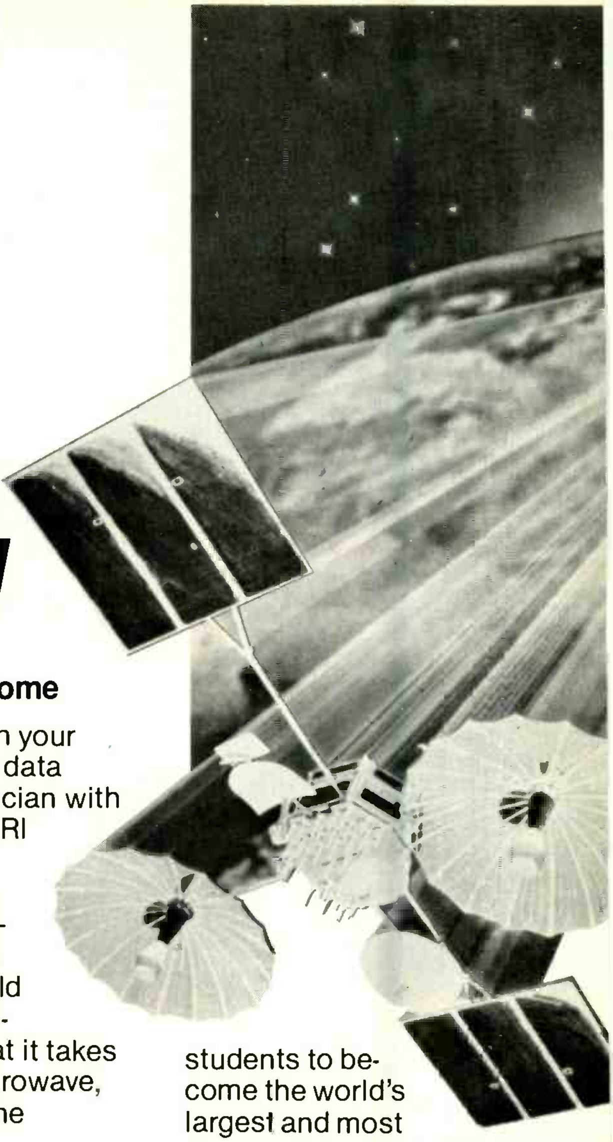

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And you'll learn at your own comfortable pace, without classroom pressures or evenings away from your family. Over the past 70 years, NRI has taught the latest high-tech skills to almost 2 million students to become the world's largest and most successful school of its kind.

Hands-on training includes computer, modem, breakout box and much more

NRI takes you far beyond "book learning." As part of your course, you receive plenty of practical

Training includes all this equipment you keep . . . 16K computer, modem, breakout box, digital multimeter and the exclusive NRI Discovery Lab.

hands-on training that gives you real-world skills. You get the Radio Shack Color Computer, with 16K memory to teach you the systems and language of data communications plus you get an operating modem to let you tie in with world-wide communications networks.

You build your own RS-232C interface breakout box, an indispensable installation and trouble-shooting instrument you'll use throughout your career.

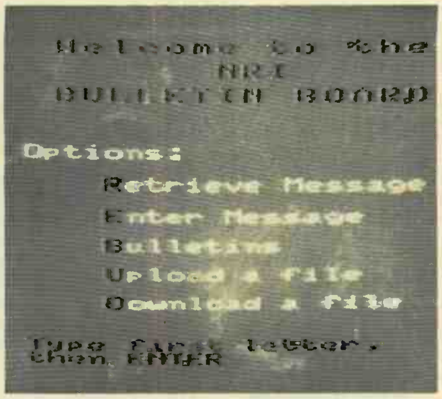
You receive a professional digital multimeter and the NRI Discovery Lab, where you construct solid-state circuits and demonstrate practical applications of the theory you've learned.

Learn on-line with the exclusive NRI data network

You'll learn what data communications is all about by actually becoming part of an operating network. Using your computer, modem, and terminal software, you'll go on line to "talk" to your instructor, take your final exam by computer link, communicate with other NRI students and leave messages on the NRI "bulletin board."

As part of your course, you'll also receive membership in THE SOURCE℠, a regular $100 value. A phone call ties you into computers loaded with instant news, stock quotes, electronic mail, educational programs, games, even discount shopping and travel reservations.

Tie into the NRI network using computer, software, and modem you get as part of your training.



```
  Welcome to the
       NRI
  BULLETIN BOARD

Options:
     Retrieve Message
     Enter Message
     Bulletins
     Upload a file
     Download a file

 Type first letter,
 then ENTER
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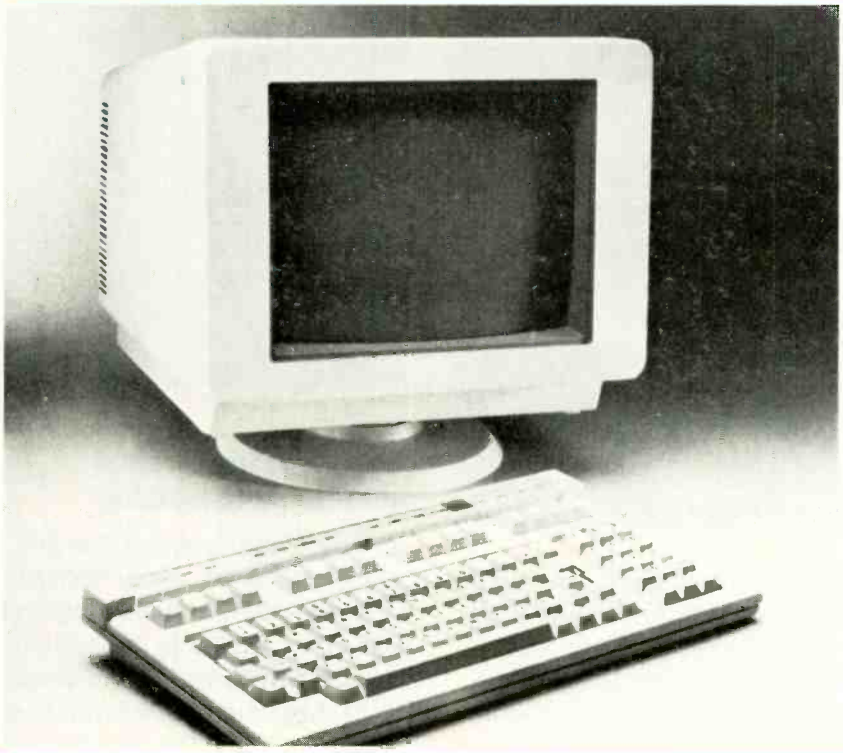
TRS-80 is a trademark of the Radio Shack division of Tandy Corp. SM a service mark of Source Telecomputing Corp., a subsidiary of the Reader's Digest Association, Inc.

NEW PRODUCTS



PC-COMPATIBLE WORKSTATION

Digital Microsystems Model DMS-816 workstation allows users to run MS-DOS or CP/M programs on the company's HiNet local area network. It duplicates the functions of IBM's ROM for I/O and has an IBM-compatible monochrome video display and keyboard with all the functions of the IBM PC. The company claims that 90% to 95% of the business applications programs that run on the IBM PC will run in the workstation. The DMS-816 has an integrated 12″ video monitor and detachable low-profile keyboard; Z80A and 8088 processors; 256K (expandable to 512K) of RAM; 500K-baud RS-422 network port; 19.4K-baud RS-232 printer port; and parallel port. Software included with the computer consists of MS-DOS, Perfect Writer, Perfect Calc, Perfect Speller, and Perfect Filer. $1695 for the DMS-816, $500 for HiNet/PC system software to manage the network.

Circle No. 83 on Free Information Card

COMMUNICATIONS SYSTEM

Cygnet's "CoSystem" is a microprocessor-based voice, data, and simultaneous voice/data communications system that functions independently and synergistically with personal computers. In addition to simultaneous interoffice voice and data teleconferencing, CoSystem offers such features as: electronic mail; speed dial; last-number memory; automatic redial from an extended directory; programmable function keys; automation of special PBX calling functions; automatic database access; terminal emulation; detailed records of all communications activities; and calendar/time management. The system is available in 300-baud ($1495) and 1200-baud, 212A ($1845) modem versions. Current models are for use with IBM PC, Compaq, and other computers operating under MS-DOS. An optional speakerphone costs $150. **Address:** Cygnet Technologies, Inc., 420 Lexington Ave., New York, NY 10170.

DATABAR
OSCAR

LOW-COST BAR-CODE READER

A compact, low-cost optical scanner called "Oscar" (Optical SCAnning Reader) from Databar Corp. can be used to scan bar-coded data for entry into popular makes of home computers like those from Atari, Commodore, Radio Shack, Texas Instruments, and Timex/Sinclair. Use of Oscar all but eliminates the need for tedious entry through the computer's keyboard. $79.95, includes premier issue of a new monthly magazine with bar-coded programs written in BASIC. Subscription rate for the magazine is $10 per month.

Circle No. 84 on Free Information Card

PLOTTER FOR PERSONAL COMPUTERS

The Model CR-1810 ComScriber I plotter from Comrex offers low-cost plotting on either paper or transparencies for personal computer users. Its pen produces high-resolution letters and graphics symbols with an accuracy of 0.00025" and a pen travel speed of up to 6" per second. Pen motion is user controllable via a 12-key touchpad. Though the plotter is basically a single-pen device, multiple-color plots can be performed, using a built-in pause feature that makes it easy to change pens. The basic plotting area measures 8½" × 11", but the length can be extended to as much as 20". Character height can range from ⅛" to 20". The plotter uses standard pens, paper, and transparencies. It measures 14.3"W × 8.8"D × 2.9"H and weighs 7.25 lb. $695.

Circle No. 85 on Free Information Card

COMPUTER COMMUNICATIONS TERMINAL

The Model RM1000 radio modem from Macrotronics is a hardware/software system that converts personal computers into communications terminals that support Morse, Baudot, and ASCII codes. It has multistage active filter demodulators with dual LED bargraph tuning displays for Morse code and RTTY reception and offers three RTTY shifts. A crystal-controlled AFSK tone generator provides stable RTTY keying, while relays are used for push-to-talk and Morse code transmitter keying. A hardware clock displays time, which can be inserted into the text. The software's multilevel split-screen format displays transmitted and received text in chronological order, and a review window permits viewing and editing of text that has scrolled off-screen. Sixteen programmable messages can be linked and are dynamically allocated. A buffered ASCII parallel port permits printing of current text or text in the review window. **Address:** Macrotronics, Inc., 1125 N. Golden State Blvd., Suite G, Turlock, CA 95380.

RM 1000
Radio Modem

SOFTWARE SOURCES

Financial Analysis Program. Profin from Business Software is an easy-to-use financial-analysis software package for use in personal computers. It is designed to assist users in evaluating all financial criteria involved in an investment before making a decision. It forecasts and budgets investment possibilities and analyzes discounted cash flows, returns on investments, and capital expenditures. The user does not have to set up mathematical calculations or lay out a spreadsheet. Profin is written in Microsoft BASIC V5.2 and runs under CP/M-80, MS-DOS, PC-DOS, and CP/M-86. It requires a minimum of 64K of RAM and 240K of disk storage. Available through software dealers.

Communications Utility. BLAST (BLocked ASynchronous Transmission) from Communications Research Group is now available for the **IBM PC, Apple, CP/M,** and **MP/M** computers, for transferring binary and text files between computers, with terminal emulation to mainframes. The programs employ a high-level SDLC/HDLC type protocol for reliable transfers in both directions simultaneously over the telephone lines. It converts text files to the format required by the other system and features text file uploading and downloading and supports auto-dial/auto-answer modems. $250. **Address:** Communications Research Group, Inc., 8939 Jefferson Hwy., Baton Rouge, LA 70809.

Graphics for Pocket PCs. PocketGraph I from PocketInfo Corp. is designed for use in Radio Shack **TRS-80** PC-2 and **Sharp** PC-1500 hand-held computers. It can be used to draw bar, line, pie, and scatter graphs with the computers' 4-color plotters. A user-defined function can be plotted for any range of values. Data is entered into a variable-size matrix ranging from 99 rows to 99 columns. Data can come from the PocketCalc IV spreadsheet program. $29.95 cassette tape. **Address:** PocketInfo Corp., 7795 S.W. 184 St., Beaverton, OR 97007.

What's on the best-seller list in IBM Personal Computer software?

6
NET PAY
IRA
FEDERAL
STATE
FICA
LOCAL

Games can make anyone
a winner while treating
you to hours of fun
and fantasy.

Payroll can boost your
productivity and make employee
deductions less taxing.

Word processing can
give any writer
visible support for
creating and editing.

Electronic spreadsheets help
build financial models that
can shape your future.

Inventory control can help put you on top by keeping track of what's what and where.

Languages like BASIC can encourage students to write programs of their own.

Stock monitoring can help put you in the chips by tapping the world of Wall Street.

Accounting can give you a leg up when balancing the books.

Data management can help tame your file of names, numbers, facts and figures.

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CIRCLE NO. 41 ON FREE INFORMATION CARD

NEW PRODUCTS

"FAMILY PACK" COMPUTER

Franklin has combined a number of items with its Apple II work-alike ACE 1000 personal computer to produce its new "Family Pack" aimed at the home user. The Family Pack includes a selection of educational and recreational software, a home finance software package, joystick, and BASIC programming manual. $1495.

Circle No. 86 on Free Information Card

ELECTRONIC TYPEWRITER INTERFACE

Selectone's Model AR-180 Micro-Type is designed to interface Adler 1010/1011 and Royal 5050/5011 electronic typewriters with personal computers. Using Intel's 8031 microprocessor, it provides an RS-232C and a Centronics parallel interface on a single circuit board that easily installs inside the typewriter. Readily accessible DIP switch programming allows the user to configure the typewriter to most computers and word-processing packages. Other features include: 4K buffer; computer control of tabs, margins, underlining, boldfacing, superscripting, subscripting, and linefeeding; and compatibility with most common baud rates and handshaking protocols. **Address:** Selectone, Computer Prods. Div., 28301 Industrial Blvd., Hayward, CA 94545.

GIVE SIGHT TO YOUR COMPUTER

Micromint's Micro D-CAM digital image sensor gives the gift of sight to personal computers. It uses a 256 × 128 silicon array and menu-driven software to interpret, enhance, and store images in a computer. Applications include creating graphics, recognizing patterns and characters, robotics, process control, and security. The device features continuous exposure control and is claimed to be easy to incorporate into any user application. Supplied software includes utilities for automatic exposure, multilevel greyscale generation, screen dumps, picture storage, and image enhancement. It comes with interface card, extension cable, optic RAM, lens, remote housing, manual, and utility software. Versions are currently available for the IBM PC and Apple II and can be specially ordered for RS-232 interfaces. $295.

Circle No. 87 on Free Information Card

SOFTWARE SOURCES

Word-Processing System. AlphaBit's Lazy Writer word-processing system is now tailored for use in the Radio Shack **TRS-80** Model 4 computer. This version makes use of the better screen display on the Model 4 by displaying text in 80 × 24 format and is fully compatible with text created on the 64 × 16 version used in the Model I and III computers. The Model 4 version consists of two sets of programs, one to use in any Model III DOS, the other with Radio Shack's new TRSDOS V6. Another version of Lazy Writer is available for use in the Lobo MAX-80 computer operating under LDOS. $175 for both versions. Current Lazy Writer users can obtain upgraded versions for $39.95. **Address:** AlphaBit Communications, Inc., 11349 Michigan Ave., Dearborn, MI 48126.

Speedy Basic. APCBASIC from American Planning is now available for the **IBM PC** computer, virtually all **S-100** systems, and most other personal computers running under **CP/M-80** and **CP/M-86**. The language provides unique functions and capabilities while reportedly retaining the friendliness and ease of use of a limited **BASIC** for beginners. Among APCBASIC's features are: 50 functions, 18 commands, and 42 statements; exact BCD arithmetic that eliminates rounding errors; and multiple buffers that maximize disk throughput. An included Runtime version further speeds execution by up to 50%. **Address:** American Planning Corp., Suite 243, 4600 Duke St., Alexandria, VA 22304.

Advisor. Three programs that enable a personal computer to act as an advisor to its human operator during difficult moments in dealing with other people are offered by Human Edge Software Corp. The three products, The Management Edge, The Negotiation Edge, and The Sales Edge elicit from the user, in conversational English, information about himself, the situation, the goal, and the opponent or employee. The information is combined and analyzed by the program, and the user is provided with an easy-to-read printout that "walks" him through the proper scenario to achieve the optimum resolution to the situation. Each program, $250.

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Bandwidth	60 MHz	60 MHz	100 MHz
No. of Channels	2	2	2 + Trigger View
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Vert/Trig B/W Limit	—	—	Yes—20 MHz
Single Sweep	—	—	Yes
Accuracy: Vert/Horz	3%	3%	2%
Delay Jitter	1:5,000	1:10,000	1:20,000
Trigger'g Sensitivity	0.4 div at 2 MHz	0.4 div at 2 MHz	0.3 div at 10 MHz
Input R-C	1MΩ –30pf	1MΩ –30pf	1MΩ –20pf
Variable Holdoff	4:1	4:1	10:1
Price	$1200†	$1450†	~~$1950†~~ Now $1650†

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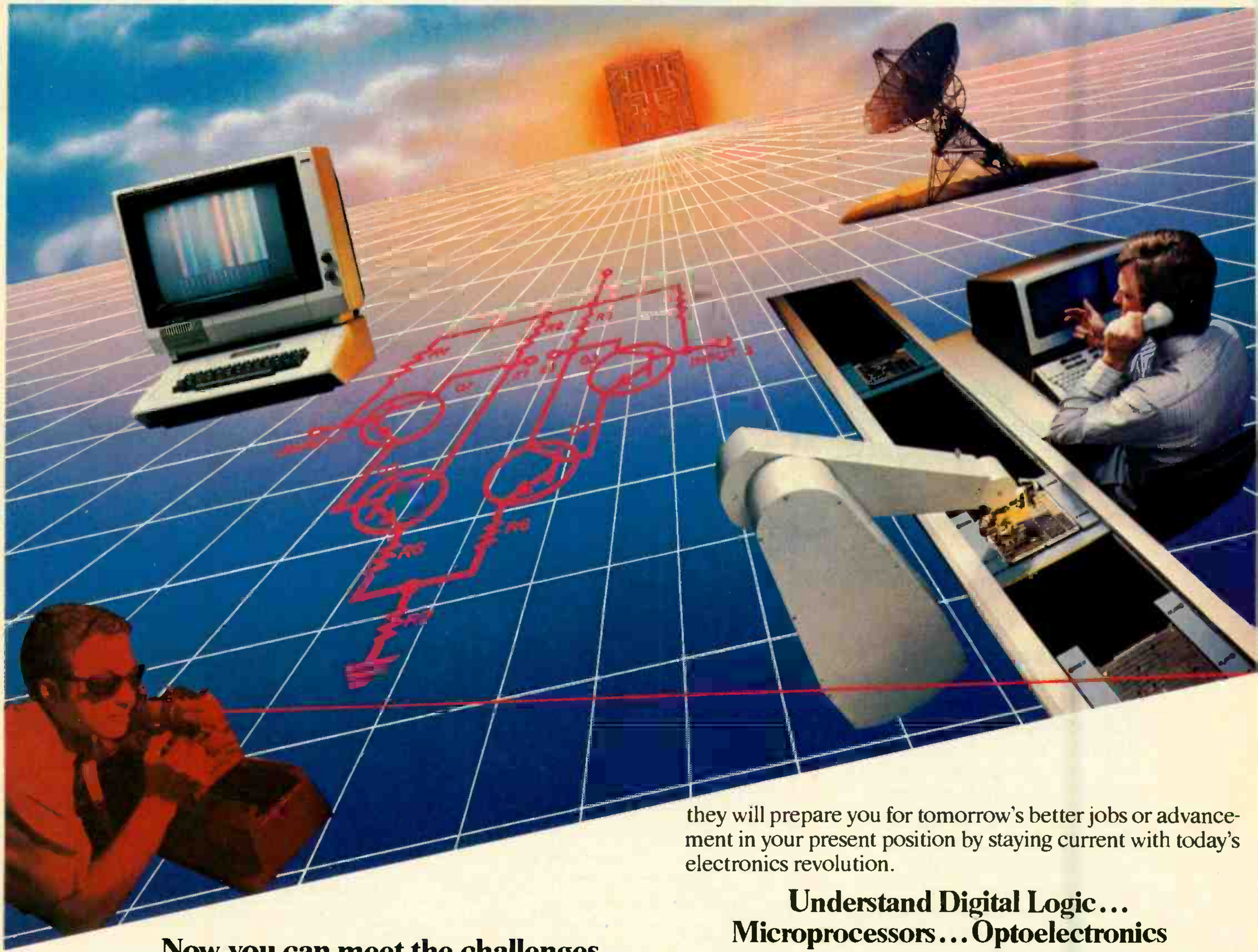
Contemporary



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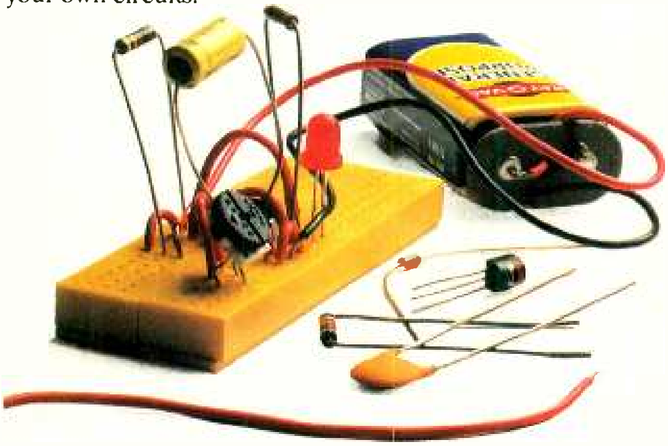
This essential hands-on experience with actual electronic components gives you a clear and simplified understanding of contemporary electronics. Every module will include additional components that you mount on your expanding Explorer Lab system. You'll use your Lab throughout the Series and later to design, build, and test your own circuits.



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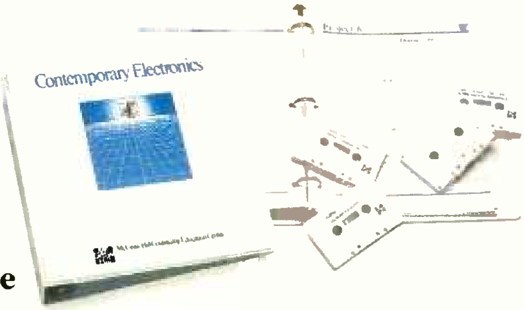

Update Your Knowledge of the New Electronics

This program is for anyone who has an interest in electronics. It's designed for you whether you are someone looking to find new directions in this wide open field... or the kind of person who wants to understand what's going on in the world around you... you could be a teacher who would benefit from a refresher course in contemporary circuits, components, and applications... a manager or supervisor in an electronics related business or industry... an engineer in another field who finds electronics playing an ever more important role in your work. It's even for the electronics engineers and technicians, or people with similar backgrounds who feel their training is out-of-date.

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NEW PRODUCTS

VERSATILE DISK-READING COMPUTER

Vector Graphic's Model 4-S computer can read a range of soft-sectored floppy-disk formats. It automatically detects if a disk was created under MS-DOS or CP/M-86 and reads 8- and 9-sector single- and double-sided disks with 48- and 96-tpi formatting. It also offers 737K formatted storage capacity. The included CP/M-86 (MS-DOS 2.0 is optional) allows CP/M-86 and MS-DOS to reside on the same hard disk. Other software included with the 4-S consists of a GSX-85 graphics package, 8-bit CP/M simulator and MBASIC, and software development tools. Hardware consists of Z80B and 8088 processors; 128K (expandable to 256K) of RAM; detached keyboard; 12″ hi-res graphics display; two modified S-100 expansion slots; tone generator; and one serial and two parallel ports. The 4-S system is available with different drive configurations, ranging from single and dual minifloppy drives to a single minifloppy drive with 5M, 10M, or 36M hard-disk systems. $3295 to $9995.

Circle No. 89 on Free Information Card

IBM PC-COMPATIBLE DESKTOPPER

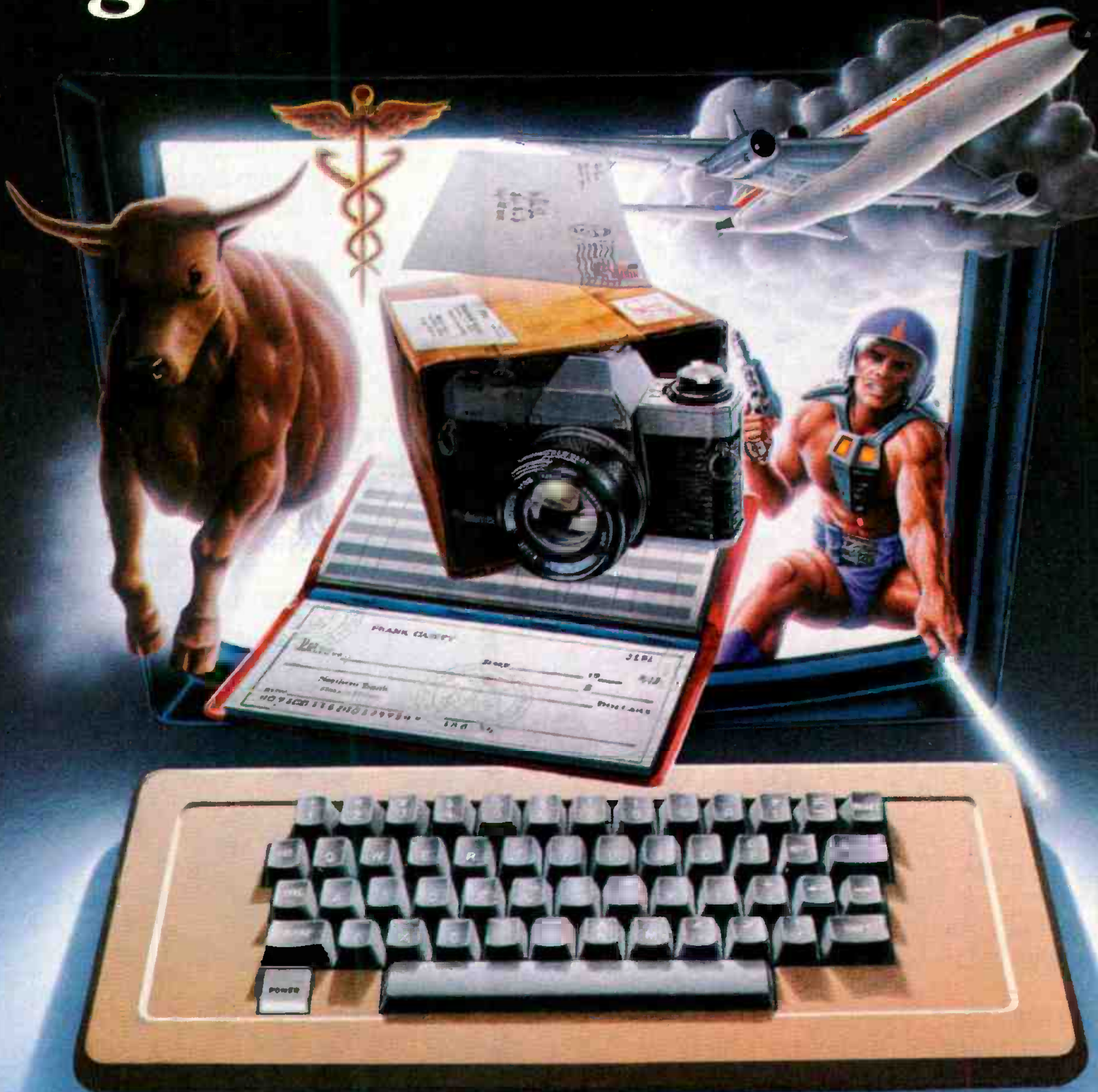
TeleVideo's Model TS 1605 16-bit personal computer is claimed to be fully hardware and software compatible with the IBM PC. The 8088-based computer comes with 128K (expandable on-board to 256K) of RAM; two half-height 368.6K floppy disk drives; RS-232 asynchronous serial port; IBM-style DB-25S parallel printer port; detached IBM-style keyboard; and 14″ green video display monitor. It can display up to 80 characters by 24 lines and hi-res graphics of 640 × 200 pixels.

Circle No. 90 on Free Information Card

SOFTWARE SOURCES

Information Processor. The Concentric Information Processor (C.I.P) is a database/information-management and report-writing program for the IBM PC and PC compatibles. It allows users to do their work directly on the screen, just as it will appear in final reports. The program, from Concentric Data Systems, Inc., is distinguished from other products in the database category not only by its broad application of visual techniques, but also by an extensive on-line help system that allows even first-time computer users to become productive quickly. C.I.P. is operated using single keystrokes, and requires no command language. Features include: horizontal scrolling for 132-column capability with an 80-column display, built-in calculation facility, and in-place file reorganization that accommodates the changing needs of a user without adversely affecting the information within a file. C.I.P. can be used with other products such as VisiCalc or Lotus 1-2-3. **Address:** Concentric Data Systems, Inc., 18 Lyman Street, Westboro, MA 01581; 617-366-1122.

We don't care which computer you own. We'll help you get the most out of it.



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CompuServe is the easy to use videotex service designed for the personal computer user and managed by the communications professionals who provide business information services to over one fourth of the FORTUNE 500 companies.

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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.

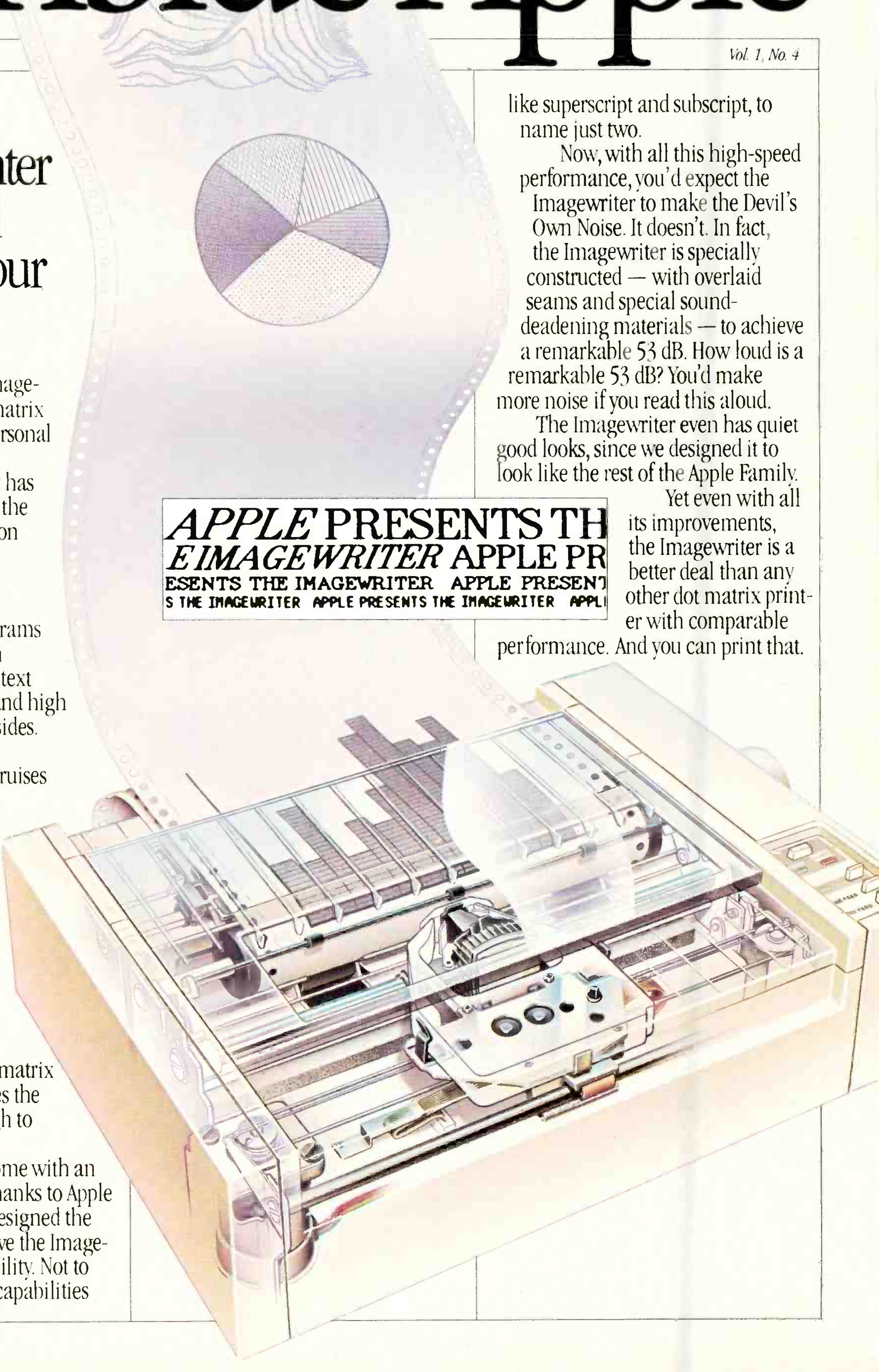
What's more, the graphics dump is up to 60% faster than other comparably priced dot matrix printers. And that makes the Imagewriter fast enough to handle the Lisa™

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.

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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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.

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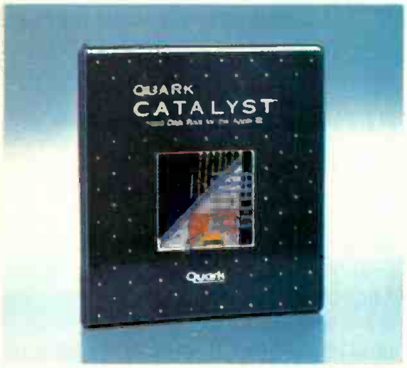
So if you have an Apple III and a ProFile and more floppies than you care to flip through, get yourself a Catalyst. And boot those disks for good.



Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014. For the authorized Apple dealer nearest you, call **(800) 538-9696.** *In Canada, call* **(800) 268-7796** *or* **(800) 268-7637.** *© 1983 Apple Computer Inc.*

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NEW PRODUCTS

IBM COMPATIBLE PORTABLE

The Model RL-H7000 Senior Partner from Panasonic is an IBM-compatible computer bundled with a wide range of software. The 8088-based computer comes with 128K (expandable to 512K) of RAM and a 320K floppy-disk drive, with room for an optional second drive. It features a built-in 80/132-column thermal printer; 9" 80 × 25-character green video display; color graphics capability with RGB output; Centronics parallel and RS-232 serial ports; and a slot for an optional IBM-compatible expansion card. Software included with the Senior Partner includes: MS-DOS, Wordstar, VisiCalc, PFS File, PFS Graph, PFS Report, and GW BASIC. The computer is claimed to be able to run virtually all IBM software without modification, and its keyboard accepts IBM overlays. The 28.7-lb Senior Partner measures $18\frac{1}{4}'' \times 13\frac{3}{16}'' \times 8\frac{1}{4}''$. $2495.

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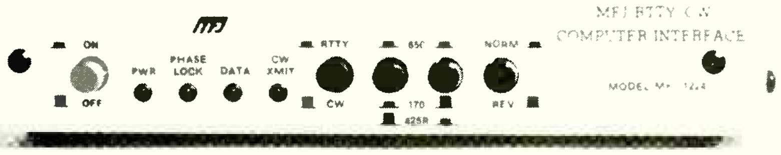

RTTY/ASCII/CW INTERFACE

The Model MFJ-1224 Computer Interface from MFJ Enterprises, Inc. lets radio operators use a personal computer as a full-feature RTTY/ASCII/CW send/receive communications station. The device copies on both mark and space and contains an automatic noise limiter and an eight-pole active filter for 170-Hz shifts to assure good copying under varying signal conditions. It uses Kantronics software that features split-screen display; 1024-character type-ahead buffer; 10 message ports of 255 characters each; status display; CW-ID from keyboard; Centronics-type printer compatibility; and send/receive speeds of 5 to 99 wpm on CW, 60/67/75/100 wpm on RTTY, and 110/300 baud on ASCII. $99.95 plus $4.00 for shipping.

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SOFTWARE SOURCES

Data Transfer. The Copylink communications package from U.S. Digital Corporation allows high-speed transfer of text and program code between dissimilar computers and operating systems, as well as providing access to public database services, Telex and TWX capability, unattended data transfer, and emulation of both smart and dumb terminals. Other features include: manual- and smart-modem support, advanced dialing features and null-modem (direct wire) transfers to 19,200 baud. Documentation includes a manual and a 334-page book, "The Complete Handbook of Personal Computer Communications." $99.

IBM PC Tutorials. Cdex Corporation has released two comprehensive training tutorials for users of the **IBM PC** and PC-compatible computers. The two products, "How to Use Your IBM PC with PC-DOS" and "How to Use Your IBM PC with CP/M-86 and Concurrent CP/M," each include four diskettes of interactive instruction and a reference guide of important keystroke sequences and operating system commands. The programs are menu driven, and users can choose depth and pace at which they learn. $69.96. **Address:** Cdex Corp., 5050 El Camino Real, Suite 200, Los Altos, CA 94022.

Idea Processor. "Docupower!" from Computing! is an idea organizer that works with any word processor. The product asembles your random paragraphs, sections, pages, or any other word-processor texts into a master indexed resource file of usable ideas. There's no need to retype anything you've already typed; just pick the sections you want from the master index to automatically create new texts, reports, letters, proposals, school themes, articles, etc. After you mark any sections, paragraphs, or groups of pages of text you think you may use again, Docupower! adds the material selected to a master resource file and automatically makes an index, sorted by category. The program is available in 20 disk formats for all **CP/M, CP/M-86** and **IBM PC**-compatible computers. $149. **Address:** Computing!, 2519 Greenwich, San Francisco, CA 94123.

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Compare the Tandy TRS-80 Model 2000 to the IBM® Personal Computer

Price Comparison[†]	Tandy Model 2000	IBM Personal Computer
Base Unit	$2750	$2104
2nd Drive	Included (720K)	$529 (320K)
Monochrome Monitor	$249	$345
Display/Printer Adapter	Included	$335
128K RAM	Included	$165
RS-232	Included	$120
MS-DOS 2.0	Included	$60
Total Cost[*]	$2999	$3658
Feature Description	**Tandy Model 2000**	**IBM Personal Computer**
Internal Memory	128K Standard	64K Standard
Disk Capacity Per Drive	720K	160K or 320K (optional)
Microprocessor Clock Speed	8 MHz	4.7 MHz
True 16-Bit Microprocessor	Yes (80186) 16-bit/16-bit data path	No (8088) 16-bit/8-bit data path
User-Available Expansion Slots[*]	4	2
Graphics Options		
Color Resolution	640 × 400	320 × 200
Number of Colors	8	4
Monochrome Resolution	640 × 400	640 × 200

[*] Comparable IBM configuration with monochrome adapter and display, communications adapter, two 320K disk drives and 128K RAM.
[†] Manufacturer's pricing as of 9/1/83.

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3. **NTS Microprocessor Trainer** is included in our Industrial and Microprocessor Technology Course. It is a portable unit, contained in a convenient high-impact carrying case. Hardware/ Firmware includes Monitor Operating System-Expandable User Memory-User Experimental On-Board Section-Breakpoint Editor-Single Step Trace-Cassette I/O.

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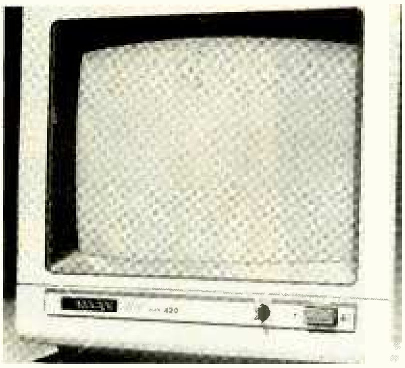
NEW PRODUCTS

DUAL SERIAL CARD

STM Electronics has a dual RS-232C serial card for its CP/M-based Pied Piper portable computer. The card provides two 110-to-9600-baud asynchronous/synchronous serial ports and is software controlled to eliminate the need for setting DIP switches. Users can readily configure the two ports to be either synchronous or asynchronous and adjust baud rate to meet different requirements. $120. **Address:** STM Electronics Corp., 525 Middlefield Rd., Suite 130, Menlo Park, CA 94025.



RGB/COMPOSITE-VIDEO COLOR MONITOR

Taxan's new RGBvision Model 210 is an RGB and composite-video color monitor for the Apple II+ and IIe computers. Its medium-resolution display capability offers 380 lines resolution with 0.63-mm slit pitch, and a 15-MHz bandwidth. The composite-video mode is NTSC standard and offers 2 watts of audio output power. It features on/off-volume and contrast controls up front and brightness, sharpness, color, and hue controls on the rear. A removable antiglare screen is provided. $399.

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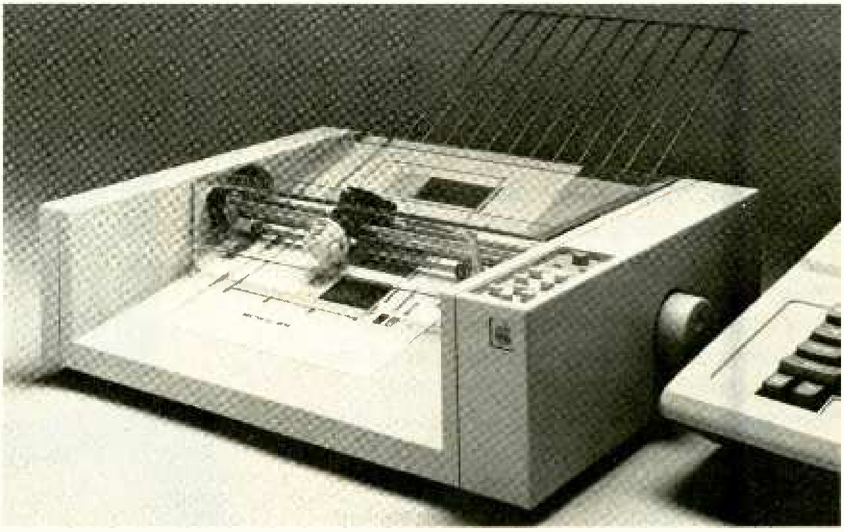
COMPUTER/VIDEO INTERFACE

A new computer/VCR interactive interface and authoring system for the Commodore VIC-20 and C-64 computers has been announced by Videobook Corp. The Prometheus interface connects the computers to any Panasonic 5000, 6500, or 8500, Canon, or Hitachi VCR. A retrofit modification kit for solenoid VCRs that lack the required input plug will soon be available. $49.95. **Address:** Videobook Corp., PO Box 19597, Seattle, WA 98109.



COLOR PLOTTER

A multi-color plotter, Model 410, that produces presentation-quality graphs and charts on paper and transparencies has been introduced by Apple. The plotter is compatible with Apple Business Graphics and many other software programs that utilize the high-resolution, multi-color graphics capabilities of the Apple II and Apple III. It features four color pens that can be automatically interchanged during graphics software execution. Plotting speed is specified at 3.94I per second, with 0.004I resolution and 0.008I repeatability. Media size can be up to 11″ × 17″. The plotter uses a standard RS-232C serial interface to connect directly to the Apple III's built-in serial port, while Apple's Super Serial Interface Card is required to connect the plotter to Apple II, II Plus, and IIe. Supplied with the plotter are: connector cables; 50-sheet package of 8½″ × 11″ plotter paper; eight different color pens for paper printouts; and operating and installation manuals. $995.

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HIGH-PERFORMANCE DESKTOP COMPUTER

Tandy's new TRS-80 Model 2000 Personal Computer is an MS-DOS-based system that offers a high-performance, next-generation processor for the professional microcomputer user. It uses the Intel 80186 16-bit, 8-MHz microprocessor with full 16-bit data path to give it almost three times faster speed than MS-DOS systems built around the 8088 processor. Included with the computer are two thin-line 5¼″ floppy-disk drives with 720K capacity per drive; 640 × 400-pixel display resolution with capability of displaying up to eight colors; 128K of RAM (expandable to a system total of 768K); detached keyboard with 12 function keys and separate numeric keypad; display/printer adapter; RS-232 serial I/O port; and four expansion slots. Supplied at no extra cost with the computer are MS-DOS and BASIC. Available as options are monochrome and color video displays. The Tandy 2000 System retails for $2750. The Tandy 2000 HD System, which replaces one floppy drive with a 10M hard disk and 256K of RAM, is $4250.

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RUMORS & GOSSIP

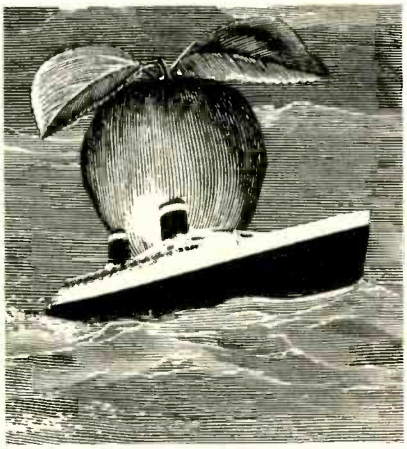
▶ Apple is rumored switching to Sony microfloppy in its forthcoming MacIntosh microcomputer, a less-pricey version of the Lisa. . . . Adam Osborne is reportedly about to start a new venture based on software publishing. . . . Commodore is expected to shortly announce a new disk drive for the C-64 which employs the user port rather than the 488 serial bus interface. This would speed disk I/O, the slowness of which has long been a complaint of C-64 owners. . . . Videobook Corp., Seattle, WA, is rumored readying a personal computer that runs Apple, Commodore 64, and IBM PC software and sells for under $500. . . . MicroOffice Systems Technology, which introduced the "RoadRunner" knee-top computer last fall (with an 8-line by 80-character LCD display, running CP/M) is promising to introduce units with 16- and 25-line displays by mid-year. . . . At least six IBM PC clones are expected from Taiwan during the first quarter of this year. . . . Morrow Designs is expected to announce transportable and portable machines compatible with the IBM PC. . . . Mattel Inc., maker of the Aquarius home computer, is rumored getting ready to follow in TI's footsteps and exit the home computer business.

OSBORNE NEWS

▶ Don't count Osborne Computer Corp. out of the game yet. Despite the fact that the company is operating under Chapter 11, there are signs that Osborne computers may live on. The Osborne I and Executive models are still selling well in England where IBM PC only recently went on sale, and portables such as the Compaq, Corona and KayPro are either not yet available or have very limited distribution. In fact Osborne is selling so well in England that the British distributor is considering starting production there. The Osborne machines are also still doing well in Canada and several other foreign countries, too.

Here in the U.S., many dealers who have healthy stocks of Osborne units are holding "close-out" sales offering the Osborne I for as little as $800 and the Executive for under $1500. These prices offer buyers real bargains since Xerox has gone on record as promising to provide service support for these units for at least another two years and purchase $1 million in spare parts from Osborne.

There are rumors that several companies are interested in buying the company. It still has several thousand Osborne I and Executive models in inventory and the parts to build many more. The company also has reportedly completed development of an IBM PC compatible version of the Executive and a true portable, and is ready to go into production on the units.



APPLE NEWS

▶ If you have been to a local computer flea market lately, you are aware that Apple has not yet won the battle of stopping the importing of Apple II clones from the Far East. Although Apple has been successful in having the U.S. customs service impound Apple copies, it has not been able to stop importing of parts to build Apple IIs. Thus, at computer flea markets one sees printed circuit boards and assembly instructions for the Apple II being sold for as little as $25. And there are Apple II keyboard copies, ROMs, and a bag of parts, power supply, and even cases. So a copy of the Apple II can be put together by a hobbyist in a few hours for under $300.

Further, dealers, despite Apple's attempts at preventing discounting of units, are offering discounts on the IIe. Most dealers attempt to conceal them by bundling the unit with peripherals and software. However, there are dealers selling the basic unit unbundled for well under $1000. Apple is expected to shortly reduce the suggested retail price of the IIe to just under $1000.

Apple Computer and Rana Systems Inc. have entered into an agreement to provide a disk add-on system for the Apple II that will provide IBM PC compatibility. The add-on will provide two 360K drives, 8088 processor, 256K of RAM, and the MS-DOS operating system for just under $2000. The success of this product is uncertain since it costs more than the Apple itself.

Apple's "Elf" transportable computer (rumored in this column previously) should be announced by the time this appears in print. The unit is expected to use a 6500-type processor and hence have a high level of Apple II compatibility. It should have 64K of RAM expandable to 128K with some expansion slots on the motherboard. It will use a microfloppy drive and, thus, the overall unit will be physically much smaller than the Apple II. RS-232 and Centronix ports are expected to be standard. A true battery-operated, portable CMOS version is expected before year-end.

BAD TIMES IN THE HOME COMPUTER BIZ

▶ Atari, which had expected to ship at least a half million of its new XL series of computers by the end of last year, is rumored to have actually shipped only a little over 100,000 units. Shipments, which were supposed to begin in September, did not begin until mid-October.

Atari is rumored readying a new hi-end computer that is IBM PC compatible. If true, it may signal a move by Atari away from the low-end home computer business in which it has as yet to show a profit.

Warner Communications, Atari's parent, reported a loss for the first 9 months of '83 of almost $425 million. While the company's profits from other businesses rose by 32%, the Atari video game and computer divisions produced a loss of over $536 million on sales that dropped from $1.41 billion to $753.6 million.

Texas Instruments exited the home computer business after losing half-a-billion dollars on its 99/4 computer. It held a "fire sale" during the Christmas season to sell off over 100,000 units in stock. And Coleco Industries, which promised to start shipping its Adam system by the end of last August, did not actually begin shipments until the end of October. Thus it expects to ship

BITS &BYTES

far less than the half-million units promised by the end of '83.

Interestingly, Atari and Coleco reacted to the introduction of the IBM PCjr home computer by raising their home computer prices. The PCjr, which is tagged for $669 base price for its entry model, may signal a leveling off in the pricing battle that has laid waste to the home computer market.

MORE BAD NEWS IN THE COMPUTER BIZ

▶ Digital Equipment Corporation disclosed that it had sold about 19,000 micros in the last quarter, about 30% less than it had expected.

Apple Computer revealed that earnings for the last quarter dropped by 73% despite an increase in sales of 55%. Expenses for research and development and marketing and distribution soared.

NATIONAL SAMPLING 32-BIT MICRO

▶ National Semiconductor started shipping samples of its new NS32032 32-bit microprocessor last October, fully two months before its promised shipment date. National claims that the 32032 is the first microprocessor to break the 1-MIPS (Million Instructions Per Second) barrier and that it will have a 7-MIPS unit by 1987. The unit is said to be upward compatible with the National Semiconductor 16000 line of 16-bit microprocessors and it operates at 6 MHz (a 10-MHz unit is expected shortly). The 32032 is expected to find wide use in applications such as CAD/CAM, telecommunications, robotics, and military and space applications.

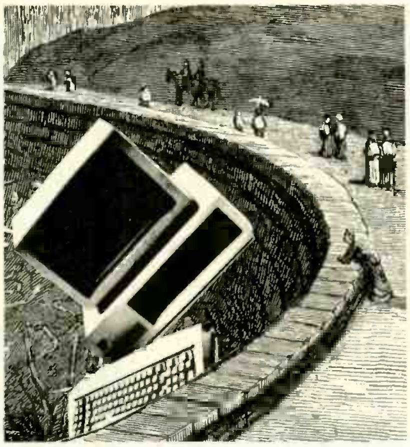
NCR is also sampling a 32-bit microprocessor and Intel is expected to begin sampling its 80386 micro (upward compatible with the 8088 and 8086) this spring.

FIRST OPTICAL STORAGE DEVICES

▶ Shugart has released its Optimem 1000 1-gigabyte optical disk drive, priced at $6000. The device uses a laser to write indelible information on a preformatted 12" removable cartridge optical disk. This is now the second such unit to become available, the first being from Panasonic. Panasonic is also shipping a 7" video disk that some customers are using for data storage. An erasable version is expected next year.

Storage Technology is expected to introduce a 4-gigabyte optical unit using a 14" medium and a technology similar to that used by Shugart. The unit will be compatible with IBM mainframes.

NEC and 3M Co. are cooperatively developing a unit with 12" disks and a technique using a laser to burst preformed blisters. NEC is expected to start shipping units shortly. Phillips, Sharp and Sony are also known to be working on systems even though no formal announcements have been made. Hitachi, Toshiba, and Sanyo are all currently beta testing small low-cost units and announcements are expected shortly.



THE SOFTWARE SHAKEOUT

▶ Sale of software is approaching that of the record business ($3.5 billion) and the number of new programs issued last year exceeded the number of new record albums introduced. PC Telemart, Fairfax, VA, a computerized catalog, already lists 15,000 titles and 40,000 products (many titles come in different versions for different computers). The number of software products doubled last year and will probably double this year again.

The explosive growth in the number of software products has made the role of the software distributor more important than the developer. Thus, Softsel Computer Products, a distributor, did an $8-million business last year, while the leading developers such as Microsoft, VisiCorp, MicroPro and Digital Research did $70, 53, 51, and 46 million, respectively.

All of the leading software developers businesses are based primarily on one product and they are striving to broaden their product lines. About 50% of Microsoft's revenues came from its Basic interpreter, for example.

Some companies have already begun to offer inducements to salesmen to push their products. So far the software market has not seen a price war, but new products being introduced are carrying lower prices and price declines are inevitable.

RANDOM NEWS BITS

▶ Xerox, which only two months ago boasted that it planned to open 50 computer stores a year for the next few years, has sold off 43 of its current stores and shut the remaining 10. Rumors are that they always operated in the red. . . . Intel has introduced a nonvolatile byte-wide 4K RAM. Its secret is an EEPROM shadow memory that retains data when power is turned off. . . . Docutel/Olivetti has introduced a kneetop computer. What is interesting about the unit is that it is the third such machine (the other two are from Tandy and NEC) designed and made by Kyocera in Korea. . . . Bank of America announced a "Personal Computer Account" for owners of home computers who wish to do bank transactions using their systems and the phone lines. . . . Fujitsu Ltd. is the first company to introduce a personal computer using the Microsoft MSX operating system. Sales of the unit are currently being limited to Japan.

QUOTATION OF THE MONTH

▶ "The iAPX432, although not a business success, is a technical triumph in that it blazed a lot of computer architecture territory. We developed a number of capabilities and functionality that we have since adapted to products like the 286 and 386. We do believe in the architectural direction of the 432 and are currently very intensely developing the next 432 product."

David House
Vice President & General Manager
Microcomputer Group
Intel Corp.

LES SOLOMON ON

COMPUTER HARDWARE

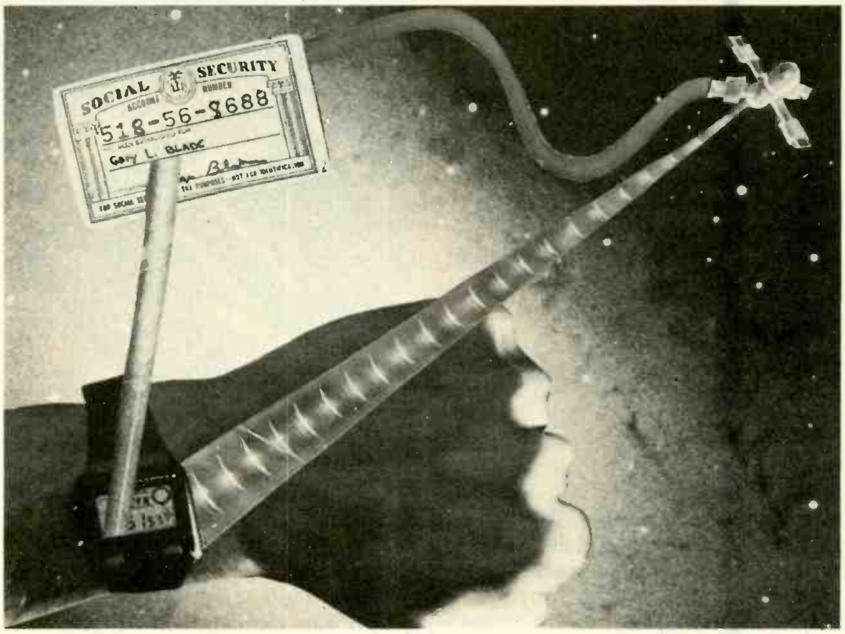
THE ULTIMATE COMMUNICATOR

DURING the past several years, I have been reading about the latest communication techniques using satellites and physically small, low-power transmitters that enable scientists to keep track of the movements of small creatures wandering about the surface, or in the seas, of this planet. It appears that constant monitoring can take place whether the small animal is scurrying around the polar icepacks, creeping through tropical jungles, or swimming around in some lagoon.

The thought struck me the other day that this monitoring technique could form the basis for what I call the "1984 Ultimate Communicator," a technique that combines computer technology, digital devices, and a little r-f technology.

Consider the digital watch that most of you have on your wrists. The complexity of even "el cheapo" model is the equal of that used in large-scale digital computers only a few years old. They have seven-segment LCD readouts, multi-functions (some include a calculator), and even a liquid-crystal screen capable of resolving TV images. And the power source for all this digital activity? A cell so small that it can be easily lost in a pocket or purse—yet so powerful that the watch can run for a couple of years before battery replacement.

Now let us look at a couple of recent developments. First is a new technique that allows an LCD screen that is the equivalent of an 8" diagonal CRT to display 25 lines at 80 characters (the same as most terminals). The second is the development of "software on a chip" (in this case CP/M), while the third is new CMOS deposition techniques that allow a 256K-bit RAM or a CPU to have a mere 10-μA standby power. In fact, as the deposition goes under a 1-μm line, even greater chip densities can be reached.



An ever-watchful satellite will have your number.

The r-f and telemetry devices have also reached new highs (or is it smallness) in physical size and required operating power. If the package is small enough not to bother a small animal, then it will not bother a larger animal—man.

Now let's put the items together.

Even with only a slight knowledge of electronics, you can see that it is now possible to build a digital device that will act for all intents and purposes like a conventional computer terminal, but instead of being tied to a telephone line so that data can be passed back and forth, it is coupled via a radio link to a satellite somewhere up there.

Since any given satellite can cover a good portion of this planet, and since satellites can communicate with each other, this allows two-way communications between an earth station and a personal communicator to take place no matter where on the planet the user is.

But that is not all. Since the introduction of digital computers, methods for maintaining data integrity have been at the forefront. In the area of personal computers alone, software "piracy" has cost the fledgling industry millions of dollars. In industrial, scientific, banking, and military areas, data integrity is paramount. This has given birth to a new set of chips called "data encryption" devices that will allow data communication only when a unique user code is employed. (One out of 2 to the 57th power in the case of one chip.)

Thus, it is possible for each person to be given a unique number (Social Security?) at birth, and use this number for all data communications. Since this is a unique set of personal digits, and since satellite transmissions even now cover the planet, if anyone called your number, and you didn't answer, you would be among the missing. ◇

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192K-768K bytes*

MICROPROCESSORS:
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8-bit: 8085

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5.25" disk drive,
8" disk drive
Winchester drive

KEYBOARD:
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13 function keys,
18-key numeric pad

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

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

DIAGNOSTICS:
Memory self-test on power-up

AVAILABLE SOFTWARE:
Z-DOS (MS-DOS)
CP/M®
Z-BASIC Language
Microsoft BASIC
Multiplan
SuperCalc
WordStar
MailMerge
Data Base Manager
File Manager
General Ledger
Accounts Receivable
Accounts Payable
Inventory Control
Sales Invoicing
Lotus 1,2,3
PeachText 5000
Fortran-86
Cobol-86
Pascal
Basic Compiler
Most standard 8-bit CP/M Software

*192K bytes standard.
**Optional.
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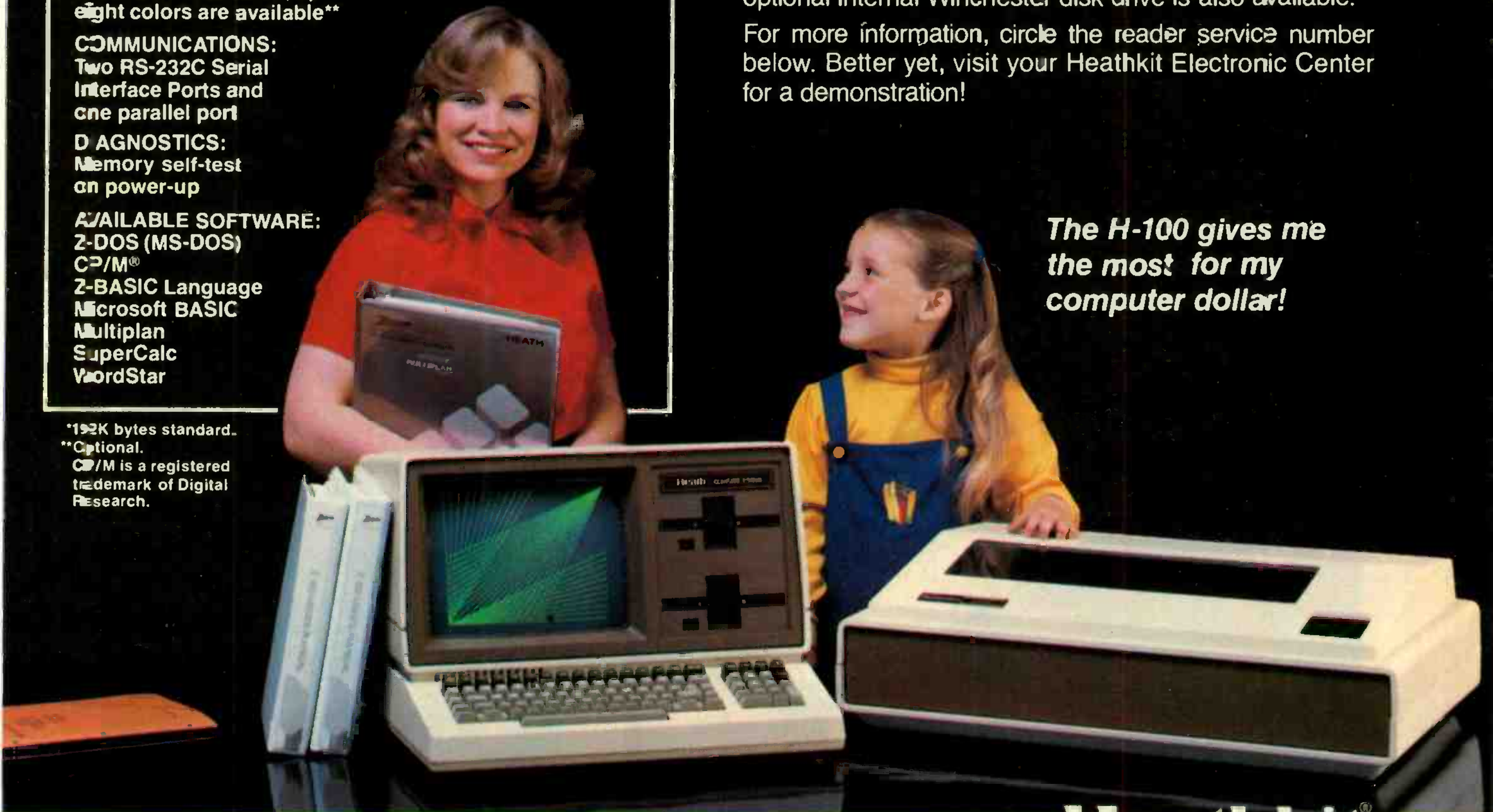
For more information, circle the reader service number below. Better yet, visit your Heathkit Electronic Center for a demonstration!



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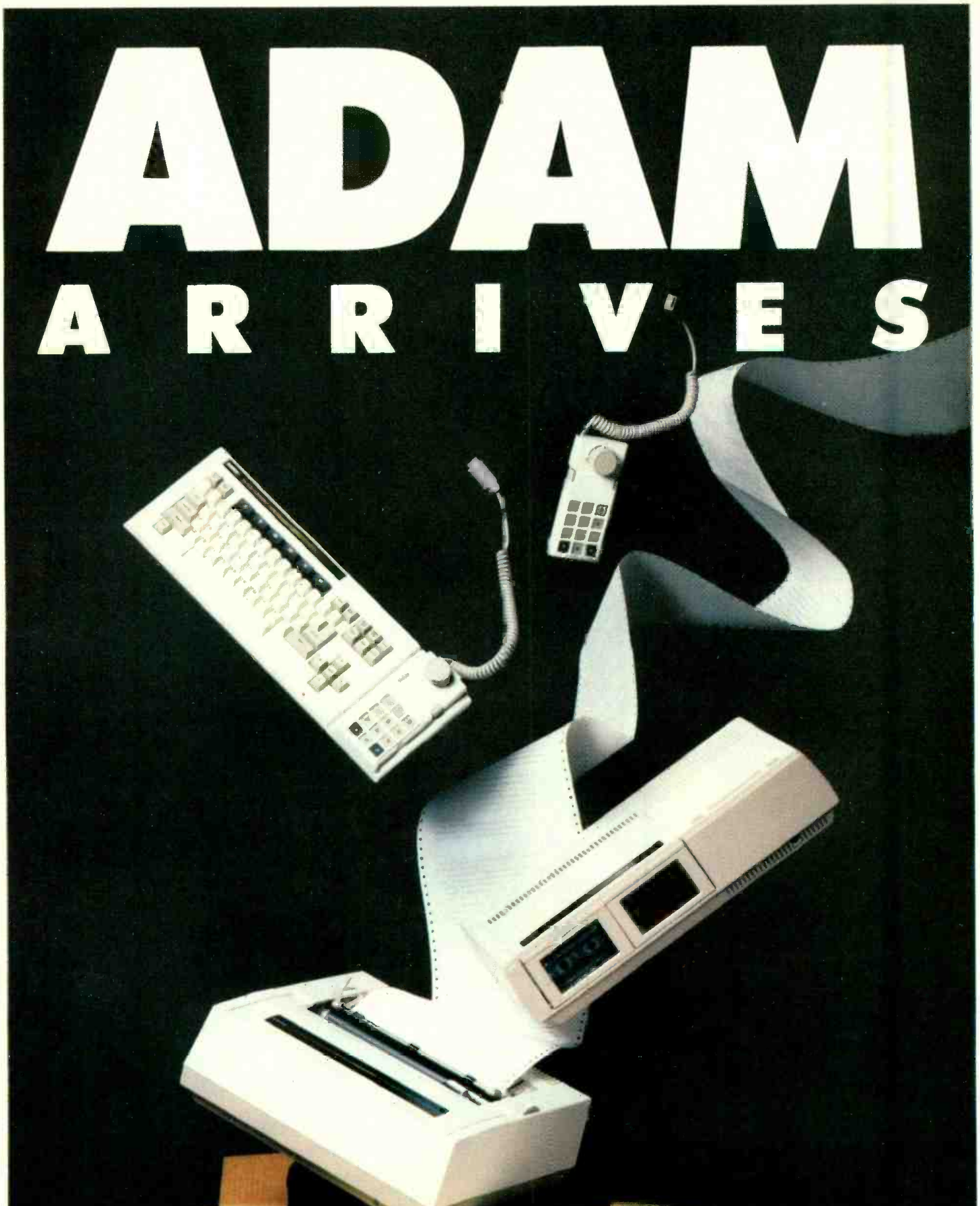
ADAM ARRIVES



Useful as soon as it's uncrated, Adam is an exciting package for the beginner or experienced computerist

By Charles P. Rubenstein

THOUGH almost too long ago to remember, Coleco's introduction of the Adam Family Computer System last summer had the same kind of impact as a 90%-off sale at a department store. After all, Coleco was offering an 80K computer with a high-speed digital tape drive, a daisy-wheel printer, and bundled software for the unheard of price of $600! Normally, that amount could only buy the printer. And with the reputation that the company had built up with its enormously successful ColecoVision video game machine (whose cartridges are compatible with the computer), you just knew that Adam was something special. Now, after months of waiting and a couple of price increases (the latest suggested retail figure is $750), Adam has emerged. Here's a hard look at this exciting package.

The Basic System. The Adam Family Computer System consists of a keyboard, a memory console with built-in digital data drive and ColecoVision cartridge port, a SmartWriter daisy-wheel (letter-quality) printer, connecting cables, adapters, and a pair of multi-function ColecoVision controllers. Also included in the basic package are three digital data packs (C-250 tape cassettes): SmartBASIC, "Buck Rogers Planet of Zoom," and a preformatted blank tape.

When you turn Adam on, it comes up as an electric typewriter. Press a key and it becomes a word processor. Load a tape and you can learn and use BASIC or play true-to-life arcade games.

The keyboard and two multi-function ColecoVision controllers.

A Look Inside. The recipe for Adam's "central nervous system" goes something like this: take one Z80 microprocessor and 64K RAM, add a ColecoVision video controller and 16K of video RAM, and stir gently. Then fold in a "master" Motorola MC6801 single-chip microcomputer as a network controller. Finally, add three more MC6801s to govern the operation of the digital data drives, the printer, and the keyboard.

The MC6801s operate at a 1-MHz clock rate in a network arrangement that treats each of the peripherals (printer, tape drive, and keyboard) as a separate self-contained computer system.

Identification and communication among these intelligent peripherals is accomplished through the "master" network controller in communication with each unit's National LM339 quad comparator used as a port decoder. All of this is orchestrated, as necessary, under the control of the Z80 microprocessor.

Adam's memory allocation is shown in Table I. There is the basic 64K RAM and an additional 16K of video RAM. The built-in word processor is contained in a 24K ROM and a general-purpose operating system takes up another 8K ROM. There is also 8K of ROM dedicated to peripheral control. Adding up the pieces, the basic system comes with 80K RAM and 40K ROM.

The Memory Console. Adam's memory console contains the Z80 microprocessor; a Coleco video controller; the master and tape-drive MC6801s; 80K of RAM; the 24K word-processor ROMs; a ColecoVision game-cartridge socket; an "Adamnet" 6-pin modular telephone plug connector; a 60-conductor edge-card expansion bus; an r-f modulator; and three card sockets (two 30-pin and one 44-pin edge-card connectors) for whatever the Coleco wizards decide

It achieves its operating goals and nothing is near it for the price

Memory console with data drives and game cartridge socket.

they want to come up with next.

The 19″ × 13.75″ × 4.25″ memory console weighs in at about 9.5 lb with a single data drive. Unseen by the user is the completely r-f shielded computer and video-signal generator boards inside the console. Adam provides for a variety of audio/video outputs at the rear of the console. There is a standard (r-f) TV output through a phono plug which can be switched to channel 3 or 4 as desired. Another phono plug supplies video output signals for standard monitors, and a third yields both audio and video signals on a 7-pin DIN plug. On the right side of the console are two ports for the ColecoVision hand controllers, and an expansion slot. On the left side are a power and printer-output connector as well as the Adamnet connector. The keyboard cable connects to a 6-pin modular telephone plug on the front in the lower right-hand corner.

The digital data drives are conveniently poised for operation on the front left side of the console. One drive comes with the basic system while a second optional drive can be easily installed by the family user in about 10 minutes with a Phillips screwdriver. The drives are reasonably designed except that it is easy to insert a data pack in backwards due to inadequate labelling of the pack front. However, Adam "knows" that the pack is not in properly, and says so; but I perceive that the life of the drive may be reduced somewhat due to forcing the pack in. The doors seem a bit too flimsy and actually bow out when properly inserted data packs are in use. This is caused by spring-operated safety features that assure good data transfer. The drive is on whenever a tape is in it since the tape is constantly being stretched to keep it taut. This tends to heat the drive, and thus the pack. There is no indicator to tell you when the drive is running nor any mechanism to prevent the door from being opened while the pack is in use.

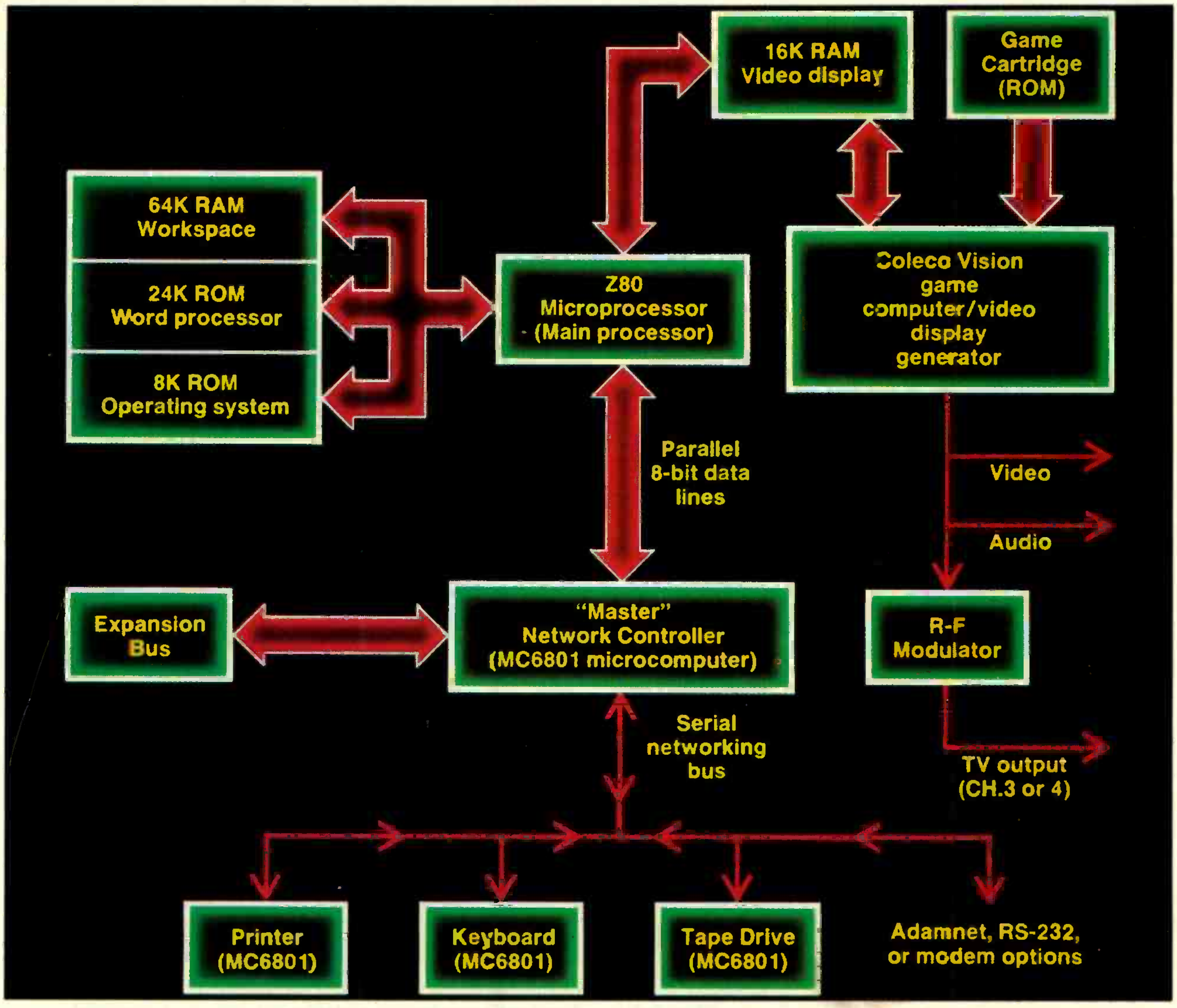
The C-250 digital data pack cassette tapes are preformatted to hold about 500K (253 2K blocks) of data or, as advertised, about 250 double-spaced pages of text. To give some feel for what this means, the complete four-level "Buck Rogers Planet of Zoom" program is about 144K long. There are no true specifications for the drives or pack other than the supposed access time of 19.2 kilobytes/second. I found that this number is of no great consequence since a considerably longer time is spent checking the directory, finding and loading the program, and then executing it (i.e., 56K of SmartBASIC loads in about 68 seconds).

The Keyboard. Adam's keyboard is networked and controlled, as are all of its peripheral devices, by an r-f-shielded, Motorola MC6801 single-chip microcomputer and LM339 quad comparator device decoder. The keyboard unit is housed in a rugged beige and brown plastic case, and attached to the memory console by means of a 6-wire, modular telephone-type connector. Its 75 keys are the full-travel, tactile-feedback type designed for both the more brutal among us, and our young children. The keys are ruggedly built, yet they let you know when you have pressed them properly. Their initial feel, to individuals familiar with more conventional typewriter and terminal keys, leaves something to be desired. In fact, they feel quite tinny. However, after using the keyboard a while, you become accustomed to it.

The keyboard is composed of a 54-key standard alphanumeric keyboard (includes TAB, CONTROL, SHIFT, and LOCK keys); a set of 6 "smart keys" labelled I, II, III, IV, V, and VI above the standard area; a set of 10 function keys for use with the word processor; and five cursor-control keys.

The SmartWriter Printer. Another peripheral means yet another MC6801 networked into Adam's central nervous system. However, the printer is more than just another smart peripheral. For beating inside the bowels of this cleverly designed daisy-wheel is the system power supply.

The SmartWriter constitutes, at the


16K RAM Video display
Game Cartridge (ROM)
64K RAM Workspace
24K ROM Word processor
8K ROM Operating system
Z80 Microprocessor (Main processor)
Coleco Vision game computer/video display generator
Parallel 8-bit data lines
Video
Audio
Expansion Bus
"Master" Network Controller (MC6801 microcomputer)
R-F Modulator
Serial networking bus
TV output (CH.3 or 4)
Printer (MC6801)
Keyboard (MC6801)
Tape Drive (MC6801)
Adamnet, RS-232, or modem options

Block diagram of Adam's "central nervous system."

very least, a major breakthrough in cost-effective packaging. Here, included with the complete Adam computer system is a 10-character-per-second letter-quality, bidirectional daisy-wheel printer whose cost should be what the entire system is being sold for. Yes, it is a bit noisier than the dot-matrix printers that retail around $400; yes, the construction is not as rugged as you might want; and yes, it is a bit difficult to insert and adjust paper in the platen. But—the sound level of this printer is only slightly higher than an IBM Selectric, or other daisy-wheel printer (probably because of its plastic shell construction); And its cost, if available separately, would probably be under $200!

Of course, when compared with printers costing much more, there are some problems with the design of the printer. The line cord and power cable both are connected in the center rear of the printer making the use of fan-fold paper a bit sloppy. The daisy-wheel mechanism is exposed to little hands and inquisitive fingers. And, as a result of the internal *system* power supply, the printer "hums," the left side of the paper platen (above the power transformer) gets warm (about 3°C above room temperature), and the rear upper-right-hand corner of the top of the printer gets hot (about 15°C above room temperature).

As is often the case with inexpensive daisy-wheel printers, the letters often get printed on an ever-so-slight angle. On testing the printer speed and word-processor abilities, I found an even greater problem which may be related only to fan-fold paper. The printer sometimes inserts a space(s) between lines. I printed out 53 lines of copy, and the printer inserted seven random line spaces! Repeating this test four times resulted in a total of 24 random line spaces. The speed at which this was accomplished was a respectable 10.73 characters/second. A 9-line screen, printing from within the word processor, was printed in about a minute, at a rate of 9.79 cps. As an aside, built into Adam is an irreversible CTRL P command which will attempt to print everything currently on the screen. This can be helpful when writing BASIC programs when you do not wish to have only a listing of the program, but rather the results, etc., as well.

The ColecoVision Controllers. There are two multi-function ColecoVision controllers. One can be placed in a cradle on the right side of the keyboard and serve as a joystick cursor controller and as a number pad. This is not as nice a feature as it may seem because the number pad is an exposed membrane type, which I found harder to use than the standard number keys on the regular keyboard.

Each controller has a disk-topped joystick handle that needs a full 0.25" travel to turn on the internal switch elements. This tends to make for slower, sloppier, and more tiresome game playing, yet allows even the heavy handed

Adam's ability to do more than one thing at a time is called multitasking

person to play without destroying the unit. The two pushbuttons on either side of the controller are used for speed, fire, etc. control. In addition to being used as an accessory number pad, the diode-matrix encoded touch-tone number keypad can be used with games.

Resident Software. About five seconds after the system power is turned on, Adam awakes, ready for use as an electronic typewriter with video display. The user receives an immediate response to a keypress. Short notes, letters, or whatever can be typed with the ease of using any electronic typewriter.

To use the SmartWriter word processor, you merely press the WP "smart key" in the upper left-hand corner. This brings you to the resident (24K ROM) line-editing WP mode. The basic screen format is the same, but this time there is a scale on the left side of the screen that indicates where you are on a page. There is no indication of what line you are on other than this, although the top horizontal scale shows what column you are in. The WP has a large number of features. Perhaps the most dramatic and user-friendly aspect of it is Coleco's use of definable keys. These six keys with Roman numerals are double-size and are defined for the user interactively at the bottom of the word-processor screen.

The word-processor screen is divided into two distinct areas: a display of the last 8 lines and the line that is being edited or entered. Each line is composed of a 35-character first "line" and a 25-character second "line" for a total of 60 characters (default) per full printed line (72 characters maximum). If you want to print out the nine lines displayed, you press the PRINT button in the upper right-hand corner of the keyboard. You will be "asked" to press one of the smart keys. You can print an underlined (hilited) section of the screen, the work space (entire file), or the screen only on either fan-fold or individual sheets of paper. Once you decide, you press smart-key V to do the printing. When the printing is done, Adam returns automatically to the primary screen for more work.

The daisy-wheel printer houses the system power supply.

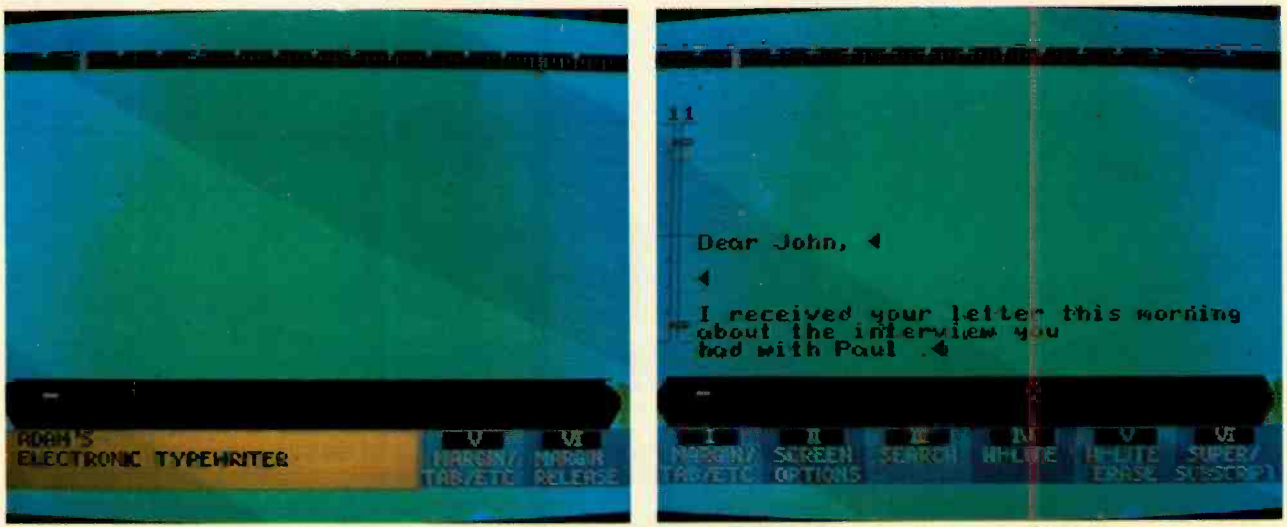
Cassette Software. Nearly anytime you wish, you may insert a digital data pack into drive 1 and push the reset switch located atop the memory console to load in software. Included with Adam are two software cassettes: SmartBASIC (an Applesoft BASIC-like high-level language), and "Buck Rogers Planet of Zoom," a multilevel, multiscreen, arcade extravaganza.

SmartBASIC. Coleco SmartBASIC, which takes about 68 seconds to load, is compatible with Applesoft BASIC. What this means is that the standard commands used for Applesoft generally can be used with Adam. For example, to list a program on the printer, you would type PR#1 and LIST, rather than using a command such as LLIST. However, PEEKS and POKES of memory locations are not the same between Adam and Apple. Thus, if you were to copy a program written for an Apple computer that included these particular commands, it wouldn't necessarily work with Adam.

I calculate the SmartBASIC program, which claims to have 225 blocks of memory left in the directory, to be 28 blocks, or about 56 kilobytes long! This seems to be rather large for a cassette-based program, so I guess the Z80 machine language requires quite a bit of code to duplicate the 6502-coded Applesoft BASIC. However, since most disk-based BASICs are 16K or smaller, I suspect that SmartBASIC includes much of the RAM space for video mapping in the graphics mode.

TABLE I—COLECO ADAM MEMORY ALLOCATION

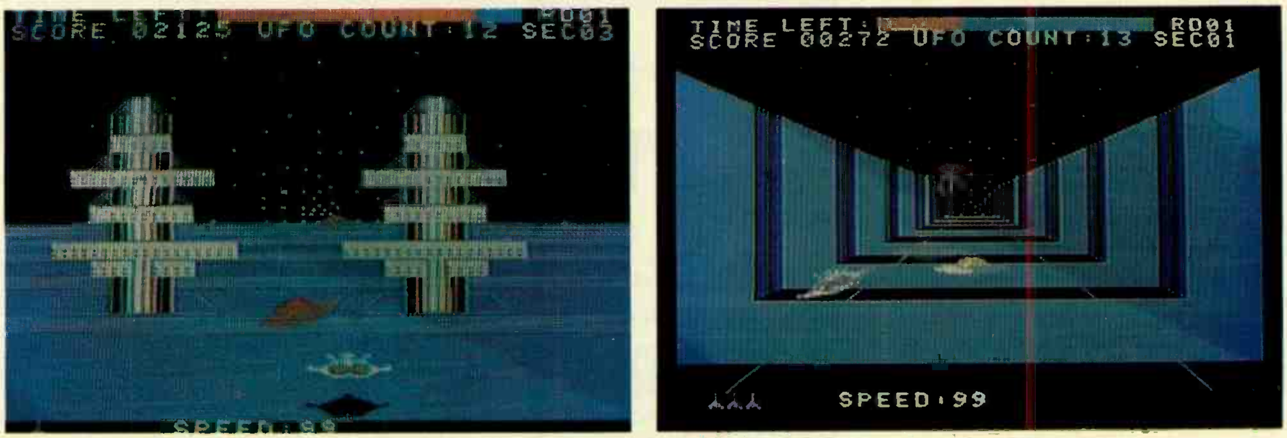
64K	Open Work Space
16K	Video Memory
24K	Word Processor ROMs
8K	Operating System ROM
2K	Keyboard Computer ROM
2K	Tape Drive Computer ROM
2K	Printer Computer ROM
2K	(Master) Network Computer ROM
64K	(Optional memory expansion)


ADAM'S
ELECTRONIC TYPEWRITER
V MARGIN/ TAB/ETC
VI MARGIN RELEASE
I MARGIN/ TAB/ETC
II SCREEN OPTIONS
III SEARCH
IV WHLITE
V H-LITE ERASE
VI SUPER/ SUBSCRPT

Dear John,

I received your letter this morning about the interview you had with Paul.

Adam's electronic typewriter mode (left) and word-processor mode (right).


TIME LEFT
SCORE 02125 UFO COUNT:12 SEC03
RD01
SPEED:99
TIME LEFT
SCORE 00272 UFO COUNT:13 SEC01
RD01
SPEED:99

"Buck Rogers Planet of Zoom" takes advantage of Adam's excellent graphics.

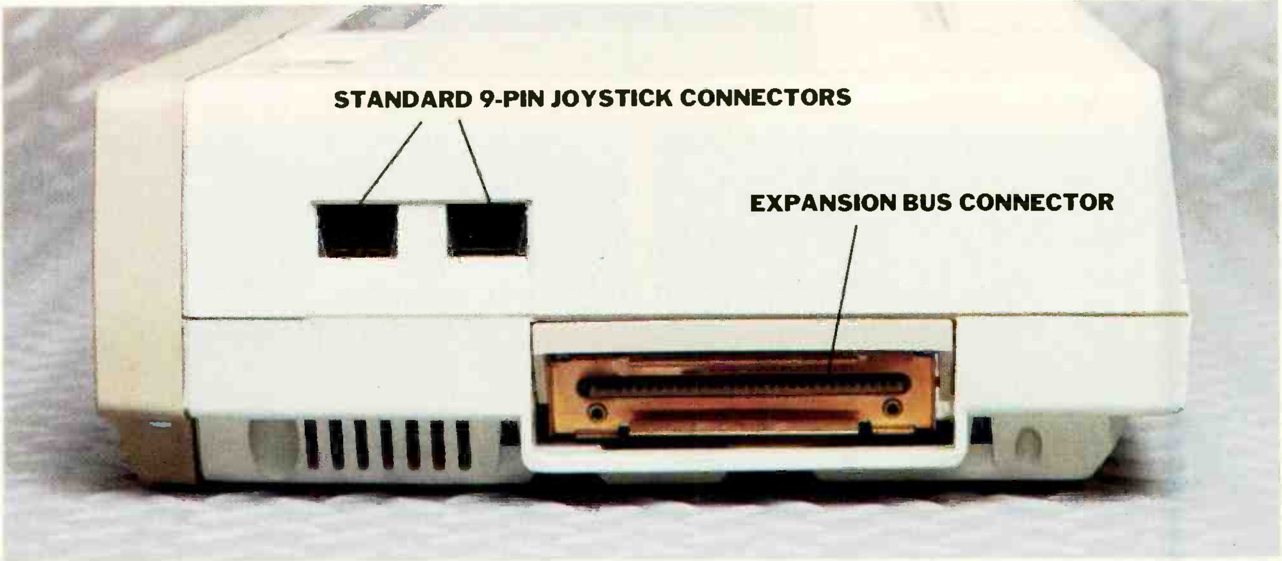
Most standard BASIC commands are usually parsed (decoded) in an area rather low in memory. Adam uses the area between 288 and 1152 decimal for these. Again, as is customary, Adam uses the area on top of the BASIC command listing (between 1152 and 1504 decimal) for the error message listing.

Adam's SmartBASIC graphics comes in four varieties, pure Text (24 lines of 36 characters) low-resolution (GR) graphics (40 × 40), hi-resolution (HGR) graphics (256 × 160) with four lines of text, or pure hi-resolution (HGR2) graphics (280 × 192). In its hi-resolution mode, the screen memory alone requires over 52 kilobytes of information for each display screen.

Since no memory map is supplied with any of the manuals, you will have to wait for information analyzing the memory contents, BASIC pointers, etc. For example, the Apple uses a PEEK (−16336) to initiate sound.

We all hear the pretty music and fun sounds of the Buck Rogers game. But how do we create our own sounds? And where are the collision and graphics registers? Also, there is no information on creating those beautiful background screens. Is there a simpler (other than byte-by-byte memory mapping) technique to create HiRes screens? How can we enter our own Z80 machine language programs? How can we hook up the outside world to Adam's network of computers? These questions cannot *be answered without proper support material.*

"Buck Rogers Planet of Zoom." Included with the basic system is the arcade game, "Buck Rogers Planet of Zoom." The game takes about one minute to load, but it should be noted that this is not just a one-shot cassette loading. All during play, the cassette loads and the screens are changed. This ability to do more than one thing at a time is called multitasking. While the interactive arcade game plays, the tape



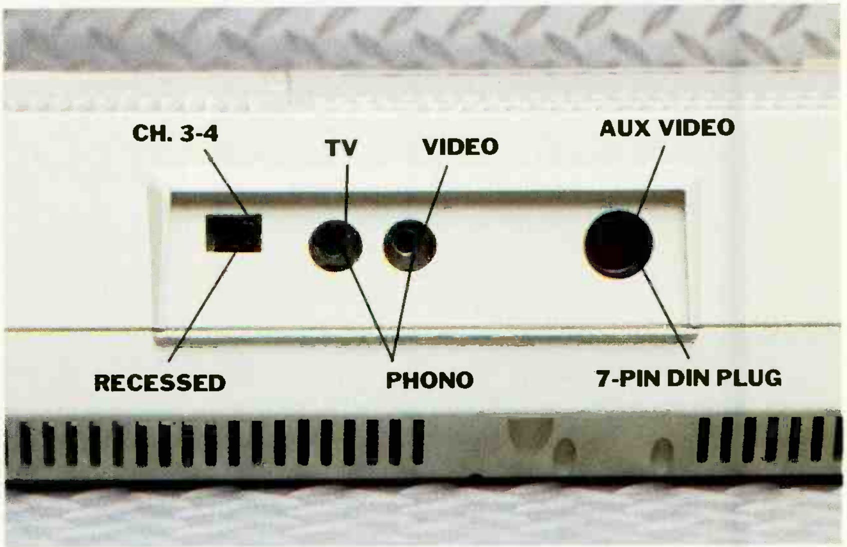
Right side of memory console with two joystick connectors and an expansion slot.

drive feeds information into the memory banks to describe the game's next screens and moves.

Adam's graphics are excellent and game play is realistic (even at the easier-than-arcade difficulty levels) and very challenging. The only disappointment is the game controller. It is relatively slow to respond, and it is quite difficult to keep controlling speed with the left button (how about a speed lock?) and fire with right button.

Comments. I found the Adam Family Computer system to be very satisfactory for its intended use. The word processor is adequate, although not comparable to professional packages such as WordStar. Though the SmartWriter printer is not meant for heavy-duty work, it does offer letter-quality print. One strong point of the system is its compatibility with ColecoVision video game cartridges. This assures quality entertainment for video-game enthusiasts. In fact, the system itself may be purchased as an add-on to the ColecoVision video game console for a suggested retail price of about $600.

Coleco intends to support Adam with additional peripheral devices. These will include a telephone modem, an RS-232 adapter, an additional 64K of RAM, and even a 3.25" CP/M-compatible floppy-disk system with 80-column converter card. Also in the works is an Adamnet, which will allow the interconnection of several Adam's for networking the already networked Adam.



Rear of memory console showing display outputs.

Conclusion. Coleco has finally arrived with Adam. Adam is designed to be as familiar to the first-time user, as it is powerful enough for the experienced computerist for home applications. It is conceived as a complete system with nothing (other than a TV set) necessary for immediate and long-term use. It is user-gentle and user-friendly. It is useful from the moment it is uncrated and begins its life as an electric typewriter, through to word processing as a serious application, and the Planet of Zoom arcade game for family entertainment. It seems to have the upward compatibility necessary to entice the experienced hacker, and the ruggedness to resist the inquisitive 2-year-old. The machine appears to have more than satisfied its "English" language operation goals, and nothing is near it for the price. I do think that a few design and programming bugs need to be fixed, and more powerful and technical manuals are needed. But, overall, I recommend Adam—for your family, your kids, and you. ◇

"MADAM, I'M ADAM"

A novice's first experience with the Adam family computer

By Lois Cantwell

I AM the kind of consumer that Coleco likely had in mind when it developed Adam—someone who is ready to make a computer-system purchase if the price is modest and confusing options are eliminated. The rumors alone of an 80K computer with built-in word-processing software (no expensive WordStar or Perfect Writer to buy), game playing, and a daisywheel printer that all together cost about the same as a printer alone, were attractive enough for me to postpone buying a computer until Adam was on the market. And now that I've met Adam and have had several hours to get to know him well, he seems to be very easy to get along with.

Adam comes packed, unassembled, in a gigantic box along with instruction manuals on SmartWriter, SmartBasic, Buck Rogers video-game instructions, SmartWriter Easy Reference Guide, and a set-up manual which instructs "Read Me First." Since a great part of Adam's charm lies in everything being "built-in," I panicked slightly when faced with connecting the various sections.

My fears were unfounded, though, since it took only about a half hour to get the computer to work. Not bad, I thought, for a technically disinclined person. One time I had to rearrange all the modules after I had everything all plugged because I had wires crisscrossing the keyboard, which made the computer impossible to use. Finally, after assembling Adam perfectly and turning on the separate color TV that doesn't come with the system, the computer refused to operate. A major problem, I thought. But, no, I had forgotten to turn the computer on! It's equally easy to forget to turn Adam off, which makes the printer get very hot. These problems were not, of course, Adam's fault.

A nice design touch is that all the cords have a "this side up" label and all the cord outlets are labeled. Without this touch, I might still be looking for the keyboard outlet. Assembly might have been a little easier if the manual supplied a large numbered diagram of the entire system that showed where to set things up and plug them in, instead of the small close-ups of where the various plugs should be attached. When you're nervously trying to fit all the right cords into their right slots, each section of computer shown in the close-ups resembles any other section. Since the modules and tabletop TV spread out over a large area that's at least 4′ wide by 3′ deep, the system isn't especially compact. This is not an unimportant consideration if Adam is being brought into a small apartment or crowded child's room, or if you are planning to use the family television as a monitor.

In many ways I fell in love with Adam. The Smart Keys were terrific! They make changing margins and tabs as simple (literally) as pressing a button until the exact numbers you want appear on the screen. I was able to change the screen color to one I liked better, or was easier on my eyes, or matched my sweater. My options were blue, green, white, black, and gray. And the type appeared in various rainbow hues. I was impressed with the actual prettiness of the type on the screen, too.

As a longtime typewriter user, it was somewhat distracting to use Adam as a word processor whose type appeared on a screen instead of a page in front of me, but that is something I could very easily get used to. Another option that Adam offered me was how much noise I wanted with my typing. If I wanted a collection of beeps and boops as I pressed keys, I could have that; a more attractive option was complete silence. I did wish I had a noise option on the Adam printer, which emitted a grinding noise when turned on and an irritating "whap-whap" when keys hit the paper. I would try placing Adam on a typewriter mat to try and muffle the noise, while keeping my eye peeled for some kind of low-cost printer cover to reduce noise further. This aside, I thought it was neat to see the printer speeding through my text unassisted, typing sentences backwards.

As Coleco claims, I found storing, filing and retrieving text on Adam to be a simple task, handled by its STORE/GET key. When I was ready to call back my text, Adam displayed a clear directory in a file-folder format. It was a simple operation to point to the file I wanted with one of the arrow keys and to ask for it. I found it was easy to clear the screen and begin a new project, too.

Not having had much hands-on experience with computers, I was a little surprised at the complexity of SmartBASIC (which I'm told is no more complex than plain BASIC). Adam is supposed to be super simple, so I was disappointed that I would have to enter intricate strings of numbers and letters, at least one time for storage, before I could do any computing. This was frustrating, even with the built-in prompts and self-corrections. I knew, therefore, that I would be combing the market for ready-to-run software very soon. Coleco's promised SmartFiler series would therefore appeal to me very much.

Now that I've had a "new owner's" exposure to Adam, I think that it lives up to the hype preceding its introduction. ◇

DISKS & DRIVES

A look at the technology behind the most popular mass storage devices for microcomputers

By Dawn Gordon

THE 5¼" floppy diskette, and the drive that uses it, have contributed enormously toward making personal computing the popular pastime it is today. Without this method of information storage, we would have to rely on such primitive mechanisms as punched cards and paper tape; inexpensive, but slow and often fallible, cassette recorders; or relatively expensive 8" disks.

The 5¼" disk is a happy medium, as it offers the speed and random-access capabilities of its 8" big brother, but at a price nearer that of cassettes. Minifloppy technology brought the speed and flexibility of professional systems into the home, and personal computing hasn't been the same since. A little polyester-and-iron-oxide disk can make a big difference, and it's about time you found out why.

In the Beginning. In the very earliest days of personal computing, programs were stored—if they were saved at all—on punched paper tape. You may have seen it used with Telex or Teletype machines. However, though it was great for throwing out of windows during parades, it did little to advance the cause of personal computing.

It was quickly realized that a better way of storing data was needed, and a system (actually a number of similar systems) was devised for turning digital information into audio tones and storing them on ordinary audio cassettes. While better than paper tape, and fairly inexpensive, this system was incredibly slow. In the days before BASIC was built into computers in ROM, it could take minutes to load even a small version of the language into a machine. Furthermore, since the tapes were used with inexpensive off-the-shelf recorders, there was no way to randomly access individual files. Unless you knew exactly where on a tape a file was stored, you had to start at the beginning and just keep going until you (or your computer) found it.

For a while, though, cassettes were *the* storage medium; there was just no other reasonable option. There was the possibility of using the professional 8" disk technology developed by IBM, but its cost was very high, and definitely not conducive to personal use. Fortunately, an innovative company by the name of Shugart Associates solved the problem in 1976, and offered the first convenient and affordable random-access mass-storage medium. Its small disk drive, and accompanying 5¼" disk (or minidiskette), finally offered many of the advantages of the 8" disk at a price the consumer could afford. For $595 you could buy a disk drive for your Apple II, along with everything you needed to make it run. For another $495 you could get a second one.

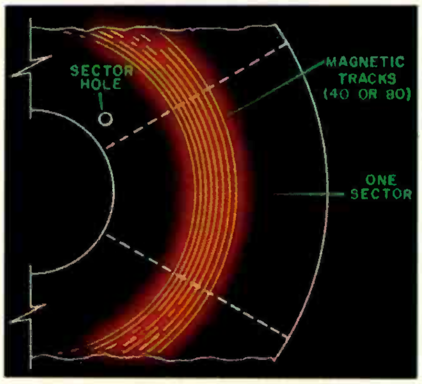


Fig. 1. Disks are formatted into tracks and sectors.

Disk Makeup. Like audio cassette tapes, floppy disks store information magnetically. There are, though, considerable differences between the two. The magnetic-oxide particles that coat recording tape are aligned in the direction of the tape's travel to receive the highest degree of magnetization from the recording head. Those on the surface of a disk are oriented randomly. This is due both to the way in which disks are manufactured, and to various factors involved in disk-recording technology.

For durability's sake, the base film, or substrate, of a floppy disk is about six times thicker than that of cassette tape, at a hefty 3 mils (3/1000"). That makes it floppy, but not droopy. Unlike cassette tape, though, its magnetic-oxide coating is very much thinner. At only 2½ microns (90-millionths of an inch) the coating found on the average floppy is three times thinner than that on standard recording tape. The reason for this is simple: The thicker the coating, the greater the chance for spillover and overwrite of digital information. A thick coating also increases the chances that enough traces of old data still persist to cause trouble even when new data has been written over it. Interestingly enough, the magnetic material is a simple form of ferric oxide, very similar to what's used on Type 1 audio tape. It appears that the really good stuff isn't necessary for digital recording.

The digital information is recorded on a series of tracks. These tracks have often been compared to the grooves on a phonograph record, but about the only similarity that really exists between the two is the name (if you consider a "groove" a "track").

When you buy a blank disk, its surface is truly blank—there are no tracks on it. This is because almost every microcomputer system uses a different method for *formatting* the tracks, which are actually concentric magnetic rings created on the disk's surface by the disk drive's read/write head. When you run your system's formatting, or initialization, program, you are creating the tracks on the disk at that time. Most disks are rated to contain 48 tracks per inch (tpi), but the actual area used usually contains only 40 tracks. Some high-density 5¼" diskettes requiring special drives are rated at 96 tpi formatted to contain 80 tracks.

When a disk is formatted, not only track information but also *sector* information is written to the disk. By dividing each track into a number of sectors, it is possible to store and locate information easily. A section of the disk called the directory stores the file name (the name assigned to a particular group of information) along with the track and sector numbers indicating where the information is to be found. Those areas

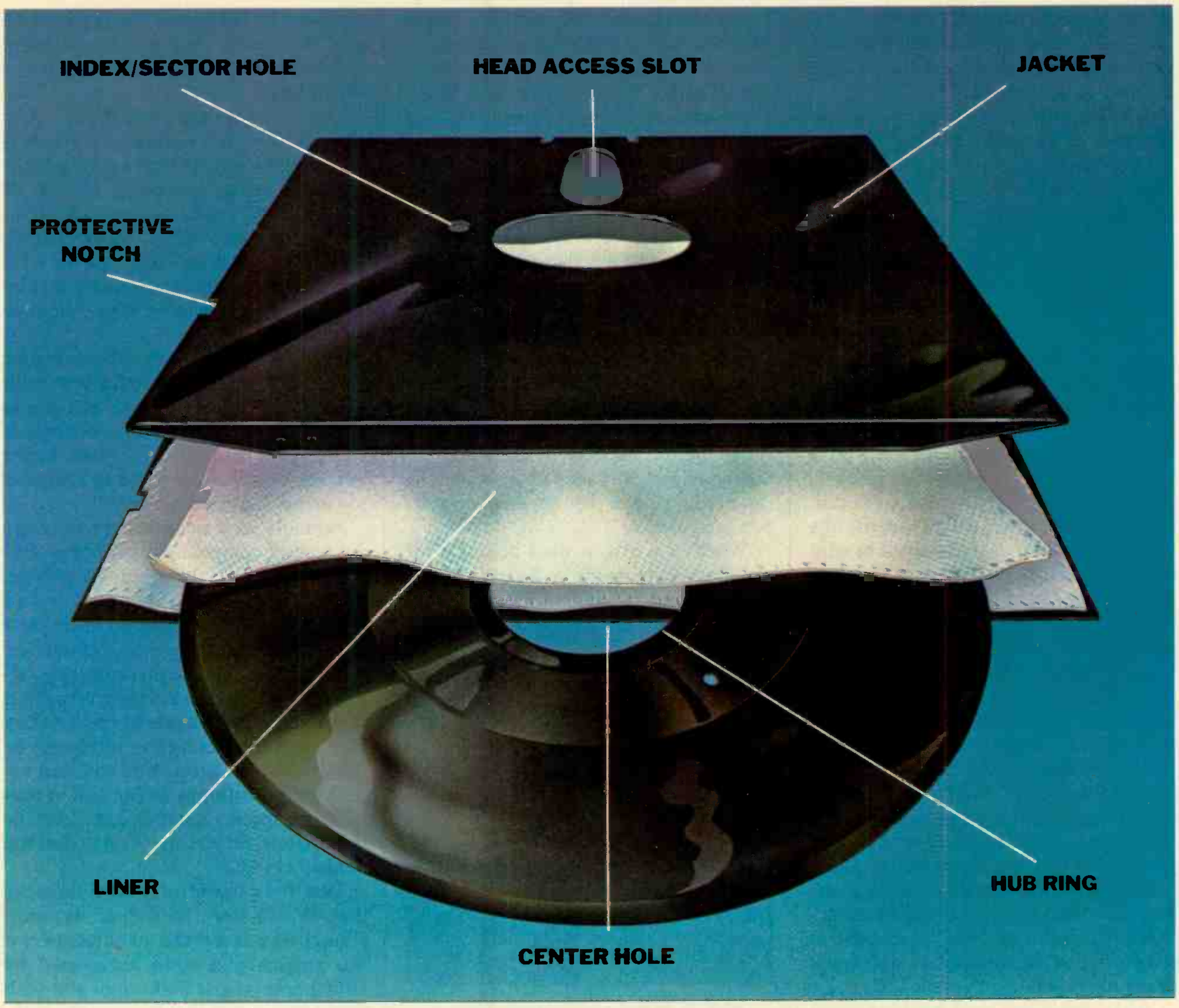


Fig. 2. The principal parts of a diskette and its jacket.

may or may not be contiguous, depending on how often the files have been altered, and the amount of contiguous free space available on the disk. The track-and-sector information stored in the directory allows you to access any file at random, almost instantaneously. The process is quite different from the serial storage method used with cassettes.

How Disks are Made. As is the case with any other high-tech product, the manufacture of floppy disks isn't as simple as you might think. As BASF Product Manager of Flexible Media, Terence Kelly, points out, "The process is a painstakingly careful and complicated one." The following is a description of the complete step-by-step manufacturing procedure at BASF's Bedford, Massachusetts facility. The end result is a finished and lifetime-certified 5¼" floppy diskette.

The process begins as a continuous sheet of plastic film called a "web" is run through a coating machine for the deposit of a liquid slurry made up of 40% magnetic oxide and 60% binders, resins and lubricants. The coated sheets are dried in large and very hot ovens and then calendered to compress and polish the surface. The finished material is rolled up into what's called a "butt roll" and the process repeated for the other side. To stabilize the disk's polyester base, the film then goes into curing ovens where it remains for 24 hours. After that time, the material is put through a stamping machine for cutting into "cookies" or "donuts." The stamping process cuts out the disk shape, as well as the center hole, index hole, and sector holes (if any are required). Then, another chemical is added to give the disk durability.

In another part of the factory, the jackets that house and protect the diskettes are being formed. The jacket material, PVC, is cured for 24 hours in heat chambers. A synthetic, nonwoven liner material is then welded into place as a bearing surface and cleaner for the disk. After the jacket is cut to size, it is folded into shape and the flaps are sonically welded. Centering and indexing holes for the disk are punched out, along with the write-protect notch and head-access slot, and the magnetic disk is slipped inside. The finished diskette is finally loaded into a certifying machine, which fills the entire surface of the disk with data and checks that data for errors to certify that the disk is good.

If an error is found on only one side of a disk, it will be classified and sold as single-sided. The results of the certification test also determine whether the disk will be sold as single- or double-density. (A single-density disk is one that is usable at low data-packing levels, but cannot meet the rigid requirements of high-capacity, double-density recording techniques.) Diskettes that do not pass inspection are "trashed," and the jackets reused.

Finally, after a disk passes inspection by the certifying machine, the final flap of the jacket is sonically sealed, and a hub-reinforcing ring is added. Labelling and packaging follow, and the product is ready to be shipped.

BASF quality control consists of inspection of samples of disks at every step of the manufacturing process, and between 85 and 90% of the disks pass that inspection.

Inside a Drive. The disk drive itself is a marvel of miniaturization. Very much like a super-high-speed linear-tracking phonograph turntable, the drive is a highly accurate device. The main spindle that spins the disk at 300 revolutions per minute is belt-driven from the drive motor. A tachometer and special servo system keep the spindle rotating at a constant speed.

In drives for single-sided diskettes, the read/write head, which is made of a ceramic material, is maintained in contact with the disk by a pressure pad similar to those found in audio cassettes. In drives for double-sided diskettes, the two heads, one for each side of the disk, usually act as pressure pads for one another.

When a diskette is inserted into the drive and the door closed, a hub clamps it tightly against the spindle, and it starts to spin inside its protective jacket. When the computer commands it to, the drive's read/write head moves in or out from track to track along radial guiderails, contacting the disk through the head-access slot in the disk jacket. Extreme precision of head placement is necessary, as the width of a single track is only 12/1000".

After the correct track has been located, the next step is to locate the appropriate sector. This is achieved by an index/sector detector, which is an assembly consisting of a light-emitting diode and a photocell. The index hole cut in the disk jacket allows light from the LED to strike the disk, or to pass through an index hole when one goes by it. If the light passes through an index hole, it strikes the photocell, and an electrical pulse is generated that tells the computer the position of the disk (and thus the sector over which the read/write head is) at that instant.

Disk Types. Disks are available in either "hard" sector or "soft" sector configurations. Most computers use soft-sectored disks, which have only one index hole. A few though, like the Apple II family, use hard-sectored disks with one index hole, and ten sector holes, arranged in a ring around the disk's center hole.

Each time the index hole in a soft-sectored disk passes over the index/sector detector, the pulse generated informs the computer that it is at sector one and keeps things in synchronization. The formatting procedure mentioned earlier writes information to the disk indicating the number, size, and address of every track and sector, and this information is read by the read/write head and conveyed to the computer.

In the case of hard-sectored disks, the sector divisions are determined by the numerous sector holes, with the index hole supplying synchronizing information. The hard-sectoring scheme leaves more room on the disk for actual data storage since the sector information is determined by the holes and not by information written on the disk. It is, however, less flexible to use since the size and number of the sectors cannot be changed, as can be done with soft-sectored media.

Whether a disk is used in single- or double-density mode is determined by the drive and the electronics that generate the signal that is written to the disk. (Just remember that, while you can safely use a double-density disk as a single-density one, doing the reverse can be asking for trouble.) A single-density system records using a frequency modulation (FM) system of recording binary ones and zeroes on the disk. A clock pulse plus a standard amount of space for every 8-bit word, or byte, is used.

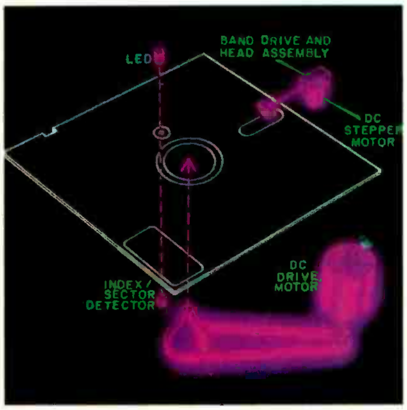


Fig. 3. Parts of a disk drive.

For double-density operation, a modified FM (MFM) system was developed to reduce the number of clock pulses by actually incorporating them in the bytes directly. Of course, more complex circuitry is required for double-density encoding and decoding, but the end result is that you can get twice as much information on the disk as you can with a single-density system.

Other Types of Disks. Disk technology is constantly moving forward (see the article on "Multi-Megabyte Minifloppies" elsewhere in this issue). New types of drive systems have been appearing over the years, and the good old 8" and $5\frac{1}{4}$" disks that we're now using may become obsolete in the not too distant future.

One variety of the present $5\frac{1}{4}$" diskette that is slowly building up steam is the 96-tpi format. It requires very-high-precision drives and disks. Instead of containing 40 tracks on each side, a 96-tpi disk contains 80. A double-sided, double-density disk of this type can hold nearly as much information as a double-sided, double-density 8" disk—close to a megabyte.

One of the latest developments in disk technology centers around a reduction in disk size together with an increase in storage capacity. The new *microfloppies,* as they are called, can hold, in the laboratory at least, as much as 1 Mb and are under $3\frac{1}{2}$" in diameter.

Actually, as is so often the case, there are several competing microfloppy formats. Three of them, to be precise: Sony's $3\frac{1}{2}$", Tabor's $3\frac{1}{4}$", and Hitachi's 3". These disks get their great capacities by using a very-high-density cobalt ferric oxide magnetic coating rated at 135 tpi. Because of their very small size, and improvements in the circuitry they use, these units can conceivably be powered by batteries. You can well expect the microfloppy to flourish in portable computer systems, but don't be surprised when you see them in desktop models as well.

Last, but certainly not least, there are the Winchester hard-disk systems. (Winchester is not the manufacturer; it was originally a code name used by IBM.) Spinning at 3600 rpm, and with read/write heads that fly over the highly polished disk surface—they are literally airborne—Winchesters allow you to lay down data in extremely dense form. It's the speed that does it, and many hard-disk systems incorporate multiple disks (called "platters") and heads in single units with staggering capacities of 60 megabytes or more. The magnetic coating used on the platters is made up of the same iron oxide particles that coat $5\frac{1}{4}$" floppies, but is far thinner. It's this thin structure, though, that allows for very high data resolution.

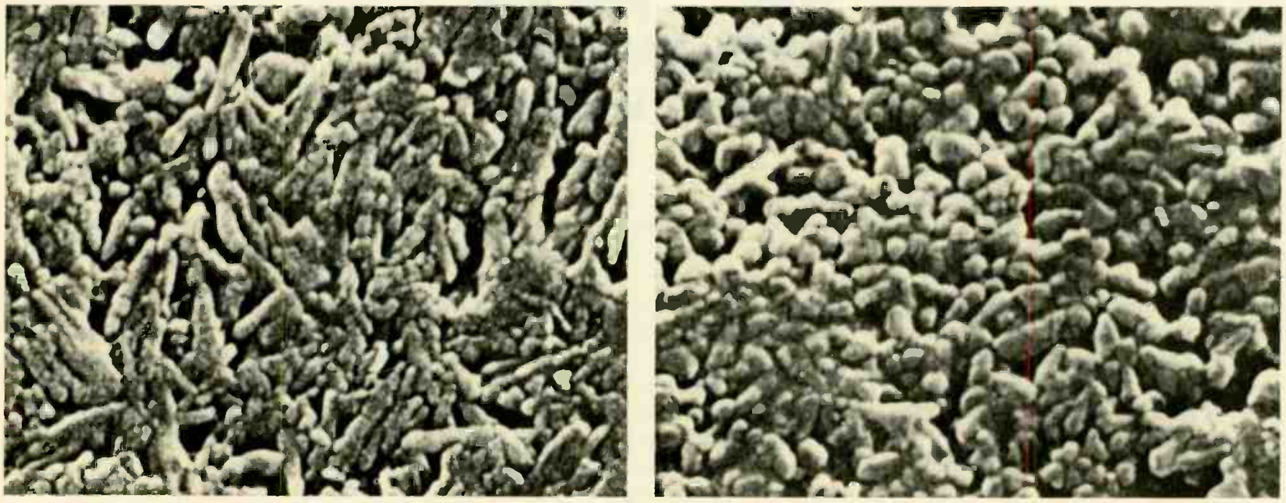
As hard-disk technology advances and the cost of producing these complex drives continues to come down, expect to see much less expensive hard-disk systems. Prices of under $1000 for a 10-megabyte drive are not far off.

Disk systems offer flexibility, reliability, convenience and, most important, speed. Reading and writing programs is no longer an anxiety-ridden 15-minute affair. If you've stored a piece of information on a disk, you can retrieve it in a matter of seconds. We've come a long way from the days of cassette tapes. ◇

MULTI-MEGABYTE MINIFLOPPIES

How a new magnetic recording medium allows for up to 10-Mb storage on 5¼" floppies

By Alijandra Mogilner



Scanning-electron micrographs of a conventional disk coating (left) and an isotropic one (right).

Mass information storage devices have been a focal point of computer hardware research and development almost since the beginning of the "computer age." The object of all this research has been to provide information storage in such a way that it can be accessed by a computer rapidly, with enough storage space to make use easy and practical. If there weren't some form of mass storage, you would have to reinput information into your system every time you turned on your computer, or even just changed from one program to another.

For years, mass storage for most home and small business applications has meant the use of 5¼" or 8" floppy disks. Hard (Winchester) disk systems have the advantage of offering greater reliability and—probably of more importance to many users—the ability to provide a large, multi-megabyte, storage area. However, until recently, they have been, for the most part, both costly and incompatible with most microcomputer systems.

Conventional 5¼" floppy disks are generally formatted with either 40 or 80 tracks and can hold from as little as about 50K of data to as much as about 700K. Lately, though, the new Japanese high-coercivity 600-oersted vertical-write emulsions capable of putting 200 tracks or more on a 5¼" floppy disk have offered small-system users an exciting breakthrough. This kind of new technology has meant that a microcomputer user could begin to approach the sort of mass information storage that was previously available only with hard-disk systems.

The Japanese, though, have been gone one better by a subsidiary of Eastman Kodak, called Spin Physics, based in San Diego, CA. It has recently announced an almost unbelievable breakthrough in mass-storage technology. Briefly, says Spin Physics spokesman Ken Thompson, its new Isomax 5¼" floppy disk offers 10 to 20 times the storage capacity of any disk the same size, using any current technology. That includes the Japanese vertical-write mass-storage systems.

However, the breakthrough has not been due to Spin Physics, or Americans, alone. Development has been quietly under way for several years. The active particle that makes the technology so revolutionary was developed by Kodak Pathe in France seven or eight years ago. Spin Physics has had the job of making that particle practical to use and has spent about six years developing it for use as a disk coating at its San Diego facility.

Isotropic Medium. Spin Physics' development is described in its patents as a "read/write isotropic 800-oersted emulsion." What that means in practical terms is that a double-sided 5¼" disk will be able to hold ten megabytes and will cost less per byte to use than any disk-storage medium currently available. Not only that, the product is far more real than many already announced "coming attractions" in the computer field. Engineering samples of 5¼" floppy disks are now being used by systems engineers and designers throughout the country.

The material of which the cobalt-doped Isomax recording medium is composed is essentially the same as that used in the fabrication of conventional disks. What is different is that it is the first to act in an isotropic (from the Greek *iso* = same + *tropos* = turn, direction) manner. The individual elements of the magnetic medium are truly isotropic in nature. In crystallographic terms, that means the magnetic structure of each particle is exactly the same in all directions. The scanning-electron micrographs on page 53 show the differences between a conventional disk coating and an isotropic one. The isotropic elements, and thus the entire recording surface, can be read from and written to both horizontally and vertically. Like Willy Wonka's magic elevator, the information can go up and down, and sideways, and backways and frontways, and *any*ways.

The new disks will be manufactured by the web-coat technology which is in widespread use today. Spin Physics will supply webs (sheet plastic coated with isotropic material) from which disks can be stamped to be sold under disk manufacturers' own brand names. The isotropic medium is also adaptable to tape and ribbon mass-storage methods, and Spin Physics has been talking with manufacturers in those areas. Users of those types of systems can expect to see isotropic media in use shortly.

Some engineers and manufacturers were hoping that the Spin Physics breakthrough could be used to create read-only disks, which would be protected against unauthorized copying. Unfortunately (depending on your point of view, of course), this was not the case, and the isotropic disks are read/write.

New Drives Required. While Isomax disks can be used in conventional drives, making the most of them will require a new type. The new drives will have to have closer head tolerances, and be more accurate in finding information. The heads will also need to maintain better physical contact with the disk surface than standard drives permit.

Spin Physics is working with all the major drive manufacturers to develop new drives that will accommodate its media. (And, at the time of writing, Eastman Kodak had just licensed a San Jose, California disk-drive manufacturer, Drivetec, Inc., to take advantage of the Spin Physics technology.) Most of the large drive-manufacturing companies have been working on programs to develop new techniques for use with vertical-write 600-oersted media prior to the announcement of the Spin Physics breakthrough. That technology already used 200 tracks or more, and had to accommodate itself to a more densely packed information surface. In a very real way, the needs of the new 800-oersted media will be met by just an extension of that same technology. The executives at Spin Physics and Eastman Kodak see their product as simply the next generation in a fast-moving field.

Not only will the drives be different, but there may be changes in the appearance of the floppy disks themselves.

Information goes up, down . . . any way . . . just like Willy Wonka's magic elevator

Disk manufacturers feel that the new emulsion may require some different "cosmetics." An 800-oersted medium is a very dense surface. That means that the tracks on an isotropic-surfaced disk will be narrower and closer together, and more tightly packed with the changes in magnetic flux that serve to store digital information. Because of this higher packing density, the disks will be very delicate and much more susceptible to damage from mishandling. They will need more protection than is currently provided. The manufacturers with whom Spin Physics is talking feel that the new floppy disks will require some kind of rigid or semi-rigid jacket, or other protective measures, to safeguard the disk media because the surfaces will be more sensitive.

These changes are considered cosmetic in nature because, while their capacities will be significantly greater than what is available at present, the disks will still use what is considered a standard format.

Capacity. Of course, the really big difference between magnetic media manufactured using Spin Physics' development and any other is how many kilobytes a 5¼" floppy disk, or other mass-storage system, will be able to hold. As a point of comparison, a current-technology 5¼" double-sided, double-density disk records at a density of 5000-6000 bits-per-inch (bpi). Disks using an isotropic medium can record up to 40,000 bpi. That means that a single-sided, double-density Isomax disk will be able to hold as much as 5 megabytes and a double-sided one as much as 10 megabytes. Compare that to the approximately 720 kilobytes available on a few current double-sided, double-density 5¼" disks.

The formats that will actually be available to the end user will be up to the manufacturers of the disk drives and of the computers that use them. There aren't any specific limitations built into the isotropic technology as far as formatting is concerned.

Actually, the new media all allow a greater flexibility in size, format, and use than do traditional ones. A good example can be seen in the mushrooming

ISOMAX UHD 800 DISK SPECIFICATIONS

Physical:

Diameter:	5.125" (130.17 mm)
Jacket size:	5.25" square
Substrate:	Polyethylene teraphthalate
Coating:	Isotropic, modified iron oxide
Thickness:	5 microns (200 ±10 microinches)
Surface Finish:	0.08 micron (3.0 microinches)

Magnetic:

Squareness:	0.85 (nominal)
Remanence:	1500 gauss (nominal)
Coercivity:	790 oersteds (nominal)

Functional:

Packing density:	To 40,000 bpi
Track density:	To 140 tpi without servo assist To 300 tpi with servo assist
Media life:	Greater than 5 million revolutions with less than 20% reduction in track amplitude
S/N ratio:	Greater than 35 dB
Overwrite:	Greater than 24 dB

popularity of the new sub-5¼" disk sizes, like Sony's 3½" microdisk. Almost all of them are already using a 600-oersted emulsion. It is really the only thing that makes such small sizes practical.

Who and When. Spin Physics has already been talking to all of the major manufacturers, and the general feeling is that the next generation of sub-5¼" disks will use its product. Whether those manufacturers will be licensees and manufacture the isotropic coating themselves, or will purchase it from Spin Physics, is still unknown. The decision is in the process of being made by Eastman Kodak marketing executives. Breaking away from its usual practice of automatically making and marketing its own products, the company has begun talking to other companies already in the disk business about licensing the technology.

However, no licenses have yet been issued, and Eastman may still decide to make the formulation itself. As Ken Thompson of Spin Physics says, "Eastman Kodak has traditionally sub-licensed to itself, but this isn't 35-mm film. This is a whole new area, so it is still under discussion."

The new technology will be available for mass marketing by the time you read this. Even as this is being written, Isomax disks are being advertised to the trade and Spin Physics is manufacturing webs and making available engineering samples. Drive manufacturers have said that drives tailored to the 800-oersted medium's particular needs will be available by the middle of this year or in early 1985.

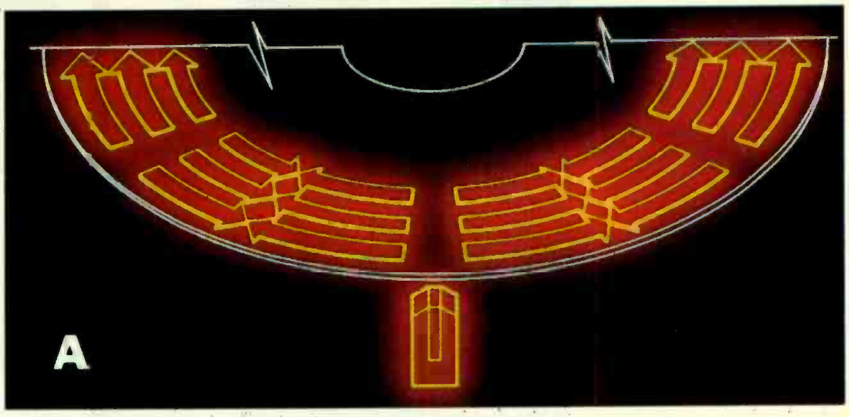
The first disks are expected to retail at about a 25% premium over what the 600-oersted-medium disks currently sell for. Spin Physics is already selling engineering samples at a price of $125 for a box of ten 5¼" disks. The company is quick to point out, though, that the cost of use per byte is significantly less than for standard disks. Its marketing personnel expect the initial retail price to be lower than the present $12.50/disk, with price erosion to occur as the product makes itself known in the marketplace. ◇

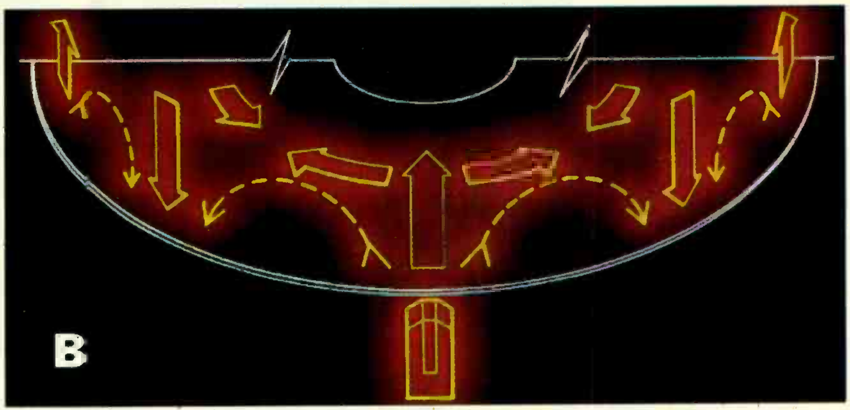
LONGITUDINAL AND VERTICAL

Conventional floppy disks are made for longitudinal recording. That is, the magnetic fields created in the disk surface's needle-shaped magnetic particles by the disk drive's read/write head are parallel to the plane of the disk. This makes it necessary for the magnetic domains (the magnetized regions) to be fairly extensive, as can be seen at A. The size of these domains necessarily limits the number of magnetic-flux reversals, which ultimately works out to bits per inch, that can exist in a given area. Thus the capacity of longitudinally recorded disks is relatively low.

The particles coating Spin Physics' disks, however, due to their isotropic properties, can be magnetized equally well in any direction. The figure at B illustrates how both longitudinal and vertical magnetization can be supported. And, again because of isotropism, the "smearing" effect encountered in recording on disks intended only for longitudinal recording does not exist. (Even though the isotropic particles may look elongated, magnetically they are perfectly spherical.)

Longitudinal media cannot retain vertical magnetization. Isotropic media can. And because magnetic fields in the vertical direction are "self-sharpening"—the isotropic medium tends to concentrate them—their resolution is much greater than in a longitudinal medium. In the end, that means that the number of bits per inch that can be recorded is significantly higher. ◇





COERCIVITY, REMANENCE AND SQUARENESS

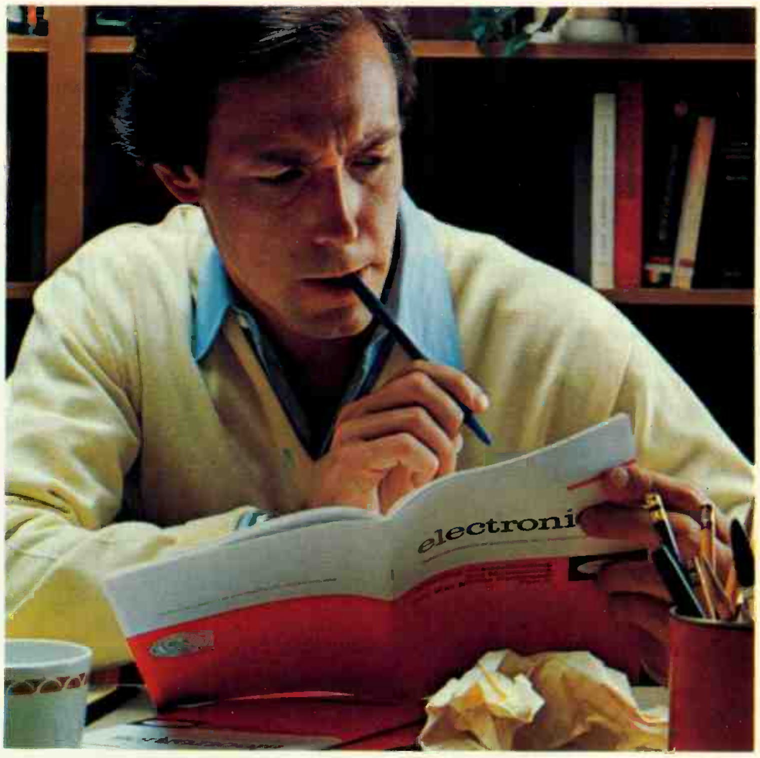
The qualities of magnetic media are measured in several ways, and those qualities bear unfamiliar names like coercivity, remanence, and squareness. Knowing what they mean will help you understand some of the factors of how effective a disk is at storing and retaining data.

The **remanence** of a material tells us how well it can be magnetized. Remanence is the flux density (the "number" of lines of magnetic force), expressed in **gauss,** of a material after it has been magnetized to saturation and the magnetizing field removed. The greater the remanence of a disk, the more strongly data can be recorded on it.

Coercivity is a measure of the attachment of a magnetic field to the particles that make up the recording surface of a disk. Its value is given in **oersteds,** an absolute measure of magnetic strength. Coercivity is defined as the value of the magnetic field (in oersteds) required to reduce the flux density of a fully saturated material to zero. The greater the coercivity of a material, the more difficult it is to demagnetize it, and, in the case of a floppy disk, the better the disk will hold onto its data.

Squareness has nothing to do with the shape of the magnetic particles making up a disk's surface. Rather, it is the ratio between the remanence of a material and its flux density at saturation. The higher the squareness ratio, the more accurately the magnetizing field is "mirrored" by the material it has magnetized. ◇

Learning electronics is no picnic.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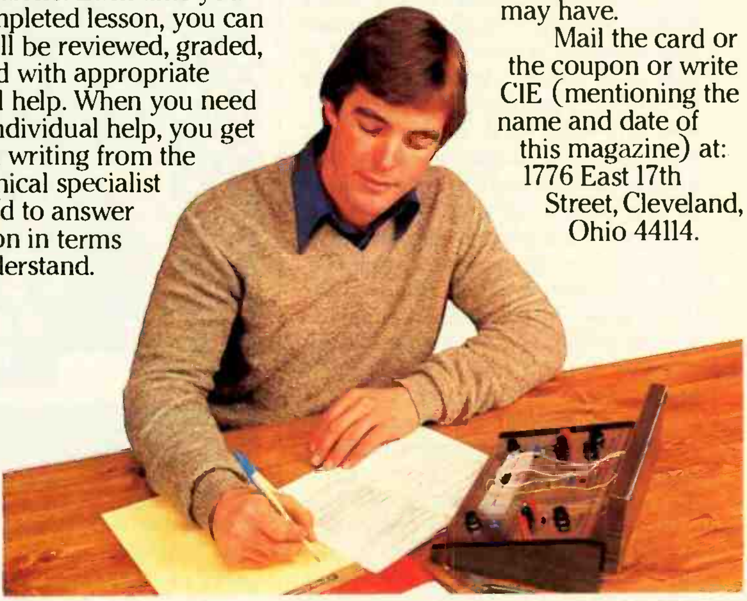

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MAIL TODAY!

First Peek at the SHARP PC-5000

A true portable with many features normally found on more expensive systems—and a plug-in bubble memory

By Alex Marx

The PC-5000 has a large display window and full keyboard.

TRUE portable computers like the Epson HX-20, Radio Shack TRS-80 Model 100, and Workslate have been in the marketplace for just a short time. But they've already made a significant impact on the buying public. What makes these computers true portables is that they conform to user expectations. Aside from having powerful computing capabilities, full-size typewriter-style keyboards, and reasonably large display windows, they are also compact and light in weight and have self-contained power sources that make them completely independent of ac line power. Any computer that conforms to these criteria is almost a sure bet to pique the potential buyer's interest. One of the newest contenders in this category is the Sharp Model PC-5000 briefcase-size portable computer.

Sharp's PC-5000 isn't just another computer like its predecessors, however. Like the portables from Epson, Radio Shack, and Workslate, the PC-5000 has a relatively large display window and a full-size keyboard. However, it also shares some of the features of the much more expensive Gavilan Computer, such as a swing-up and back display module that snaps closed to protect display and keyboard when not in use. And the PC-5000 has its own unique feature that sets it apart from all the other contenders—a plug-in bubble-memory cartridge that acts for all the world like a disk system but consumes a lot less power. Add to this a bundled software package and some interesting optional peripherals, and Sharp has a potential winner.

The System. I recently had the pleasure of testing the Sharp PC-5000. First impressions made it evident to me that Sharp has paid careful attention to its forerunners with this 12-lb (with battery installed) marvel. The PC-5000 packs a lot of hardware (and some software) into the PC-5000's $12^{13}/_{16}$″ × 12″ × $3^{7}/_{16}$″ case.

The PC-5000 has several standard features that will appeal to the serious computer user. One of these is a large 80-column by 8-line liquid-crystal display (LCD) window, which is actually a bit-addressable array consisting of 640 × 80 dots capable of displaying graphics. Another is its full-size typewriter-style keyboard with sculpted keytops. In addition to the standard character keys on the main keyboard, there are eight function keys, four cursor-control keys, and two special-feature keys in a row along the top.

The operating system chosen for the PC-5000 is Version 2.0 of MS-DOS, which makes the computer somewhat software compatible with the IBM PC. For the programmer, Sharp includes GWBASIC. The "GW," I'm told stands for "Gee Whiz," which labels this as an enhanced version of the famous Microsoft BASIC interpreter. Both MS-DOS and GWBASIC reside in a 192K internal ROM. Fleshing out the standard memory resident in the PC-5000 is 128K of RAM, which can be optionally expanded on-board, via two plug-in RAM cartridges, to a system total of 256K.

Following the tradition of other portable computers, the PC-5000 comes with bundled software. My understanding is that Sorcim's "SuperWriter" and "SuperComm" word processor and communications packages will be supplied as standard items.

Rather than going the route of a disk drive, as was done in the Gavilan computer, Sharp has chosen a 128K removable, nonvolatile bubble-memory cartridge, which is also supplied standard with the PC-5000. Measuring only $2\frac{3}{4}''$ × $2\frac{1}{4}''$ × $\frac{7}{16}''$, this cartridge offers all the features of a disk system and, in fact, is designated by the system as drive A. One of the nice things about the bubble memory cartridge is that it can be removed from its slot without having to power-down the computer—as long as the BUBBLE indicator on the top of the computer isn't on, of course. Just as with a floppy disk, the bubble cartridge can be write-protected.

The PC-5000 appears to have a virtual-drive option, which lets you plug a different bubble-memory cartridge into the slot and have it appear to the system as another drive. Hence, you get the same convenience provided with disk drives, of being able to swap program packs without confusing the system.

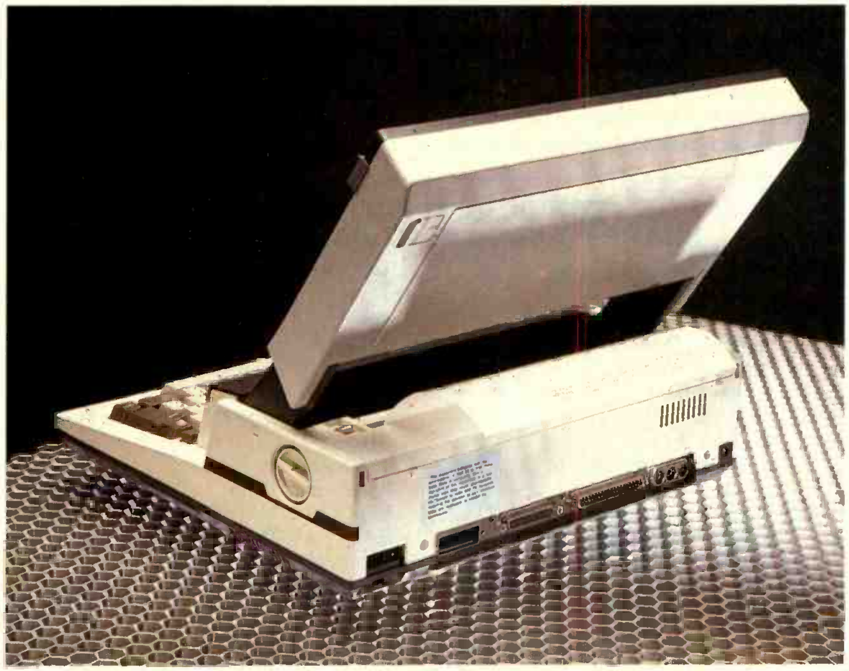
One bubble-memory cartridge is supplied standard with the computer. Additional cartridges are optionally available at $269 each.

Cassette mass-storage is supported through a built-in cassette interface. This may appear to be a throwback to a bygone era, considering that disk drive prices are at an all-time low and in light of the fact that the PC-5000 uses a sophisticated high-technology bubble-memory "drive," but it really makes good sense. It makes a reliable, sturdy backup system for valuable disks. And when your bubble cartridge fills to capacity when you're far from your disk drives, you'll appreciate this additional feature.

The price for the PC-5000's basic computing power is $1995, which isn't really excessive for a portable machine that can be expanded with optional peripherals. One such option is a $399 printer that nests inside the PC-5000's case without making the computer any larger, though it does add about 3 lbs to the weight.

An unusual feature of this printer is that it can be operated as either a thermal printer with thermal paper, or a standard printer with a ribbon cartridge and ordinary bond paper. This gives you the flexibility of using whatever type of paper happens to be available when it comes time to generate hard copy of a document or file. Being thermal, the printer is almost quiet enough to use in an office, classroom, or library, without disturbing anyone nearby. Try to do that with your run-of-the-mill impact dot-matrix printer!

Bubble memory acts like a disk system but takes a lot less power



Rear view shows how the display swings up and back.

Print quality is officially termed "correspondence," but it was very close to being "letter" quality. This is amazing, when you consider that only a few years ago thermal printers at their best were almost worse than an ordinary impact dot-matrix printer operated in the draft mode.

A plug-in modem also fits inside the PC-5000. This $349 option is compatible with both pulse and tone telephone lines and includes a 10-button dial pad. Unrealistically, you get communications software free when you buy the computer, but you must buy the modem separately.

For nonportable work you'll almost certainly want Sharp's optional dual $5\frac{1}{4}''$ floppy-disk drives for $999, anyway. Each disk has a storage capacity of 360K, and the drives will read standard IBM PC-format disks. The drives plug into a 37-pin D-type connector located on the rear panel of the PC-5000. Since this is the computer's normal expansion device, an identical connector is available on the rear panel of the disk-drive unit to permit further expansion.

Though at the present time, and for the near future, I've been informed that no other peripherals are planned for the PC-5000, it's nice to know that you *can* expand the system if and when other peripherals do become available.

The final option now available for the PC-5000 is a 64K RAM cartridge, two of which can be plugged into slots on the bottom of the computer. Adding the two 64K RAM cartridges to the 128K supplied standard with the computer brings the system up to its maximum of 256K. Each RAM cartridge carries a list price of $169.

Currently, there are just a few software packages available for the PC-5000: SuperWriter word processor, SuperComm communications package, and SuperCalc^2 spreadsheet, all from Sorcim. Sharp informs me that it's negotiating with several large software houses for additional programs for the PC-5000. My guess is that a database program and maybe another spreadsheet package like VisiCalc or 1-2-3 will soon be in the offing. And since the PC-5000 uses MS-DOS, I feel safe in speculating that much other software will be forthcoming, from Sharp and outside vendors.

The Details. The PC-5000 I tested was a preproduction model, which gave me an opportunity to get a sneak preview of Sharp's new computer product. Sharp informs me that the unit I had was the same as the one that will be in full production, although the test unit I had hadn't been optimized as the full production models will be. In fact, my test unit had been pulled out of Sharp's service department, where it had been to fix the printer.

The PC-5000 is physically small, no larger, in fact, than a portable typewriter, though it's a bit heavier. It's designed to fit into a large attache case. By the time this appears in print, however, Sharp should have ready an optional carrying case for the computer. I'm also told that an American Tourister hardcase, which I haven't seen, will be tailored to fit the PC-5000. From its description, I get the impression that the hard case is designed for shipping the computer, rather than for typical carry/use applications.

On the rear panel of the PC-5000 are several connectors and a pair of switches. From right to left, viewed from the rear, there are an ac adaptor jack, cassette interface connector, 37-pin D connector for floppy-disk drives, standard 25-pin D connector for the RS-232 serial output, and connector for the optional modem. The two switches, one rocker and the other a slide type to avoid confusion, are mounted one above the other at the far left. The rocker switch is used to apply and disable power to the computer. The slide switch is for connecting the system's ac adapter as either a power source for the computer or as a recharger for the battery pack.

TECHNICAL SPECIFICATIONS
SHARP PC-5000 PORTABLE COMPUTER

Central processor unit:	16-bit 8088
ROM memory:	192K
RAM memory:	128K
Bubble memory:	128K
LCD display	80 char. × 8 lines
Graphics:	650 × 80 dots
Keyboard:	Standard QWERTY
Serial I/O:	RS-232
Audio cassette:	1600 bps
External bus driver:	8 bits handshake
Operating system:	MS-DOS 2,0 in ROM
Program language:	BASIC in ROM
Extra functions:	Clock, sound generator
Power source:	Rechargeable battery with adapter
Dimensions:	$12\frac{13}{16}$"W × 12"D × $3\frac{7}{16}$"H
Weight:	11 lb

On the bottom panel of the computer is a recessed CLOCK switch that apparently connects and disconnects a separate internal clock battery. Setting this switch to off prevents the PC-5000 from functioning at all. This position is used whenever the computer isn't to be used for a long period of time, to prevent the internal clock battery from running down. Also on the bottom panel are two covers that protect the slots used for RAM memory expansion.

The top of the computer is divided into several distinct sections, the most forward of which is actually a hinged module that swings up and back and contains the display window. This module can be set to any of a number of click-stop positions for most comfortable display viewing. Built into the top surface of the module is a shallow well that accommodates the optional modem and has a removable protective cover.

If Sharp supports it, the PC-5000 should be a real winner

Moving toward the rear of the computer, the next section contains a flip-up cover that protects the bubble-memory cartridge slot. (Inside the slot is a plastic lever for ejecting the cartridge.) Also on this section are three LED status indicators arranged in a vertical column like a traffic light. The top (red) LED lights when the battery needs charging; the middle (yellow) LED lights when power is turned on; and the bottom (green) LED lights whenever the bubble memory is being accessed.

Continuing toward the rear, there's a hinged plastic cover that protects the optional printer mechanism. My test unit came with the printer installed, so I can only guess that some sort of dummy plastic panel comes with the computer with no printer installed. Behind and to the right of the printer well is the paper-release lever for the printer, and behind this is the final section that has a narrow slot for loading paper into and unloading it from the printer.

The rear-most section is removable to provide access to the battery compartment. The battery itself is a sealed lead-acid module that measures 5" × 2" × 1" and weighs less than 8 oz but packs a powerful 1.6-ampere-hour charge at 6 volts. This is enough power to keep the computer going for eight hours or to provide 2 hours of nonstop printing. (Additional battery packs will be optionally available.)

On the right side of the computer are thumb controls for adjusting the volume of the internal speaker and display contrast. On both sides of the computer are locking latches for releasing the hinged display/modem assembly so that it can be swung into operating position and expose the keyboard.

The main keyboard features the standard typewriter layout and automatic repeat when a key is held down for more than a second. Happily, the RETURN key is located in the correct place. An ALT key is located to the right of the space bar, far enough out of the way that it won't be accidentally pressed. Just below the RETURN key is the CAPS lock key, which, unfortunately, offers no visible means of telling you whether it's in the released or locked mode. A locking push-on/push-off key or a LED indicator would be a definite improvement here.

Arranged in a single row across the top of the main keyboard are 15 rectangular keys. At the far left are two orange-colored keys labeled ON/BRK and OFF. They control a unique "sleep" feature (*not* power to the computer) that partially powers down the PC-5000. This feature lets you turn on the computer at a preset time via the internal clock or the modem. This makes the system usable even if unattended, with minimum drain on the battery.

Using the sleep feature, you can, for example, have the computer turn on by itself and dial your office, via the modem, and download data to or upload data from your office computer, all automatically. Since a timer is involved in this function, you can set the system to take advantage of less-expensive nighttime telephone rates. You could even have your office computer call the PC-5000 and have it turn on to accept or send data. Now that's a really nice feature!

The eight function keys that follow the OFF key are used by software to activate different functions in one-key operations. To the right of the function keys are the four cursor-control arrow keys. Being arranged in a row, rather than in a diamond shape, the cursor-control keys tend, at first, to be a little inconvenient to use. Once I became accustomed to their placement, however, I had no trouble at all using them.

The last key in the top row is labeled CLR/INS. Operated in the shifted mode, it clears the screen and homes the cursor in the display window. The unshifted mode lets this key change the cursor from a blinking underline to a blinking block and permits nondestructive insertion of characters in a line.

Use Tests. How does the PC-5000 perform? The answer is, very well, even with my nonoptimized preproduction test unit. Though the screen on my test unit updated slowly, but smoothly, Sharp informs me that the production version will be optimized for greater speed. Characters displayed in the LCD window were small but very sharp. They appear to be constructed in a limited 5 × 7 matrix that doesn't support true lower-case descenders. The dots are so small that you get smooth, solid characters that aren't broken into difficult-to-read individual dots alternating with blank spaces. In addition to being able to adjust contrast for best readability, you can control the apparent "brightness" of displayed characters through software to obtain different effects.

The optional printer nests neatly into the computer to make a complete package.

The only problem I had with the display was a case of glare that tended to make the display unreadable. To deal with this problem, I adjusted both the tilt angle and the contrast of the display, but neither was very effective. With normal overhead fluorescent lighting, I experienced difficulty in obtaining an acceptable pair of adjustments. The problem appears to be with the transparent plastic insert that protects the LCD panel from damage. Putting an incandescent table lamp above the display made a positive difference.

The glare proved to be a serious problem for me, but other people who used the computer weren't as adversely affected by it. They were aware of the glare but were able to work around it. Over a long period of time, though, I imagine that eyestrain is likely to set in. The solution to the problem might be to use a slightly less polished plastic window or even an antiglare filter.

The keyboard was a joy to use. An experienced typist would have no problem with it. However, the drawback to making the computer as compact as possible is that something had to be sacrificed, in this case, a separate numeric keypad cluster (an omission common to all portable computers to date).

The optional printer was *very* quiet in operation, even though my unit was pulled from the repair bin with a bad printer. The quality of the printouts on both thermal paper and standard bond was excellent; you would have to look very closely to see that the print is generated with a dot-matrix printhead and not a formed-character element. The ribbon used for printing on bond paper is contained in a compact cassette-like case that simply snaps into place. I've never seen such an easy-to-install ribbon!

The printer can accommodate paper up to 8½" wide, a single sheet at a time. It hums along at a print speed of 37 characters per second, which isn't exactly fast. Keep in mind, though, that we're talking here about near-letter-quality print, however. The printer is also capable of printing out dot graphics, with a resolution of 1197 dots per line and at a speed of 555 dots per second. Furthermore, print intensity can be controlled via software to create shading effects.

Software received with the PC-5000 consisted of SuperCalc^2, SuperWriter, and GWBASIC. Unfortunately, since mine was a preproduction model, I couldn't fully test all the packages because SuperWriter was missing several overlay files and several features of both applications packages weren't yet implemented for the PC-5000. This situation will be cleared up in the production models, but it was frustrating not to be able to perform in-depth tests to find out what I could do with the hardware and software.

The bubble-memory cartridge I had was too full to permit any large files to be created for either SuperCalc^2 or SuperWriter. However, I was able to test some BASIC programs and found the language to be very fast, the only exception being when it displayed to the screen. Again, I'm assured by Sharp that this will be corrected in production models.

From the abbreviated testing I did perform, the limited number of lines that can be displayed on the LCD screen presented no problems. With SuperCalc^2, I was able to scroll through a large model very quickly, which made viewing somewhat less inconvenient than it might have been with the limited-size display window. I was also able to perform some split-screen operations that let me view two different portions of the model on the same screen.

Working with SuperWriter, I noted that the word processor used the function keys very effectively. I had no problem using the program for simple word processing, even without having to refer to the manual. Both SuperWriter and SuperCalc^2 have built into them extensive help screens that can be called at any time to aid you in what you're attempting to do. I don't hesitate to state that these are two great applications programs.

In theory, the bubble memory is a great idea for a portable computer. In practice in the PC-5000, it worked very well. Because it functions like a disk sys-

(Continued on page 101)

USE YOUR TRS-80 COLOR COMPUTER AS A STORAGE OSCILLOSCOPE

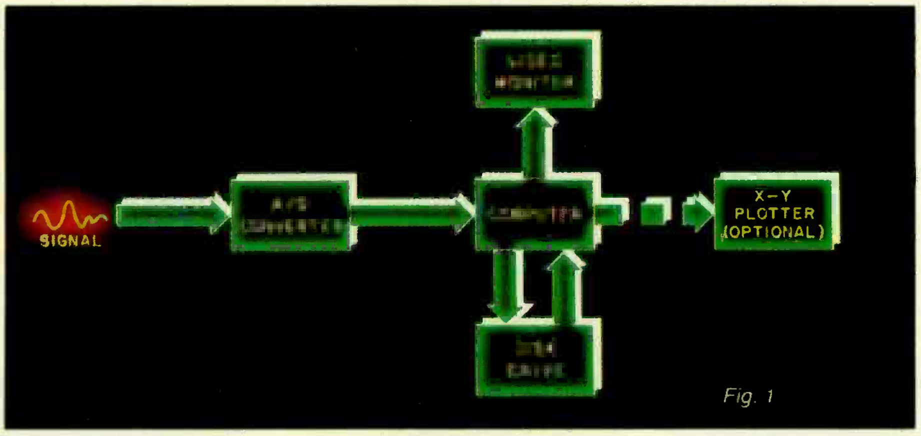

VIDEO MONITOR
SIGNAL
A/D CONVERTER
COMPUTER
X-Y PLOTTER (OPTIONAL)
DISK DRIVE

Fig. 1

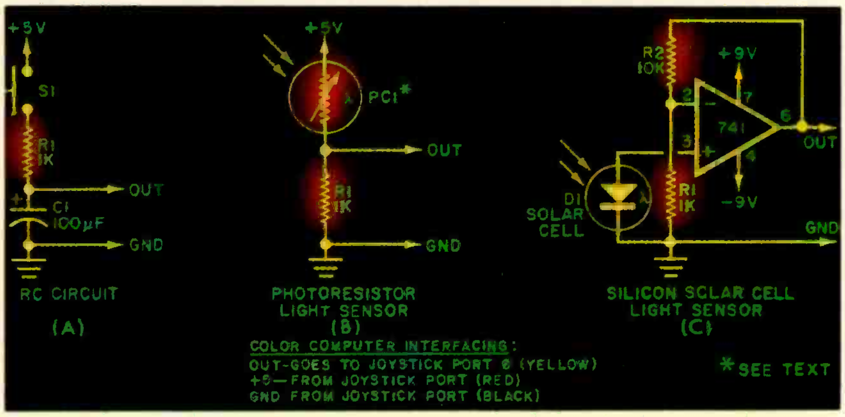
With an analog-to-digital converter on your TRS-80 Color Computer, you have the makings of a low-cost storage oscilloscope

By Forrest M. Mims, III

OF the many kinds of electronic test instruments, the oscilloscope is by far the most important. Only the oscilloscope provides a graph-like electronic picture showing how a voltage (the *signal*) varies with time. You might say the oscilloscope combines the functions of a voltmeter and frequency counter into a single but more powerful instrument. Borrowing from the old adage, you might also say a single oscilloscope trace is worth a thousand data points.

In the simplest oscilloscopes, a thin beam of electrons is repeatedly swept across the phosphor screen of a cathode ray tube (CRT) much like those in television sets. The beam can be deflected vertically by a signal applied to a sensitive amplifier whose ouput is connected to electrodes within, or an electromagnetic coil outside, the CRT. This provides a brightly illuminated graph that neatly displays the time-dependent variations in the amplitude of a signal. Simply by speeding up the time required for the beam to sweep across its screen, an oscilloscope can provide a look at signals whose amplitude fluctuates many millions or even billions of times in a single second.

Fig. 2. Three circuits whose outputs can be monitored.


+5V
S1
R1
1K
C1
100μF
OUT
GND
RC CIRCUIT
(A)
+5V
PC1*
OUT
R1
1K
GND
PHOTORESISTOR
LIGHT SENSOR
(B)
R2
10K
+9V
2
7
741
6
3
4
OUT
D1
SOLAR
CELL
R1
1K
-9V
GND
SILICON SOLAR CELL
LIGHT SENSOR
(C)
COLOR COMPUTER INTERFACING:
OUT-GOES TO JOYSTICK PORT 0 (YELLOW)
+5-FROM JOYSTICK PORT (RED)
GND FROM JOYSTICK PORT (BLACK)
*SEE TEXT

Often an oscilloscope user would like to be able to "freeze" the trace on an oscilloscope screen for more detailed study. This is especially true when the sweep speed is very slow or when a signal with a very brief duration (such as that produced by a switching logic gate) is being monitored.

One way to preserve a trace is to photograph the oscilloscope's screen. Another is to use a sophisticated instrument called a *storage oscilloscope.* Unfortunately, storage oscilloscopes are quite costly.

A little more than a year ago, a small company called Northwest Instrument Systems (PO Box 1309, Beaverton, OR 97075) revolutionized oscilloscope technology when it introduced a sophisticated computer peripheral that brought the capabilities of a storage oscilloscope to anyone with an Apple II computer and $995. Dubbed the Model 85 aScope™, the device is a module containing a fast analog-to-digital converter. When plugged into an Apple II, the aScope provides the capabilities of a laboratory storage oscilloscope costing as much as $10,000.

The aScope is supplied with appropriate software (on disk) to place labels and a graticule on the screen of the computer's monitor. The software also permits traces to be saved on disk and printed on paper.

The aScope is merely the first of an expected flood of peripherals that will allow personal computers to function as many kinds of sophisticated, programmable test instruments. Concerned about this new development, traditional makers of oscilloscopes and other test instruments have already begun to develop new systems designed around personal computers.

If you own or have access to a personal computer equipped with an analog-to-digital converter, you can develop your *own* test instruments. You can even convert your system into a slow-scan, storage oscilloscope. In the remainder of this article we will explain how.

If you own a personal computer with an analog-to-digital converter, you have the essential ingredients for a slow-scan oscilloscope. And if you have access to an x-y plotter, you can transform traces displayed on the computer's display into publication-quality images.

Best of all, you can assemble a computer-simulated oscilloscope from surprisingly economical components. While many different computers can be used, I have had excellent results with Radio Shack's Color Computer. Using a system equipped with Extended Color BASIC, I developed software to transform the computer's display into a very useful large-screen, slow-scan oscilloscope with both single-sweep (storage mode) and continuous-sweep operation. The software includes an optional graticule complete with tick marks, and the ability to store traces on a floppy disk for later retrieval and display. A second software package directs an optional plotter to draw a high-resolution rendition of a trace stored on a disk.

Getting Started. If you've ever tried to use a standard oscilloscope to observe a slowly changing signal, you can readily appreciate the advantage of a storage scope that freezes the display for later viewing and interpretation. The only other way to preserve the trace is to photograph the display.

A simple block diagram showing how a personal computer can be configured as a slow-scan storage oscilloscope is shown in Fig. 1. While any of a number of computers can be used, excellent results can be attained with a 32K Color Computer with Extended Color BASIC.

The original machine has been replaced by the 16K Extended Color Computer 2 and the 64K Extended Color Computer. Like the original product, these new machines are equipped with two analog joystick ports for a total of four A/D converter inputs. The software given here, although developed for the original Color Computer, should run on both new machines.

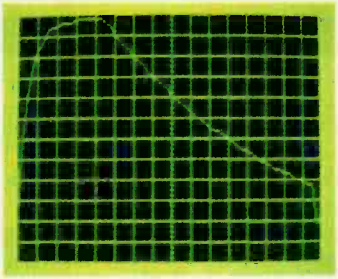


Fig. 3. Charge-discharge cycle for circuit shown in Fig. 2A.

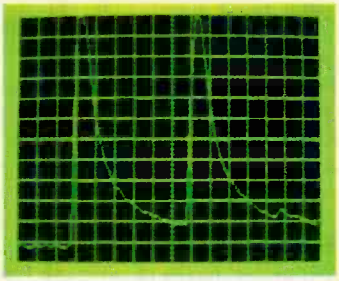


Fig. 4. Two spikes produced when flashlight is blinked twice.

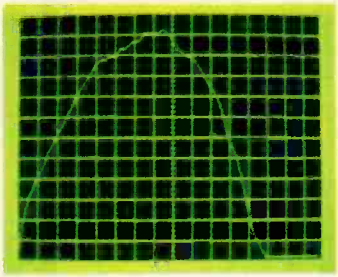


Fig. 5. Slow scan of flashlight across circuit in Fig. 2C.

Operation of the Color Computer joystick ports is described in detail in "The Electronic's Scientist" column elsewhere in this magazine. Briefly, when the joystick feature is selected, the computer generates a decimal number directly proportional to the voltage at the selected joystick port. These numbers ranges from 0 to 63 (6-bit accuracy) when the voltage varies from about 0.3 to 4.75 volts.

Normally the voltage is derived from the two potentiometers in each joystick. Each potentiometer is connected as a voltage divider across a 5-volt supply from the computer with the wiper terminal providing a variable output voltage as the potentiometer shaft is rotated.

Of course any other voltage source can be connected to the joystick ports if its excursions fall within a 0-to-5-volt window. In any case, the digitized representation of the voltage can be summoned by the simple command JOYSTK(*n*) where *n* is the port number (0-3).

Knowing this and taking advantage of the Color Computer's powerful graphics capabilities, it is easy to develop a rudimentary oscilloscope program. Here's one possibility:

```
10 PCLS : PMODE 4 , 1 : SCREEN
   1 , 0
20 FOR X=0 TO 255
30 Y=JOYSTK ( 0 )
40 PSET ( X , Y )
50 NEXT X
60 GOTO 10
```

This very simple program transforms the screen of the monitor into a black square surrounded by a green border. A moving green dot traces a solid line from left to right across the black square.

If the wiper of the potentiometer representing JOYSTK(0) (horizontal, right joystick) is rotated, the green dot will move up (or down), leaving behind a trail of dots. When the dot reaches the right side of the square, the line and dot pattern it has traced is instantly erased and a new sweep is begun.

The simple oscilloscope program can be converted to emulate a storage scope merely by changing the last line to:

```
60 GOTO 60
```

The green dot will now form a single trace which will be displayed on the monitor until the BREAK key is pressed.

Other enhancements can be easily added to the basic program. For example, the following BASIC line will add a trigger feature to intitate a trace *only* when the incoming voltage exceeds 0.3 volt:

```
15 IF JOYSTK ( 0 ) > 0 THEN 20
   ELSE 15
```

The trigger feature can be further enhanced by changing 0 [not JOYSTK(0)] to a variable. Many other features can also be added. For example, a graticule can be drawn on the monitor's screen. And, traces can be saved on disk for later retrieval and viewing.

Comscope. The simple program just discussed has been enlarged into a menu-driven computerized oscilloscope program called Comscope shown in Listing 1. While the joystick and graphics commands in Compscope are unique to the Extended Color BASIC of the Color Computer, the program can be used as a guide to develop similar software for other computers.

When entered and run, the monitor displays Comscope's menu:

```
COLOR COMPUTER
OSCILLOSCOPE
A. SINGLE SWEEP STORAGE
    SCOPE.
B. CONTINUOUS SWEEP SCOPE.
C. RETRIEVE TRACE FROM
    DISK.
FOR GRATICULE ADD G TO
    SELECTION
PRESS M TO RETURN TO MAIN
    MENU
SELECTION?
```

The menu provides a total of six options. If a G is appended to the selection, the graticule subroutine (line 2000-2160) is executed. The graticule provides a grid of 16 horizontal and 12 vertical divisions. The center horizontal and vertical lines are given short tick marks.

If single or continuous sweep modes are selected, the sweep subroutine (lines 4000-4700) is executed. In both cases, the program first asks for the desired sweep time in seconds-per-division (0.35 second minimum) and assigns it to variable SD (see lines 340-360).

The program subtracts 0.34 second from the time entered. The 0.34 s is the approximate time required for the program to execute the steps that retrieve joystick values and draw the trace on the monitor (lines 4300-4350). The result after the subtraction is multiplied by 460, the number that, when used in a one line timer loop (FOR T=0 TO 460:NEXT T), produces a delay of 1 second.

If the trace is *not* to be saved on disk, the product is then divided by 16, the number of pixels in a single graticule division, and designated SW (line 360). If the trace is to be saved on disk, the product is divided by 4. This is because traces to be saved on disk must be made at 1/4 the resolution of ordinary traces to prevent the disk buffer from filling before all or at least most of the trace has been completed.

High resolution traces *can* be saved, but since the disk drive will turn on and momentarily interrupt program execution several times during a single trace, the resultant traces will contain undesirable artifacts. This is particularly true when fast sweep speeds are selected and when the input voltage varies rapidly.

The processed seconds-per-division variable (SW) is held until needed by the sweep subroutine. It is then used in the timer loop at line 4340.

In the simple demonstration program given earlier, the trace was formed by a stream of dots. When superimposed on a graticule, however, the dots lack the visibility a solid line would provide.

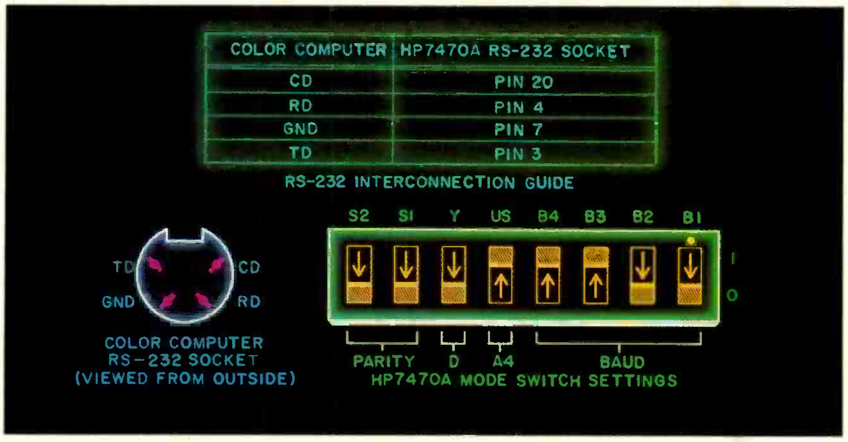
For this reason the sweep subroutine forms a continuous line trace. Line 4100 establishes a starting point for the LINE command. Line 4330 then extends a line from the starting point to the first pair of coordinates designated by a FOR . . . NEXT loop (x values) and the data retrieved from the disk data file (y values).

Incidentally, line 4200 in the sweep subroutine provides a trigger that prevents the sweep from beginning until the voltage at the joystick port exceeds about 0.3 volt. This feature can be omitted by dropping line 4200. Or you can alter the condition so that the sweep begins at any joystick value you select (0-63).

A particularly important option in the single-sweep storage scope mode is whether or not you wish to save a trace on disk. Comscope assigns your answer (Y or N) to a string variable called D$ and at various points in the program queries D$ to determine whether or not data is to be saved on disk.

At line 370, a disk data file assigned a name you specify (see N$, lines 330 and 370) is opened if D$ is Y. At line 4320 in

(Continued on page 98)



COLOR COMPUTER	HP7470A RS-232 SOCKET
CD	PIN 20
RD	PIN 4
GND	PIN 7
TD	PIN 3

Fig. 6. How to connect a plotter to the Color Computer.

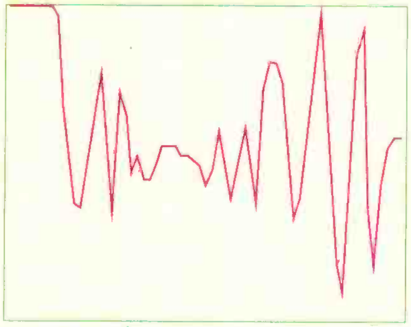


Fig. 7. Plot of joystick output.

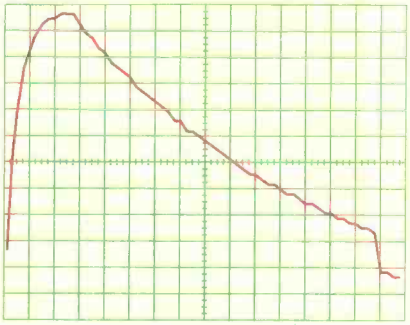


Fig. 8. Plot same as Fig. 3.

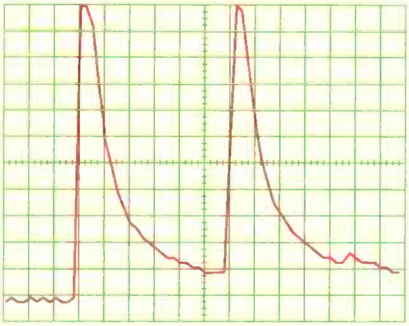


Fig. 9. Plot same as Fig. 4.

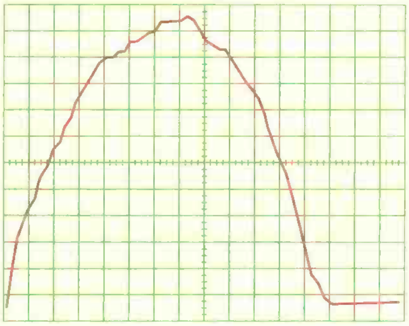


Fig. 10. Plot same as Fig. 5.

AN 8-BIT COMPUTER GETS A NEW OPERATING SYSTEM

Epson's QX-10, using new Valdocs software, offers an integrated package that provides word processing, communications, and many other features

By George Mitchell

EPSON
SYSTEM CONTROLS
STOP
HELP
COPY DISK
UNDO
FILE CONTROLS
STORE
PRINT
INDEX
MAIL
TAB
SHIFT LOCK
SHIFT
CTRL
MAR REL
TAB REL
TAB SET

EIGHT-BIT microcomputers have multiplied like rabbits during the last few years and most are fairly similar. Every so often, though, a manufacturer takes a common product like this and adds a new dimension to it. Such is the case with Epson America. Known primarily for its highly successful line of printers, Epson has developed the QX-10 microcomputer using the latest version of the Valdocs software running under the TPM (Transient Program Manager) operating system. This 8-bitter does such uncommon things as power up as a word processor and react to keys marked "insert," "bold," and "italic." With one keystroke, you can switch the QX-10 to communications and dial another computer. When the call is completed, another keystroke will return you to the document you just left.

But this innovative product has not been without difficulties. The Valdocs software has paid for its expansive, integrated approach by being slow and full of bugs when first introduced more than a year ago. A series of revisions has cleared up most of the problems, however.

The QX-10 not only runs Valdocs, but also CP/M software. Epson is marketing the QX-10 as a package that includes Valdocs 1.18,CP/M 2.21, a five-pack of Peachtree software (text, calc, proofreader, thesaurus, and mailing list), and an RX-80 FT printer and interface for a suggested retail price of $2995. This review concentrates on the QX-10 computer and the implementation of the new Valdocs software.

Anything But Modest. In design, the QX-10 is unusually sophisticated for an 8-bit machine. The system is bus-oriented and uses a modular concept to maximize system resources (Fig. 1).

The QX-10 uses a Z-80 microproces-

In design, the Epson QX-10 is unusually sophisticated for an 8-bit machine.

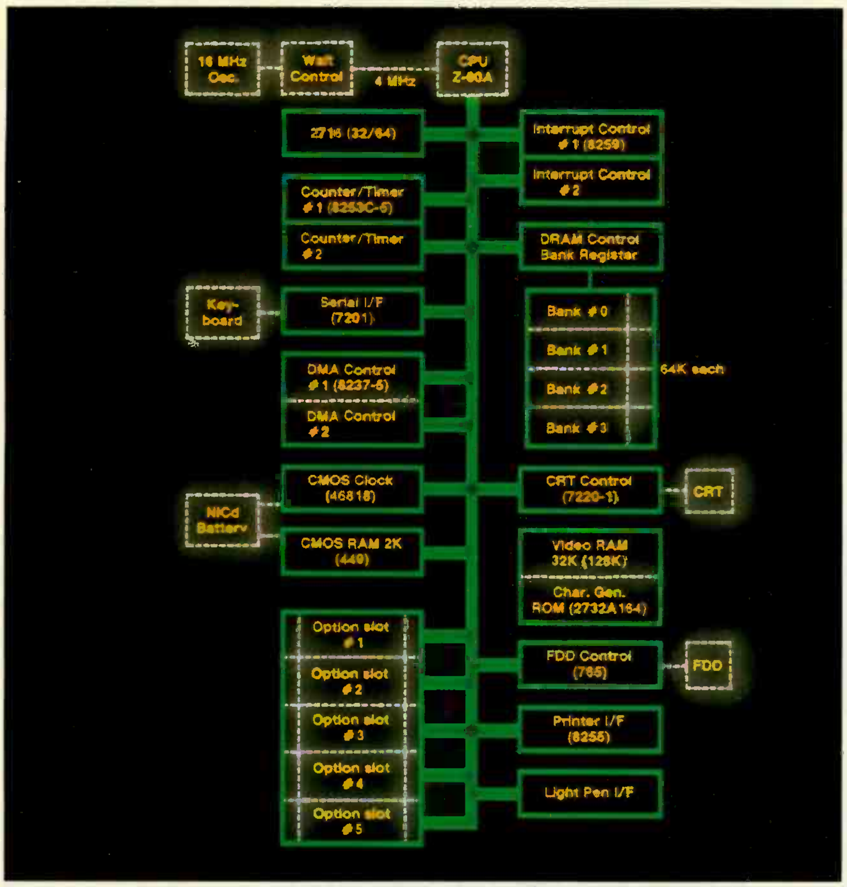

16 MHz Osc.
Wait Control
4 MHz
CPU Z-80A
2716 (32/64)
Interrupt Control #1 (8259)
Interrupt Control #2
Counter/Timer #1 (8253C-5)
Counter/Timer #2
DRAM Control Bank Register
Key-board
Serial I/F (7201)
Bank #0
Bank #1
Bank #2
Bank #3
64K each
DMA Control #1 (8237-5)
DMA Control #2
CMOS Clock (46818)
CRT Control (7220-1)
CRT
NiCd Battery
CMOS RAM 2K (449)
Video RAM 32K (128K)
Char. Gen. ROM (2732A 164)
Option slot #1
Option slot #2
Option slot #3
Option slot #4
Option slot #5
FDD Control (765)
FDD
Printer I/F (8255)
Light Pen I/F

Fig. 1. The system is bus-oriented, with a modular concept.

sor, specifically the NEC PD780C-1 operating at 4 MHz (I clocked it at 4.67 MHz), driven by a 16-MHz oscillator through a divide-by-4 circuit. The CPU fills two roles in the QX-10: data processor and system manager.

The NEC PD8237 DMA controllers and PD8259 interrupt controllers work in concert with the CPU to establish a priority of devices along the bus (Fig. 2). Notice that the disk and monitor have the highest priorities, with the options acting as slaves with their own priority and interrupt scheme.

The QX-10 comes standard with 256K RAM that is divided into four banks of 64K each. Besides this, there is 2K of battery-backed CMOS RAM, located between 8000 and 8800 hex, which is used to store system information such as data needed by the HD46818P real-time clock. In addition, about 50 bytes can be used for holding other information, either supplied by you, or later by Epson.

Dual Disk Drives. The standard system includes dual disk drives. They are 1/3-height double-sided, double-density, 48-tpi models with a capacity of 320K bytes for actual usage on a diskette formatted for data and about 290K for a system diskette.

The drives feature a positive loading mechanism that prevents accidental damage to a diskette by action of the door and also ensures proper spindle mounting and head loading. Moreover, the drive has sensors that are used to advise the system that a diskette is in or out, or has been changed. Unfortunately, CP/M hasn't been modified to take advantage of this feature; but TPM does.

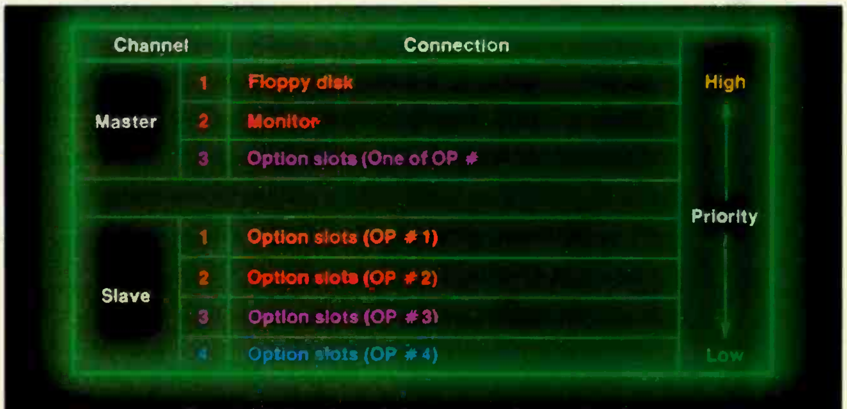
The NEC PD765A programmable disk controller is a stack device. This means that it can be set up to operate in a much more efficient manner in an interrupt-driven system with DMA than can a register device. Moreoever, the NEC controller permits the creation of large buffers and the use of "least-frequently-used" methods for speeding up access. Surprisingly, neither CP/M nor TPM makes use of this fact. The disk system, therefore, is slower than you would expect or, for that matter, want. For example, it takes 45 seconds to load in Valdocs from either a cold or warm boot.

Based on the way the memory is laid out as shown in Fig. 3 and considering specifically the area for the floppy disk, one would expect that multiple track buffers would be used, but they're not.

There are five expansion slots on the main motherboard for adding such options as a GP-IB (IEEE-488) interface, an optical-fiber interface, a color CRT interface, and a pulse transformer interface. Pin numbers and corresponding signals for the expansion slot are given in Table I. You can also add a 10M-byte Winchester to boost storage.

In addition, the system has tucked away under its low-profile (20" x 13" x 4") covers 8K of system ROM, a speaker, 7 channels of DMA, 15 interrupt levels, and 6 channels of counter/timer circuitry.

A Capable Screen. Another feature of the QX-10 is the screen display. The



Channel		Connection	
Master	1	Floppy disk	High
	2	Monitor	
	3	Option slots (One of OP #	
			Priority
Slave	1	Option slots (OP #1)	
	2	Option slots (OP #2)	
	3	Option slots (OP #3)	
	4	Option slots (OP #4)	Low

Fig. 2. Priority of devices along the bus.

system employs a 12" green-phosphor CRT capable of displaying 640 x 400 dots. The screen is controlled by the NEC-7220 display controller, and has 128K bytes of RAM dedicated to it. This provides a continuous scrolling screen, thus allowing a page-like system ideal for word processing.

The display is worthy of a review all its own simply because of the capability it offers. You can, for example, expand a figure 16 times, develop line-clipping mechanisms, and rotate figures in real-time. That is, you can if you have the software. Epson has supplied some with Valdocs, and I have found that the system works well with Fox and Geller's "dGraph."

Working in concert with the screen is the printer. The system I evaluated included an Epson FX-80 dot-matrix printer, which can achieve a dot-for-dot resolution with the screen.

A New Keyboard Design. One of the touted features of the QX-10 is the so-called HASCII—Human engineered ASCII—keyboard. It uses function keys that are predefined for a variety of purposes such as HELP, MENU, MAIL, DRAW, and even an UNDO to let you fix goofs.

This 105-key detached keyboard includes an alphanumeric set of keys, a numeric keypad, function keys, and dedicated word-processing keys. The keys are the full-travel type, which have an excellent feel to them. The layout of the keyboard is similar to one you might find on a dedicated word processor. In other words, functions such as INSERT, TAB SET, ITALICS, etc. can not only be accessed with one keypress, but are labelled as such.

The QX-10 uses 1/3-height 5¼" disk drives.

To Epson's credit, it did carry the layout design further and built in functions that take advantage of Valdocs. But the operation codes were redefined also, thus making it tricky to use the function keys with other software. The system can respond to either Televideo 920 sequences, which you can establish through the SETUP.SYS file available on the Valdocs system disk, or what they term Valdocs standard, which is the same as a Lear Siegler ADM3A. Both implementations are only partial, however, and you might find that not all things work the way you would expect.

Valdocs. The Valdocs software is designed to work in concert with the hardware. It runs under the TPM operating system and takes advantage of the HASCII keyboard. Valdocs is an integrated software package that offers word processing, graphics, communications, mail list/database, document locater, time scheduler, and calculator. It is a menu-driven system with four experience levels: beginner, novice, advanced, and expert. In operation, you boot up using the Valdocs system diskette. I was supplied with the latest 1.18 version. (Valdocs has gone through many revisions and has many to go. Each time, it does get better.)

Word Processor. The system comes up in the word-processor mode, which acts exactly like a typewriter. You can set the page any way you want. The word processor uses a window approach with the text window at the top and the menus in a window at the bottom. Tapping the HELP key brings up a menu that allows you access to six other menus, plus offers a tutorial on the basics of using the word processor. The menu is shown in Fig. 4.

Choosing the On-Screen menu enables you to center text, set margins, etc. The Miscellaneous menu permits changing wordwrap, justification, etc. Margin settings are displayed on a sta-

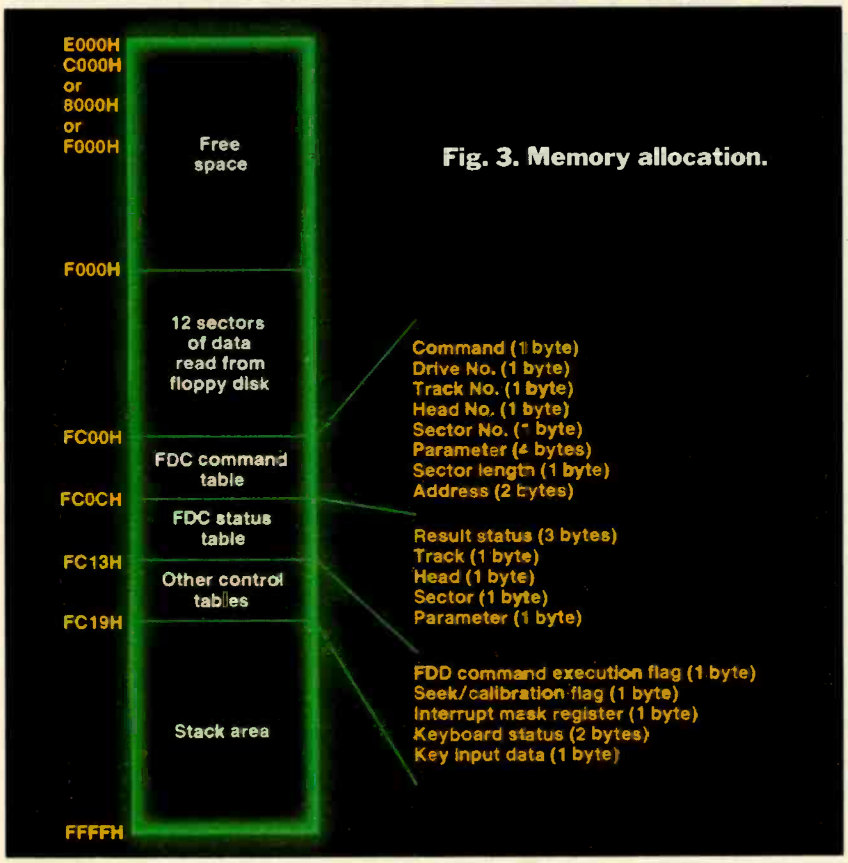
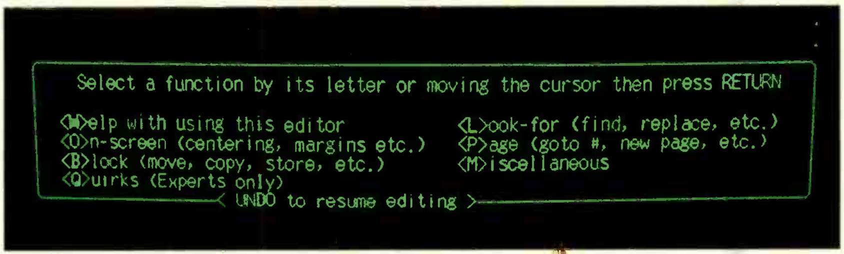

E000H
C000H
or
8000H
or
F000H
Free space
F000H
12 sectors of data read from floppy disk
FC00H
FDC command table
FC0CH
FDC status table
FC13H
Other control tables
FC19H
Stack area
FFFFH
Command (1 byte)
Drive No. (1 byte)
Track No. (1 byte)
Head No. (1 byte)
Sector No. (1 byte)
Parameter (4 bytes)
Sector length (1 byte)
Address (2 bytes)
Result status (3 bytes)
Track (1 byte)
Head (1 byte)
Sector (1 byte)
Parameter (1 byte)
FDD command execution flag (1 byte)
Seek/calibration flag (1 byte)
Interrupt mask register (1 byte)
Keyboard status (2 bytes)
Key input data (1 byte)

Fig. 3. Memory allocation.

tus line at the bottom of the text window, as are your present page and line numbers. The wordwrap and justification information isn't shown on the status line, however, so you don't know if they are on or off.

Other menus offer typical word-processing features such as block move and search. The Quirks menu, which is reserved for the expert level, allows a variety of file-management options as well as two interesting features. One of them, called "Cursor locked in center," keeps the cursor on a horizontal line at midscreen at all times. The text scrolls past it, just as with a typewriter. The menu option allows you to toggle between this mode and normal cursor.

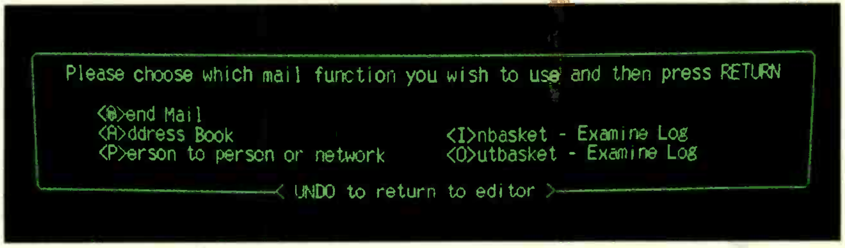
The other feature is called "Quick display." It is intended to alleviate a problem that you may find with the word processor. Since the normal operating mode uses the graphics functions to generate characters, you can get ahead of the system while you're typing, thus producing misspelled words. Although the system corrects itself, there is a slight delay which can be unnerving. Choosing the "Quick display" option turns the screen from a bit-mapped to a character display. This enables Valdocs to keep up with a very fast typist, although graphics-dependent features such as bold and italics can no longer be viewed on the screen (the codes can only be sent to a printer).



```
  Select a function by its letter or moving the cursor then press RETURN

 <H>elp with using this editor          <L>ook-for (find, replace, etc.)
 <O>n-screen (centering, margins etc.)  <P>age (goto #, new page, etc.)
 <B>lock (move, copy, store, etc.)      <M>iscellaneous
 <Q>uirks (Experts only)
 ------------------< UNDO to resume editing >------------------------
```

Fig. 4. HELP menu.



```
 Please choose which mail function you wish to use and then press RETURN

    <S>end Mail
    <A>ddress Book                        <I>nbasket - Examine Log
    <P>erson to person or network         <O>utbasket - Examine Log
 ----------------------< UNDO to return to editor >---------------------
```

Fig. 5. MAIL menu.

Each time you switch to another function the text is automatically saved in a temporary file, which can cause a delay of about 15-20 seconds. Retrieval of the text is automatic, too. Pressing UNDO while in another area returns you to the word processor with the cursor in the same spot in the text that you left it! If, while in the editor, you erase a word accidentally, you can restore it by tapping UNDO. While using the word processor, I found that every so often I would overrun the right margin and it wouldn't reformat in the normal Valdocs operating mode. A remedy I quickly found was to set the system to the expert level and choose "Reformat" under the "Quirks" menu. This set the margins correctly.

Within the editor, you can change print styles with the press of a key. For example, you can choose BOLD, ITALIC, and underline. The last function is handled by tapping the STYLE key. This key will later have its own menu to allow you to choose a variety of type styles and sizes. All font and style changes are shown right on the screen in the normal

AN IDEA BORN IN PHILLY

Have you ever wondered where designs for the latest computers come from? Well, most come from a lot of head scratching and reinvention of the wheel. Such is not the case with the Epson QX-10.

This tidy little machine was the brainchild, born as early as 1976, of a group of inventive entrepreneurs. The group called itself Technical Design Labs, then later Xitan before it disappeared into the edge of yonder. The TDL/Xitan group had the idea for a truly integrated machine that was easy to use; but in 1976 that seemed like something that was a long way off.

With an eye to the future, however, they developed what was then, and still is, considered one of the better system monitors known as Zapple, plus a powerful editor/text processor known as Z-Tel. All of this formed the basis for a series of powerful S-100 bus machines called the Alpha series. The Zapple monitor was to form the basis of the QX-10, and the data-handling functions of Z-Tel defined the basis of Valdocs.

In 1979, at the final John Dilks East Coast Computer Fair in Philadelphia, the group unveiled its newest machine, called the General. It was claimed that the General not only offered more processing power and greater memory than any of the 8-bit systems being shown; but sported an innovative word-processing and database management system with communications all rolled into one.

Unfortunately, Xitan was finding itself in a less than comfortable financial position and the General never led the battle. Fortunately, the idea wasn't forgotten. In late 1980, Epson America was formulating plans to enter the desktop computer market. Its design strategy was based on those defined for the General. Now, however, it appeared that, by using the latest in peripheral IC technology, and support devices such as ⅓-height floppies, the easy-to-use integrated system could be built.

By November of 1981, at Comdex in Las Vegas, Epson was ready to tempt the market in a modest way. It exhibited the first prototype of a machine that very closely resembled the General, except it had ⅓-height floppy drives and a high-resolution screen.

Interest was high, and Epson officials gave the go-ahead for development of the real product. Most of 1982, and a good portion of 1983, was spent in readying the hardware and software. Thus was born the QX-10 and Valdocs software system.

Unlike its precursor, the General (which reportedly operated off two Xitan Alpha systems hidden under the table that week in Philadelphia), the QX-10 not only works but is shipping at a volume of about 5000/month.

Unfortunately, though, the Valdocs software isn't as exciting as first imagined. Currently, version 1.18 (reviewed in this article) does combine word processing, database management, communications, and graphics; but a great deal still needs to be done. Specifically, the word processing is slow. The graphics, although fairly good, still aren't as flexible as those found on an IBM PC, for example. And the communications package has an excellent concept for adding phone numbers, but still needs work on the protocols.

It is an idea that was picked up from the scrap heap and made workable. And it does represent the best in the state of 8-bit architecture.

Although Valdocs can't be classified as a grade-A product yet, the designers are making headway; and, by the time you read this article, version 2.0 should be ready for release. ◇

(graphics) operating mode.

I was surprised to find that no convenient method existed in Valdocs to take advantage of the FX-80 printer's functions of condensed print, or super and subscripting. I was able to do this in Wordstar by modifying the printer drivers.

One of the nice features about Valdocs is that you will never lose files due to a full diskette. Valdocs keeps you notified and allows you to change diskettes midstream.

Once you have created a file, you can store it by pressing STORE. Valdocs allows you to store (and retrieve) documents using meaningful names up to 16 words long. After you've used Valdocs for a while you'll notice another useful feature. Suppose you have stored 50 or so documents on a disk. Pressing INDEX allows you to look at your list files in several different ways: alphabetically, sequentially, or cross-referenced.

Alphabetic filing is obvious. Sequential filing displays the files in the order that they were created with a date and number assigned to each file. The cross-index display takes the key words that appear in the index and lists them alphabetically with the particular files that pertain to them. You can retrieve a file by taking advantage of this cross-index feature. Just select a key word associated with the file name and you'll be presented with a list of files that use that key word in their names.

You can print a document by first storing it to disk and then hitting the PRINT key. The document won't start printing out immediately—instead you will have to go through a series of menus before you get hard copy. Once you start printing, you may continue on with your work since the system has a print spooler. If you just want a dump of what's on the screen, you need only press CRTL PRINT. Normal copy is printed with the screen dump only if you are in the "Quick display" mode. Otherwise, larger graphics text is printed.

Prior to any printing, you have to inform the system of the type of printer you're using. If you have an Epson printer, it's just a matter of choosing the printer by name from a list that's found in the SETUP.SYS file. If not, you must insert the characteristics of the printer you're using.

Communications. The communication function, entered by pressing the MAIL key, is designed to work off a card-file system. Here you enter name, address, phone numbers (voice and modem), and modem speed of correspondents. Plus you set up yourself with your area code, which the computer automatically checks when you make a call. If the area code is not required, it isn't used. This is great if you ever move since you only change one record instead of many. You can then send someone a document or have a person-to-person exchange by simply selecting that particular option from the MAIL function menu (Fig. 5).

You are then prompted through the various alternatives. You can set up to receive mail or schedule it to send later. The system real-time clock will turn the system on. Interestingly, you have to be in MAIL for this function to work. I thought this should have been a background function and work much like the print spooling function.

Graphics. One of the more exciting functions of Valdocs, is the DRAW capability. This allows you to enter data and create a pie chart, bar chart, scatter chart, or scientific chart. It is accurate, as can be seen in Fig. 6. The data was taken from an article in the Feb, 1982 issue of *Mini-Micro Systems* on printers.

(Continued on page 87)

ZAPPLE SEES INSIDE

When doing development work on a microcomputer, it's often necessary to have some method of digging into the internal operation of the processor and associated circuits. This is usually accomplished using a utility such as Digital Research's Dynamic Debugging Tool (DDT) or, in the case of the QX-10 operating under the Transient Program Manager (TPM), Zapple.

This powerful tool was originally designed for use on TDL/Xitan systems to enable users to load programs, modify memory, and perform various and other sundry system level tasks.

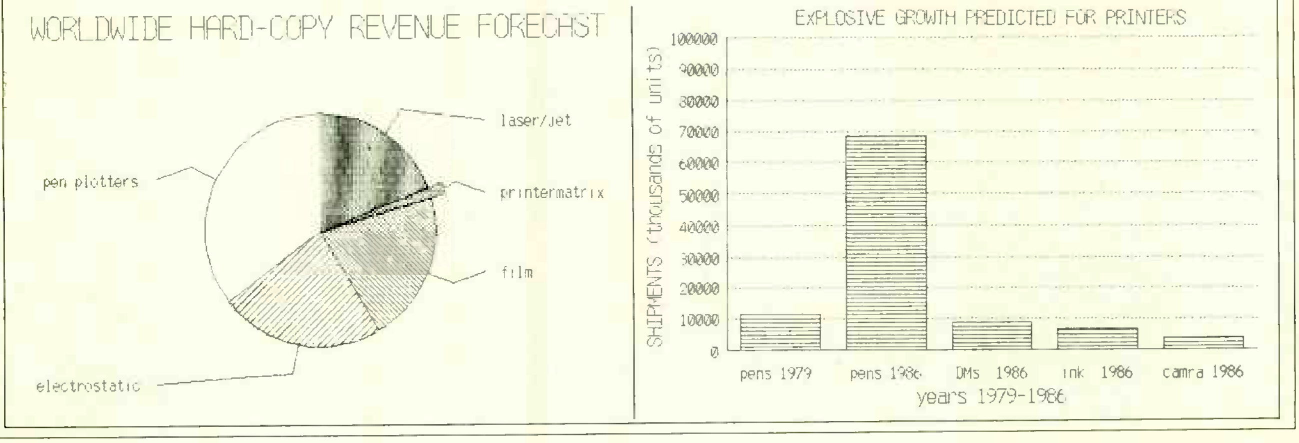
Zapple was, and I believe still is, the only utility written to take advantage of all the power a Z-80 has to offer rather than being an 8080-based program. It is relocatable and can be moved around at will in memory.

Zapple serves as a powerful development tool on the QX-10, and is a basis for the operation of TPM. Unlike early versions that were loaded off paper or magnetic cassette tape, Zapple is loaded immediately on boot up from the TPM/Valdocs system diskette. Getting to it, however, isn't via a direct route. You have to set up the QX-10 to permit trapping to Zapple. This is accomplished by using the Valdocs SETUP program, changing the Experience level to EXPERT and turning on the Control \ (backslash) function.

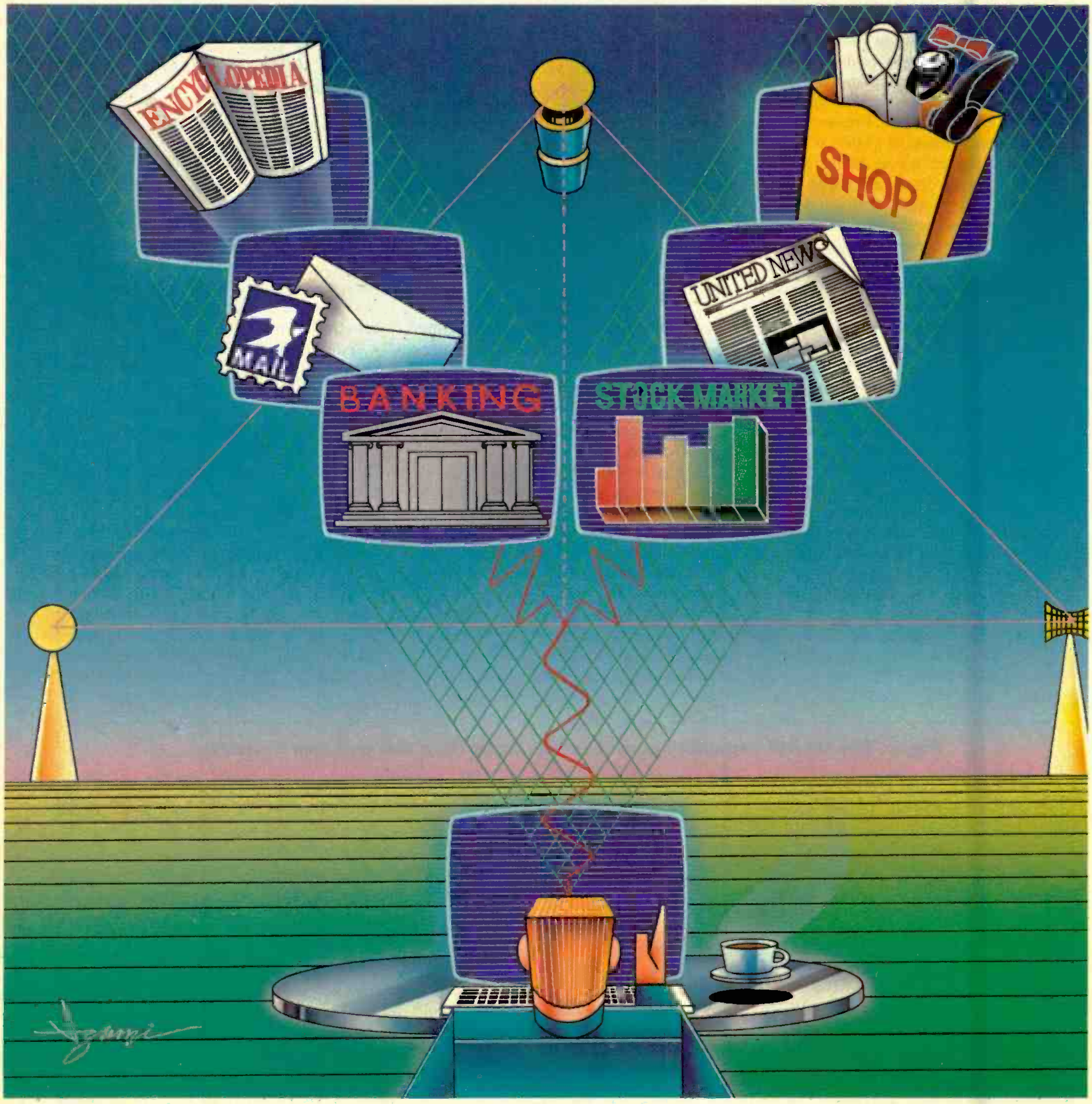
Once this is accomplished, and you've saved the new setup parameters by simply tapping the UNDO function key, you can trap to Zapple at any time by doing the CONTROL backslash function.

You are greeted with an breakpoint @EA26 and a greater-than sign. Now you can use Zapple. Once you're through, you can trap back to Valdocs by entering a GO100, which causes a reboot. ◇

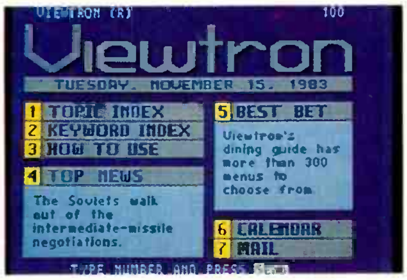
Fig. 6. The DRAW capability permits entering of data and creation of charts.



Let's clear up some of the confusion about what videotex is—and the services it can provide


ENCYCLOPEDIA
SHOP
UNITED NEWS
MAIL
BANKING
STOCK MARKET

VIDEOTEX AND YOU



VIEWTRON (R) 100

Viewtron

TUESDAY, NOVEMBER 15, 1983

1 TOPIC INDEX
2 KEYWORD INDEX
3 HOW TO USE
4 TOP NEWS

The Soviets walk out of the intermediate-missile negotiations.

5 BEST BET

Viewtron's dining guide has more than 300 menus to choose from

6 CALENDAR
7 MAIL

TYPE NUMBER AND PRESS [illegible]

By John Helliwell

If you are confused about what videotex is, you're not alone. Much of the cause of this confusion lies in the fact that different people have different ideas about what the service is.

Some people will tell you that videotex has something to do with television, frequently citing "two-way TV" as the basic reason for the existence of the service. Others will tell you that it has something to do with home computers. Adding to the confusion, companies like Radio Shack and RCA offer boxes they call "videotex terminals" that bear a strong resemblance to home computers. The confusion is further compounded by the fact that the companies are selling business terminals under the name "videotex."

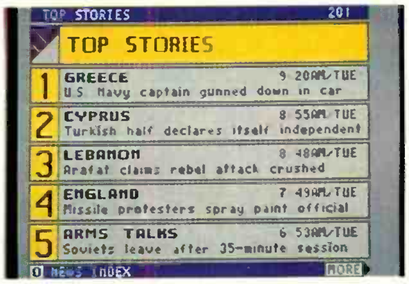
Nor is hardware the only area in which the term "videotex" is applied from different viewpoints. The very definition of the term depends on who's doing the defining. A number of people contend that this type of service is videotex only if it's aimed at the home market. No wonder people are confused!

The object of this article is to clear the air about what videotex is and, just as importantly, what it isn't. We'll then go on to tell you in very general terms how it works and how and when you can get in on the action.

Start at the Beginning. In an attempt to clarify the issue, you have to start at square one. Clear your mind of anything you may have heard about videotex, particularly of any notion that videotex has something to do with television. Now you're ready to learn what videotex is with an unbiased mind.

A good way to understand what videotex is is to take a look at the typical airlines reservations counter. Every airlines office in the country is equipped with one or more computer terminals that look something like a TV receiver to which has been added a typewriter-like keyboard. Instructions to the computer are typed in from the terminal's keyboard. The computer may be in the same room as the terminal or halfway across the continent. The computer displays on the screen of the video monitor the information requested, such as the number of seats available and their locations on a given flight, the state of a customer's credit balance, and any other data. Interacting with the computer through the video terminal, the reservations agent has the ability to perform such transactions as reserving seats on a flight or recording a bank deposit.

One gets the impression when using the terminal that he's the only one accessing the computer. Actually, though, hundreds of reservations agents may be using the computer at the same time. This technology has been fairly common for the past 10 years or so.



TOP STORIES 201

TOP STORIES

1 GREECE 9 20AM/TUE
U.S. Navy captain gunned down in car

2 CYPRUS 8 55AM TUE
Turkish half declares itself independent

3 LEBANON 8 48AM/TUE
Arafat claims rebel attack crushed

4 ENGLAND 7 49AM/TUE
Missile protesters spray paint official

5 ARMS TALKS 6 53AM/TUE
Soviets leave after 35-minute session

0 NEWS INDEX MORE

In theory, there's nothing to prevent you from buying a terminal for $1500 or so and contracting with a number of services to gain access to their computers over the telephone line. There are dozens of "time-sharing" computers in the country that you can use in this manner, though, in most cases, the data available to you would be terribly specialized and virtually useless.

The roots of videotex are varied. We start with computer data banks with enough information in them that's of

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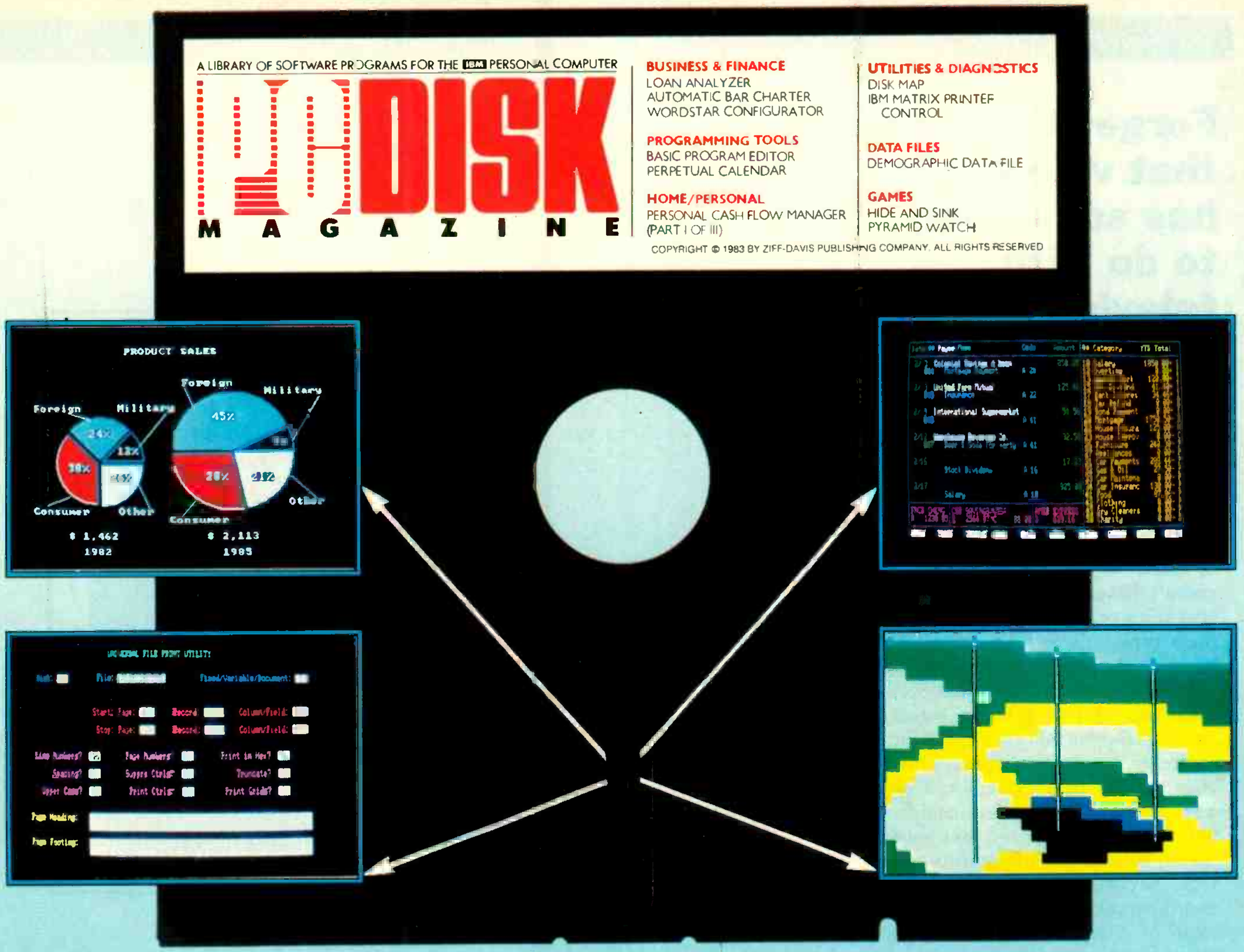
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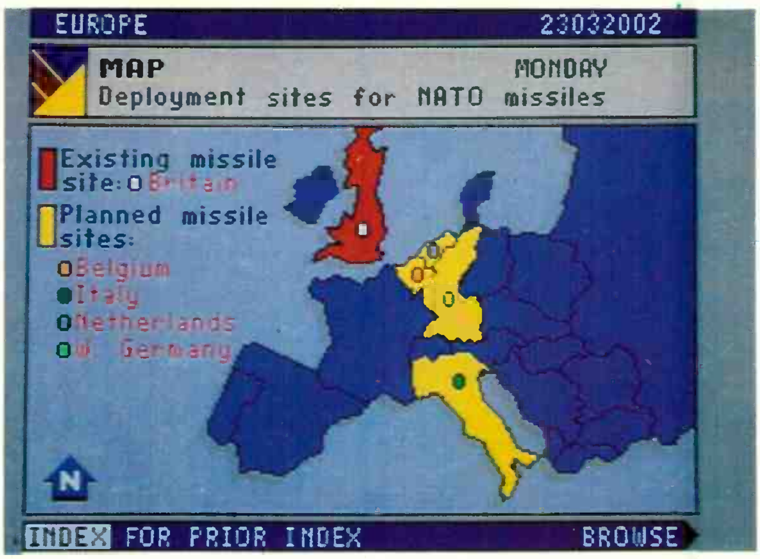
Forget the idea that videotex has something to do with television



A typical screen for a "Top News" story.

general interest to the public and that can be presented attractively with color graphics. The cost of the terminal to access such services, of course, must be relatively inexpensive, and access must be made very simple so that the user doesn't have to learn computer programming or complicated codes. Given these criteria, every household would want—and need—a terminal.

Different companies have moved toward this goal in different ways, frequently stopping short of providing all the features mentioned above, while still claiming the name videotex. Compuserve and The Source, for example, often claim to provide videotex services, mainly because the information and services they offer are of "general interest" and their customers are individuals instead of companies. What this statement implies is that it's the user who decides whether the service is or isn't videotex.

Companies that offer business information in a graphics format—graphs of stock quotations, for example—sometimes name their services videotex. One such company is General Motors' Buick division, which is putting together a "videotex" system that will link together all its dealerships to provide information about its products, using a lot of graphics. The people who are putting together these systems are saying that it's graphics that establish the service as videotex.

Clearing the Air. People who are deep into technology feel that true videotex has two fundamental and immutable characteristics. First, it's aimed at the individual (normally home) user. Second, it must use both text and graphics to display information. We may not get away with imposing this definition, but in the interest of having everyone understand what everyone else is talking about, it's worth a try.

The technical base of videotex isn't difficult to understand. At the center of the videotex system is an expensive, large, and powerful mainframe "host" computer. It is linked to the telephone network through a number of "ports." A videotex decoder in your home is also linked to the telephone system to give it access to the host computer.

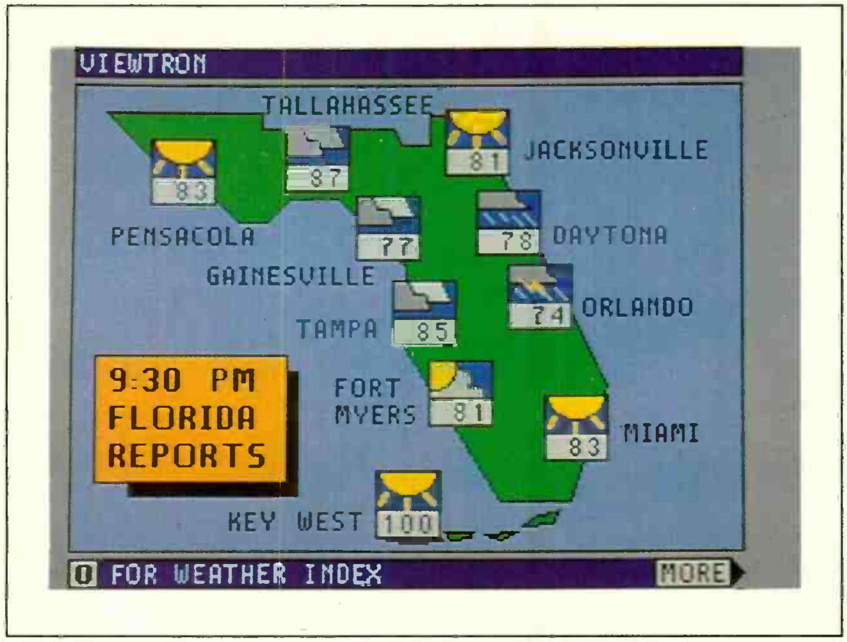
The decoder is similar to a microcomputer. It has one or more microprocessors inside it and the necessary circuitry to produce a TV-like signal to drive a video display monitor. And, like some home computers, a modem that translates the decoder's digital signals into audio-tone signals to be carried over the telephone network is built into the decoder. Another similarity to the home computer is that you communicate with the decoder using a keyboard.

The videotex decoder is unlike the typical home computer in that there are limitations to what you can do with it. Even though it might be smart enough to, say, play games or do word processing, the intelligence that makes this possible usually won't be accessible to you. On the other hand, there are areas in which the videotex decoder is actually better than a home computer. For example, its modem is likely to be considerably more sophisticated than anything you'll find for a Commodore VIC-20 or Atari computer.

The videotex decoder is designed to work with some kind of video display monitor. The most likely candidate, mainly because almost every household has at least one, is the ordinary TV receiver, preferably a color unit. But don't jump to the conclusion that using a TV receiver means that videotex has something to do with television! The TV receiver is required only as a display; all videotex decoding is accomplished separately from the TV receiver. In fact, you don't even need a *receiver* per se. If you had one of the new component TV systems in which the tuner and amplifier are separate items from the CRT display monitor, you'd connect the decoder directly to the monitor itself. The rest of the TV system isn't even needed, except to be able to receive normal broadcast TV programs when you're not using the video monitor for viewing videotex information.

Currently, and for the next few years at least, most videotex services will use the telephone network for communications. But any two-way medium that can carry signals from your home to a host computer and from the computer to your home could work. So, as two-way cable-TV (CATV) networks emerge, we're likely to see a new medium for transmitting videotex informa-

It's a new medium of communication that has yet to be exploited



The screen for the weather forecast might look like this.

tion. Current CATV networks are capable of single-direction-only information transfers, and they are only to your home. This situation will almost certainly change in the near future.

The Videotex System. Most of the hardware required in videotex systems is analogous to the hardware used in airlines reservations systems. That is, it consists of terminals, displays, communications lines, and a central computer. One more essential element is needed, however. This is a common code that will allow all subscribers to the system to communicate with the host computer.

The airlines reservations computer and the computers at The Source and Compuserve can communicate with subscribers only if they agree on how to present the information that's being transmitted. Fortunately, most of the world some years ago agreed to use ASCII (American Standard Code for Information Interchange) coding for communication of alphabetic and numeric information. The 7-bit code assigns a unique pattern of seven 1s and/or 0s for each letter and number and such common punctuation characters as the question mark, comma, and parentheses. The code for *A* is 1000001, *m* is 1101101, * is 0101010, and so on. Computers, terminals, communications links, and most software use the same ASCII codes.

ASCII codes cover only alphabetic and numeric information. However, one of the characteristics we've decided must be part of the true videotex system is that available information must include graphics. We'll take this demand a step further and add that the graphics must be in color.

Every computer system that uses color graphics, from Apples to Ataris to IBM mainframes, has to devise an encoding scheme for graphics. Unfortunately, manufacturers of different computers take different approaches to achieving this goal. This is the problem. Apple solved the color-encoding problem differently from Atari, and IBM has its own approach that's different from the other two. While this wouldn't be a problem for the videotex system, it would have to be guaranteed that everyone involved, including the host computer and all subscriber terminals, were going to use equipment and software from a single source.

Naturally, the forces that brought the computer industry to the ASCII standard impelled those planning videotex systems to a common graphics standard. If everyone involved in the videotex industry agreed on a standard for encoding graphics, there would be more expertise, more software, more competition to supply the hardware, and more marketability of acquired experience. Indeed, there is an emerging North American standard for encoding graphics information, called the North American Presentation Level Protocol Syntax, abbreviated NAPLPS.

Drawing the Lines. NAPLPS is the forerunner, but it didn't emerge without a battle. In the beginning, were two proposals for encoding videotex graphics. One was the British *alphamosaic* scheme called Prestel, while the other was the Canadian *alphageometric* scheme called Telidon. The battleground for both was the United States, which was clearly seen from the outset as the most lucrative market for videotex.

To understand the difference between the two standards, you might consider the problem of having to describe, without visual aids, a simple picture to someone over the telephone. Imagine also that the person at the other end of the line has only a limited knowledge of the English language.

Your first step would be to lay a grid over the picture (see illustration) to establish a frame of reference. In our example, the grid represents only a small fraction of the picture that can be displayed on the TV screen. The entire picture would consist of tens of thousands of such squares.

Notice the small rectangle in the upper left of the grid and the letter Z in the lower right. Let's assume you're trying to convey this picture to your non-English-speaking friend at the far end of the telephone line. If your friend's English vocabulary is *very* limited, you might try to name the color in each grid square.

Beginning at the far left of the first

(Continued on page 92)

Jet Set Printers

Recent advances in technology have made ink-jet printers competitive pricewise with other types —as exemplified by the Radio Shack CGP-220

By Mark S. Zachmann

THE other day I did something I would never have considered doing—or even been able to do at all—a month earlier. I walked into a Radio Shack store and, for $699 and change, took home an ink-jet printer. Ink-jet printers have been around for a while, but their prices—thousands of dollars—made their use with microcomputers prohibitive. Times and technology have changed, though, and there are now several printers of this type available at a price comparable to that of a dot-matrix or formed-character printer. One such is Radio Shack's CGP-220.

How They Work. Inexpensive ink-jet printers of this type use a technique called *drop-on-demand* printing. Instead of shooting out a continuous jet of ink and using electrical fields to deflect it to form characters on the target paper (much the same way as the electron beam in a TV picture tube is deflected to paint an image on the screen), drop-on-demand printers use a technique similar to that found in dot-matrix printers.

The print head contains a linear array of orifices through which ink is squirted by a piezoelectric mechanism that generates a "squeeze" when commanded to by the printer's 6809 microprocessor and character-generator ROM.

When the squeeze is applied, a drop of ink spurts out of the print-head nozzle and hurls through the air to impact on the paper. There it forms a dot that dries almost instantaneously. By using a head with several nozzles, different-colored inks can be applied to the paper. If the actions of the nozzles are sequenced correctly, a number of different colors can be produced by the mixing of the inks on the paper.

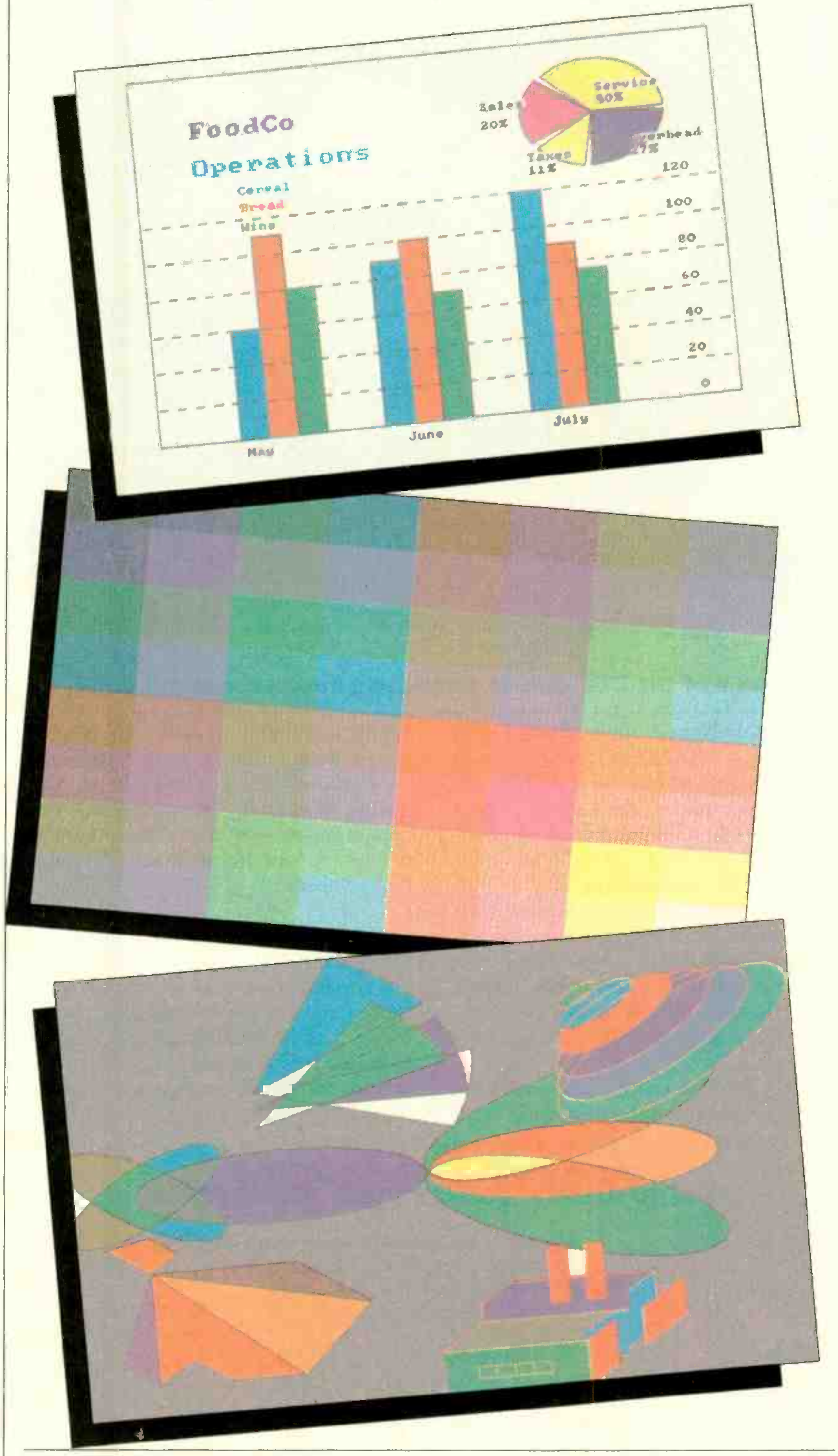
The ink for the CGP-220 comes in flattish plug-in plastic cartridges. The printer has two receptacles into which those cartridges can be inserted—one for black ink and the other for the tri-color pack contaning yellow, magenta, and cyan inks. The ink itself is contained in what appear to be metallized plastic pouches within the cartridges. The tri-color cartridge contains three such pouches stacked vertically and supported by plastic separators. Changing a cartridge is easy since it is merely a matter of unplugging the old one and inserting the new one.

Print-head nozzles in ink-jet printers can be arranged either vertically or side-by-side. The CGP-220 uses a horizontal array of four nozzles, one for each color ink. The head traverses a metal rod as it moves from one side of the paper to the other. The mechanism is shown on page 81. By combining the inks from different nozzles, seven colors can be produced: black, red, green, yellow, blue, magenta, and violet.

Ink-jet printers have several significant advantages over dot-matrix printers, their nearest rivals. For one thing, they are better at color printing. Color dot-matrix printers use a ribbon with several color bands impregnated in it. Not only is the printing process with this type of mechanism noisy and time consuming, but the quality of reproduction leaves something to be desired. The inks used by ink-jet printers can actually be mixed on the paper, giving a result superior to that produced by depositing the colors separately by making several passes across a ribbon.

A second advantage ink-jet printers have over the dot-matrix type is their reliability. There are fewer moving parts and they are forced to operate much less strenuously than those in the matrix printers. There are no solenoids and no wires or pins to wear out.

Ink-jet printers are relatively fast—comparable in speed to dot-matrix printers. What primarily makes them this way is the lack of mass of the print head. It has no heavy solenoids and heat sinks to carry, and all it has to do is



Many interesting effects can be achieved with an ink-jet printer.

Radio Shack
TRS-80
CGP-220
COLOR INK JET PRINTER
RESET
FEED
ON LINE
READY
ALERT
POWER

Design of the CGP-220 is simple and inexpensive, but good.

spray lightweight droplets of ink. Finally, there is the lack of noise. Ink-jet printers don't whine, buzz, or screech. The noisiest part of the CGP-220's operation is when the head changes direction and you hear a sort of "click" as it does so. The rest is silence.

For all their advantages, ink-jet printers do have a few shortcomings. Unless proper care is taken, the ink in the nozzles can dry out and clog. (A printer from Olivetti, though, uses a dry-powder ink that presumably avoids this problem.)

Also, for best results, a special plastic-impregnated paper should be used. While acceptable results can be obtained with ordinary bond paper, the ink has a tendency to soak into it, producing sometimes fuzzy results. The special papers, available in both roll and sheet form from Radio Shack, eliminate that problem.

The CGP-220. Operation of the Radio Shack CGP-220 ink-jet printer is based on a mechanism that is produced by Canon and used in several other printers such as the Quadram Corporation's Quadjet. It is a simple and inexpensive design, but a good one into which much thought has gone.

The bidirectional printer has two modes: graphics and text. In the graphics mode, it prints at the rate of 2600 dots per second and provides a monochrome resolution of 560 dot-columns (with 7 dots per column) per line. In its multi-color graphics mode, the resolution becomes 640 dot-columns per line (80 dots per inch), with 8 dots per column. To fill an 8½" square page with graphics takes approximately 5 minutes. Direct screen dumps can be done from the TRS-80 Color Computer.

The text mode produces 5 × 7 characters—in black or in color—at approximately 37 cps. A 5 × 7 dot array does not produce very attractive characters; but, for a device that will be used principally for color graphics, this is not a particularly harmful drawback.

Radio Shack has overcome the nozzle clogging problem with what the user's manual terms the "Green Lever." The green lever actually serves several purposes. When the printer is not in use or is to be transported, it caps the nozzles of the print head and locks the mechanism to keep it from being damaged. In addition, the lever can be used to "pump" the ink supply to make the colors printed more saturated (sometimes the output of the printer looks a little on the pastel side).

The CGP-220 supports elongated character sets, variable pitch, character repetition (256 repetitions maximum), and provides some special characters such as those used in European languages.

Radio Shack should have included a method in hardware or software to tell the printer not to advance a line when a carriage return is sent, or to ignore linefeeds. As it is, when you send a CR-LF pair to the printer you get double-spaced text, whether you want it or not.

Unfortunately, some features common in similarly priced dot-matrix printers are absent. They include underlining, bold face, italics, partial line feeds, and proportional spacing. Since the device is programmable from BASIC, it is possible that some of these features *are* available under program control, but they do not seem to be readily callable from, say, a word processor.

Remember, though, that this printer is primarily a graphics device; and, for its price, it does an awful lot. If you want a near-letter-quality printer, there are plenty around—but they can't produce pretty colored pictures. ◇

TECHNICAL SPECIFICATIONS RADIO SHACK CGP-220 INK JET PRINTER

Resolution:	640 dots × 8 columns (color scan graphics mode) 560 dots × 7 columns (bit image mode) 12 cpi, 5 × 7 dot-matrix (text mode)
Speed:	2600 dots/second (graphics) 37 cpi (text)
Ink cartridge:	Black (4,000,000 char.) Tri-color (3,000,000 char.)
Interfaces:	Centronics parallel Serial (600/2400 baud, 4-pin DIN connector, connects directly to TRS-80 Color Computer)
Size:	15¾" × 11⅝" × 4¼"
Weight:	12.3 lb

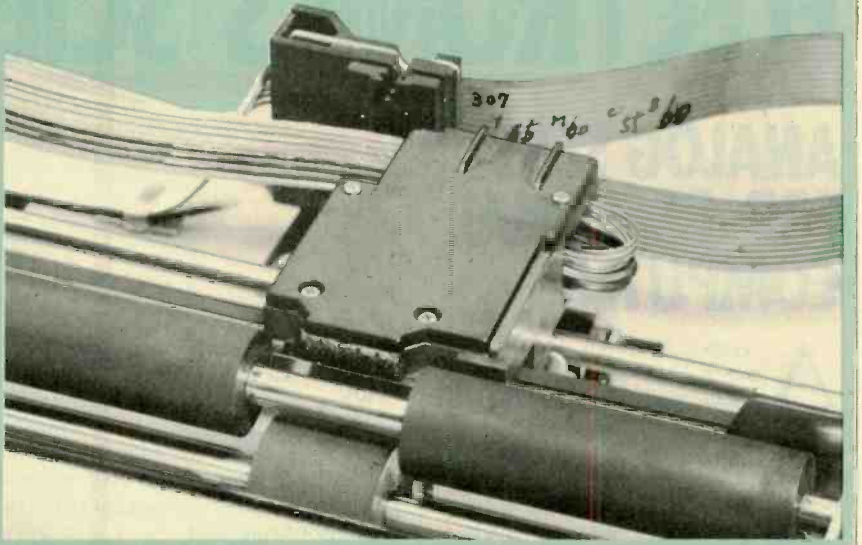
TYPES OF PRINTERS

The printers used with microcomputers can be separated into two different categories. *Fully-formed character* printers, sometimes referred to as "letter-quality" printers, give the best results. They generally use Selectric-type print elements—commonly known as "golf balls"—or daisy wheels. Daisy wheels have the characters embossed on the ends of spokes that are attached to a central hub, and the appearance of this configuration is what gives them their name. As the wheel, which is attached to the print-head mechanism, moves back and forth across the paper, it is rotated to bring the proper character into a position where it can be hit by a small solenoid-driven hammer. The character strikes a ribbon, producing printed characters just like a typewriter.

The quality of the print is excellent, but the massive head assembly keeps speed down (to about 55 cps maximum, and usually less) and the noise level is high. Still, daisy-wheel printers are faster and quieter than "golf-ball" types. Those usually print no faster than 14 cps and, in addition, are mechanical nightmares, usually having over 600 moving parts.

The other type of printer is the *dot-matrix* type. Dot-matrix printers, which include the ink-jet family, use a variety of techniques for producing a pattern of dots on a piece of paper to form a character. The higher the resolution of the printer—expressed in dots per inch or in terms of the matrix (5 × 7, 7 × 9)—the better the characters will look. Most dot-matrix printers have the ability to produce some graphics, and to generate different character sets and sizes. At present there are five principal types of dot-matrix printers.

The most expensive, and fastest, dot-matrix technology is *laser printing*. Laser printers work much like wet-process photocopiers. The paper rotates on a drum, as first the paper goes through a sensitization process. Then the laser, pulsed on and off at a very high rate, sweeps over the paper, energizing portions of the paper where its light falls. The paper is then dipped in a developing solution and stabilized. One advantage of using a laser is that the light beam can be focused very tightly, which gives excellent resolution and results in distinct, well-formed, characters. Another advantage is speed.



A horizontal array of four ink nozzles moves across the paper.

The most prevalent dot-matrix technology is *impact* printing, which is usually what is meant when the term *dot matrix* is used. The print head of a dot-matrix printer contains a number of vertically mounted stiff wires, or pins, pointed at the paper. As the head travels across the paper, the solenoids push the wires out against an inked ribbon. This technique can produce *near-letter-quality* results, depending on the size, shape and number of wires in the print head. Sometimes to achieve near-letter (or *correspondence*) quality printing, several passes over the same line must be made, with the print head offset slightly each time. That causes the spaces between the dots to be filled in. Since wires are so much lighter than print wheels, impact printers are faster than formed-character printers, sometimes operating at several hundred characters per second. Impact dot-matrix printers tend to be noisy.

Another type of dot-matrix printer is the *thermal* printer. It requires a special kind of paper. Its head has wires arranged like those in the impact type; but as the head passes over the paper, the wires don't move, heating up instead. This causes a chemical change in a coating on the paper, causing it to turn blue or black.

The paper is somewhat unstable and if kept in a warm place, or exposed to high heat, discolors, making it difficult (and sometimes impossible) to read what's on it. Thermal printers are, however, extremely quiet and are inexpensive compared to the other types.

A relative of the thermal printer is the *electrostatic*, or *electrosensitive* printer. It too uses a special paper, but this type has had an ultra-thin layer of metal deposited on it. The wires in the print head "zap" dot-sized portions of the metallic coating by passing an electrical current through the paper to an electrode behind it, exposing the black surface of the paper beneath. The paper used by this sort of printer is also very delicate, and great care must be taken in handling it. Electrostatic printers, while not costly, are rare today.

Finally there is the *ink-jet* printer, the subject of the body of this report. ◇

PRINTER SAMPLER

	HP 2688A	NEC 3550	Epson FX-80	Radio Shack CGP-220
DPI (vert.)	300	N/A	150	80
DPI (horiz.)	300	N/A	80	80
Speed (rated)	6 pages/min.	33 cps	160 cps	37 cps
Noise	Quiet	Very loud	Noisy	Quiet
Colors	1	1	1	7
Character quality	Letter	Letter	Good	Fair
Graphics quality	Great	—	Good	Good
Price	$29,000	$2000	$600	$699

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ELECTRONICS SCIENTIST

ANALOG SENSORS FOR PERSONAL COMPUTERS

ANYONE who has built a fair number of electronic circuits knows the frustration of not being able to make quick changes to an assembled project. But if you own a personal computer, you may already possess the key ingredient for solving this common circuit builder's malady.

Thanks to its programmability, a computer allows you to change the operation of many kinds of circuits simply by entering a revised program. Often changes can be made just by altering a few numbers in an existing program.

In this column we'll explore how a personal computer equipped with an analog-to-digital converter can greatly expand the capabilities of a very simple circuit. While the emphasis will be on analog sensors, you'll quickly see many other possibilities for adding "intelligence" to other relatively simple circuits to monitor light, temperature, barometric pressure, and various other parameters.

Of course, there are circuits that can accomplish these same functions without using a computer. And these circuits would probably be less expensive to build and more compact than a computerized sensing system. However, the computer provides an easy-to-use, yet highly sophisticated, means for storing and displaying measured data.

For example, an accurate and reliable light meter can be made by connecting a silicon solar cell to an operational amplifier as shown in Fig. 1. When connected to either an analog or digital voltmeter, this circuit can be used to manually monitor the intensity of sunlight and artificial lights. In either case, measurements have to be manually recorded.

When connected to the A/D input of a computer, the light level measured by the circuit in Fig. 1 can be automatically stored in the computer's memory for later readout. Moreover, a simple program will allow the computer to sample, at any time interval specified, the output from the sensor circuit. Another program can then be used to display or print out the samples as a function of time on a line or bar graph.

When used in this role, a computer can be considered a "smart" data logger or, perhaps, chart recorder. The computer is so "smart" it can even be programmed to correct for nonlinearities in the sensor being used.

Furthermore, the computer can be programmed to prepare publication—quality graphics on an x-y plotter and can even be programmed to send control signals to various output devices when the input signal falls below, or exceeds, any specified level.

Selecting a Computer. Any computer that can be equipped with an analog-to-digital converter board can be used to monitor an analog sensor. Such boards are available from various sources for personal computers made by Apple, IBM, Radio Shack, Timex, and others.

Some computers include a built-in A/D converter. For example, the two joystick inputs on Radio Shack's Color Computer are actually four separate inputs to a built-in 6-bit digital-to-analog (D/A) converter.

Each Color Computer joystick contains a pair of 100-kilohm potentiometers connected as voltage dividers across a 5-V supply. As the rotor of each pot is turned, the output voltage varies from 0 to +5 V.

Within the computer, an analog multiplexer (MC14529B) selects, under program control, one of the four joystick voltages. The selected voltage is then applied to one input of one of the comparators within an LM339 quad comparator. The other comparator input is connected to the output of a simple 6-bit D/A converter made from the network of six resistors and six buffers (MC14050B) shown in Fig. 2. A machine-language successive approximation routine is then used to determine, to the 6-bit accuracy of the D/A converter, the analog equivalent of the joystick position.

Evaluating Computer A/D Systems. Before selecting an A/D board or system for your computer, collect as much information about the available boards as possible. Talk to someone who has actually added an A/D capability to a

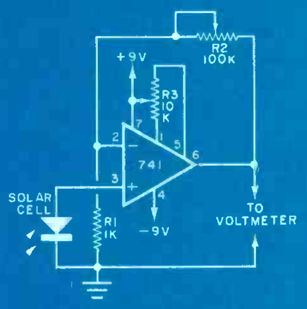

Fig. 1. Light meter circuit.

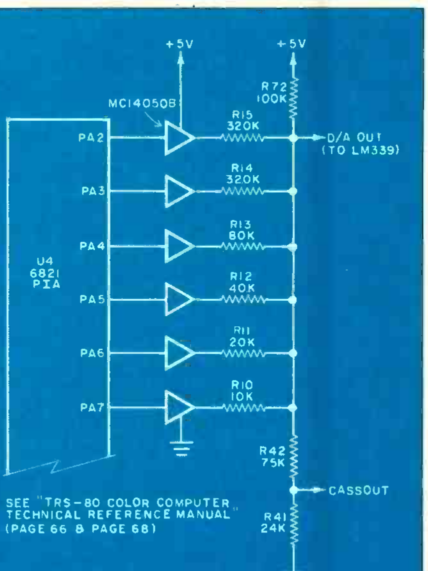

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Fig. 2. D/A converter circuit.

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personal computer, to find out if using the board requires a knowledge of machine language. If so, you may want to make sure the board is supplied with at least some software.

When the board is installed in your computer, perform a calibration check to make sure its output is linear with respect to its input. For example, the graph of Fig. 3 plots the joystick values displayed on a Color Computer (0 to 63) versus the input voltage provided by the joystick.

Thanks to the 1% tolerance precision resistors in the Color Computer's D/A converter network, the graph in Fig. 3 is almost perfectly linear. Broad-tolerance resistors would have almost certainly caused at least a few perturbations in the curve.

Note, however, that the plot does *not* extend all the way from ground to +5 V as implied in the description of the Color Computer joystick interface. Instead, it extends from approximately 0.3 to 4.81 V, very close to the design specification of 0.25 to 4.75 V.

Refer back to Fig. 2 and you'll see why the Color Computer joystick inputs don't extend to ground and +5 V. Resistors *R72, R42* and *R41* are included at either end of the D/A resistor network to intentionally limit the minimum and maximum excursions of its output voltage. Although not checked, it is assumed that shorting these resistors would allow the output of the D/A to extend from ground to +5 V.

A Computerized "Smart" Light Meter. The simple light meter circuit in Fig. 1 works quite well and is adequate for many light measurement purposes. However, by connecting the basic circuit to the A/D input of a personal computer, a "smart" light meter having capabilities not available in commercial light meters will be produced. This computerized "smart" light meter is so sophisticated it can even be used in a low-budget scientific laboratory.

Figure 4 shows one way to connect the basic light meter to one of the joystick ports on a Color Computer. The interface cable can be made from insulated hookup wire and a 6-pin DIN connector plug. Or, you can simply unsolder the *yellow* wire connected to the rotor of one of the pots in a Color Computer joystick. Solder 10" lengths of color-coded wrapping wire to the yellow lead and the ground (black) and +5-V (red) connections and thread the leads through a small hole drilled in the joystick case near the FIRE button.

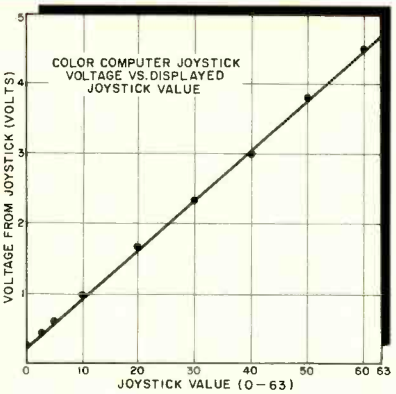

Fig. 3. Graph showing linearity of the computer's A/D circuit.

Keep in mind that the basic circuit in Fig. 1 can be connected to other computers having A/D conversion capability. Just be sure to follow the instructions regarding analog-to-digital interfacing.

Before connecting the light-meter circuit to a computer, it's a good idea to adjust its offset and gain using a dc voltmeter connected across its output (as in Fig. 1). First, isolate the solar cell so that no light can fall upon its sensitive surface, then adjust offset potentiometer *R3* until the dc output is as close as possible to 0 (or 0.25 V for the Color Computer).

Next, allow full sunlight to illuminate the solar cell and adjust gain potentiometer *R2* until the output reaches the maximum voltage input for your computer's A/D converter (4.75 V for the Color Computer).

The light meter circuit will now output a range of voltages compatible with your system. Incidentally, to keep readjustments to a minimum and to protect your circuit from unauthorized control "twiddling," it's a good idea to use screwdriver-adjustable trimmers for both *R2* and *R3*.

Programming the "Smart" Light Meter. If your computer permits and if your light measurement requirements do not require ultra-fast response, it's surprisingly easy to develop simple BASIC programs for a customized smart light meter. Though the routines that follow are intended for use with a Color Computer, they illustrate the kinds of programs that can easily be developed for many other computers.

The following program displays the light intensity at the surface of the solar cell on a scale of 0 to 63:

```
10 CLS
20 PRINT @ 0, JOYSTK(0)
30 GOTO 20
```

When this program is run, a number ranging between 0 and 63 will be displayed at the upper left corner of the video monitor. The number will fall to 0 when the solar cell is dark and rise to 63 when the solar cell is brightly illuminated.

It's easy to dress up the program to provide a fancier readout. First, we can add some text to explain exactly what the flickering number means. And we can insert a correction factor to change the 0 to 63 scale to a more convenient scale of 0 to 100. The correction factor is determined by dividing 100 by 63. The result is multiplied by the joystick value to provide a readout scale of from 0 to 100 (1.5873). While this procedure is intended for the Color Computer, a similar method can be used with other computers.

Here's one possible version of the im-

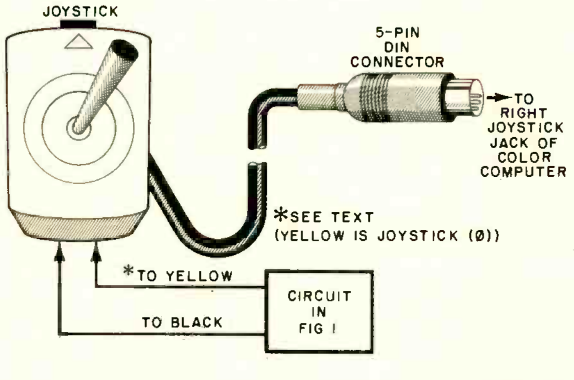

Fig. 4. How to implement a computerized "smart" light meter.

proved program:

```
10 CLS
20 PRINT @ 0, "SMART
   LIGHT METER"
30 PRINT @ 64, "LIGHT
   INTENSITY (0-100):"
40 PRINT USING "##";
   1.5873* JOYSTK(0)
50 GOTO 30
```

When this program is run, the screen displays:

```
SMART LIGHT METER
LIGHT INTENSITY
      (0-100):
nn
```

with the light intensity level denoted by "*nn*." Note the use of the PRINT USING statement in line 40 to round off the corrected value of *nn*. PRINT USING is available with Extended Color BASIC. If your computer does not have PRINT USING, check the operator's manual to see if alternative statements are available. For example, INT will print only the integer portion of a number, but no rounding will occur.

If you're still not impressed by the capabilities of the "smart" light meter, perhaps adding an analog display capability will convince you. Here's one of many ways the graphics capabilities of the Color Computer can be used to provide an analog output:

```
 10 CLS(0)
 20 PRINT @ 8, "SMART
    LIGHT METER";
 30 PRINT @ 256,
    "0''''''''''''''.5
    ,,,,,,,,,,,,,,,,1";
 40 PRINT @ 99, "LIGHT
    INTENSITY
    (0-100):";
 50 PRINT USING "##";
    1.5873*
    JOYSTK(0);
 60 X=JOYSTK(0)
 70 SET (X,15,3)
 80 FOR T=1 TO 50:
    NEXT T
 90 RESET (X,15)
100 GOTO 30
```

When this program is run, the screen displays three horizontal, text-filled yellow bars across a black background as shown in Fig. 5. The right end of the center bar provides the light meter's digital readout. The bottom bar is the

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scale for the analog output. As the light intensity is varied, a blue dot slides back and forth along the upper side of the analog scale. This provides a highly visible moving-dot analog readout.

Still another capability of the smart light meter is *data logging*. When suitably programmed, the computer will sample the output from the solar-cell circuit at any desired interval and display the readings on the screen or print them on a printer as a list of numerical entries. The readout can be embellished with explanatory text. Some computers can even provide a readout of the time at which each sample was made for future reference information.

This program shows one of many ways to use the Color Computer as a data logger for the smart light meter:

```
 10 CLS
 20 INPUT "SAMPLE
    INTERVAL
    IN SECONDS"; SI
 25 INPUT "NUMBER OF
    SAMPLES";N
 30 CF=(SI-.35)*460
 40 CLS
 45 PRINT "SMART LIGHT
    METER"
 50 PRINT "SAMPLE
    INTERVAL:";SI;
    "SECONDS."
 60 PRINT ""
 70 FOR S=1 TO N
 80 Q=Q + SI
 90 D=INT(1.5873*JOYSTK
    (0))
100 PRINT S;".";Q;":";D
110 FOR T=1 TO CF:
      NEXT T
120 NEXT S
130 PRINT "TEST
      COMPLETE."
140 END
```

When this program is run, the computer will ask you to enter the interval in seconds at which you wish samples to be made and the total number of samples you wish the computer to record. Let's assume we want the computerized smart light meter to record ten samples of sunlight intensity separated by intervals of 10 seconds. On a day when the sky is filled with clouds, a typical post-test display might look like this:

```
SMART LIGHT METER
SAMPLE INTERVAL: 10
    SECONDS
 1.   10 : 94
 2.   20 : 94
 3.   30 : 89
 4.   40 : 71
 5.   50 : 63
 6.   60 : 59
 7.   70 : 82
 8.   80 : 91
 9.   90 : 95
10.  100 : 94
 TEST COMPLETE.
 OK
```

The first column gives the sample number. The second column gives the accumulated time in seconds when the sample was made. The third column gives the light intensity on a scale of 0 to 100.

Adding Set Points to the Smart Light Meter. Any of the preceding programs can be supplemented with *set points* that might trigger a sound or even close (or open) an external relay when specified conditions are met. Here's an example of a simple set point program for our smart light-meter:

```
10 A=JOYSTK(0)
20 IF A<20 THEN SOUND
   150,5
30 GOTO 10
```

When run on a Color Computer, this program instructs the computer to emit an audible tone when the light level falls below 20 (on a scale of 0 to 63). If you've done much electronics experimenting, you'll recognize the comparator-like operation of the program.

Of course the programmability of the smart light meter makes the set-point option far more powerful than a hard-wired comparator. With a few keystrokes we can quickly change the system's set point and both the frequency and duration of the output tone. We can also add additional set points; and we can even establish one or more programmed windows into which (or outside of which) the data must fall if a tone is to sound (or cease sounding).

Going Further. As you can see, interfacing a personal computer to an analog sensor can greatly expand the capabilities of the circuit. The programs given here are merely a few examples of what can be done.

If you want to further embellish the capabilities of the smart light meter, you might wish to combine a series of programs into a single program. You can then use a menu routine to call up the data presentation options you want.

You can easily add provisions for converting the data into hard copy. And you can even write routines that will perform numerical analysis of the data. For example, add these lines to the data-logging program:

```
 92 X=1.5873*JOYSTK(0)
 94 Y=Y+X
123 Z=Y/N
125 PRINT "AVERAGE
    LIGHT LEVEL:";Z
```

Now the data-logging program will automatically sum the sampled light levels and display their average when the sampling is complete. (The displayed average will be slightly higher than the average of the displayed samples since the samples are truncated to simplify the display.)

The smart light meter can even control external devices with no modifications or external hardware if the computer includes a cassette port. For example, the Color Computer includes an internal relay that is accessible via the cassette jack and that is closed or opened by the statements MOTOR ON and MOTOR OFF.

Actually, the possibilities are almost endless. Replace the light-sensor circuit with a simple voltage divider and a couple of probes and you can assemble what computer pundits have been writing about for years: an automatic lawn and garden watering system. ◇

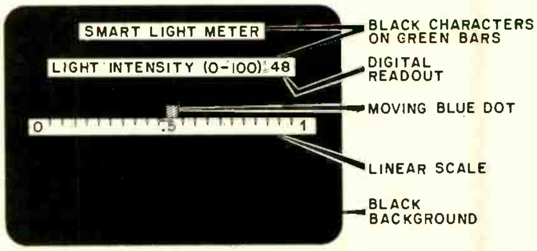

Fig. 5. Light meter's digital and moving-dot display.

Epson QX-10

(Continued from page 71)

The data was entered and Valdocs calculated the pie segments. They were exactly the same as those that appeared in the original article. After creating a graph you can edit it, save it to disk, display it on the screen, or print it out.

I found some difficulties with the graphics program. Firstly, DRAW is inflexible. I'd like to place labels where I want them. In addition, I'd like to enter the data once and use it to produce a variety of graphs. Secondly, in printing, the Valdocs package does a one-for-one dot representation of the screen. This is OK, except that, for graphs with a high-resolution (i.e. many segments), the screen presentation is run together, and so is the hardcopy (Fig. 7). Often, the resolution of the graph can be as important as the data being represented. It appears that the current intent is to provide a quick method of taking a snapshot of data, thus resolution is sacrificed.

Other Applications. There are two further applications that are standard features of Valdocs. One is an appointment book and the other is a calculator.

When you press SCHED, the screen displays a page that looks just like the left-hand side of a standard desk calendar

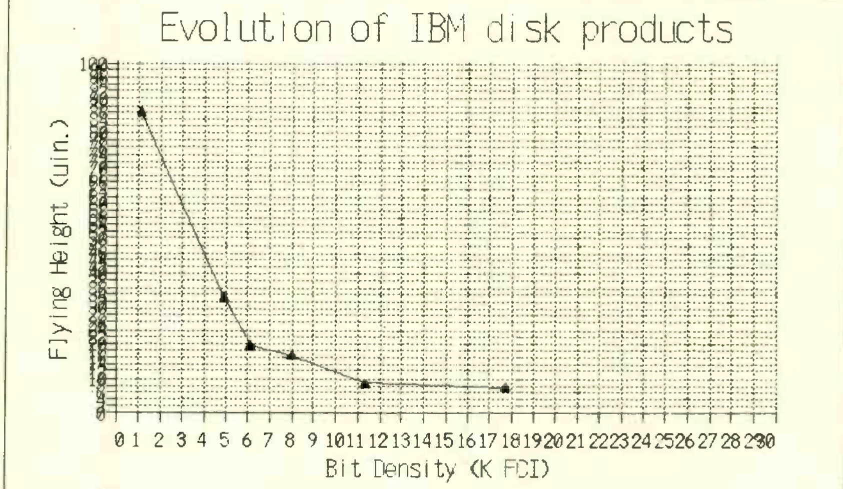

Fig. 7. For graphs with high resolution crowding may occur on the vertical axis.

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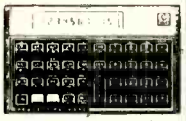

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for the current date. Through various menu functions, you can display a note page, go to a specific date on the calendar, set a timer, and print out one or more pages of the book, among other things.

The CALC function gives you access to a general-purpose calculator that interacts with the word processor so you can perform calculations and insert them anywhere in a document. The calculator will total columns or rows that appear in a document automatically!

Documentation. A "Valdocs User's Guide" is provided with the system. It's written with the non-computerist in mind and makes liberal use of screen shots, diagrams, and cartoon illustrations. When describing key-press operations, the key legends are shown in reverse in the copy, which helps provide clarity when reading.

This light-and-easy treatment has some drawbacks, however. One particular part of the manual that was disconcerting was the description of the setup of the DIP-switches located on the rear panel. The manual says that, if you plan to use the machine with Valdocs, be sure to flip switch 1 down and leave the others up.

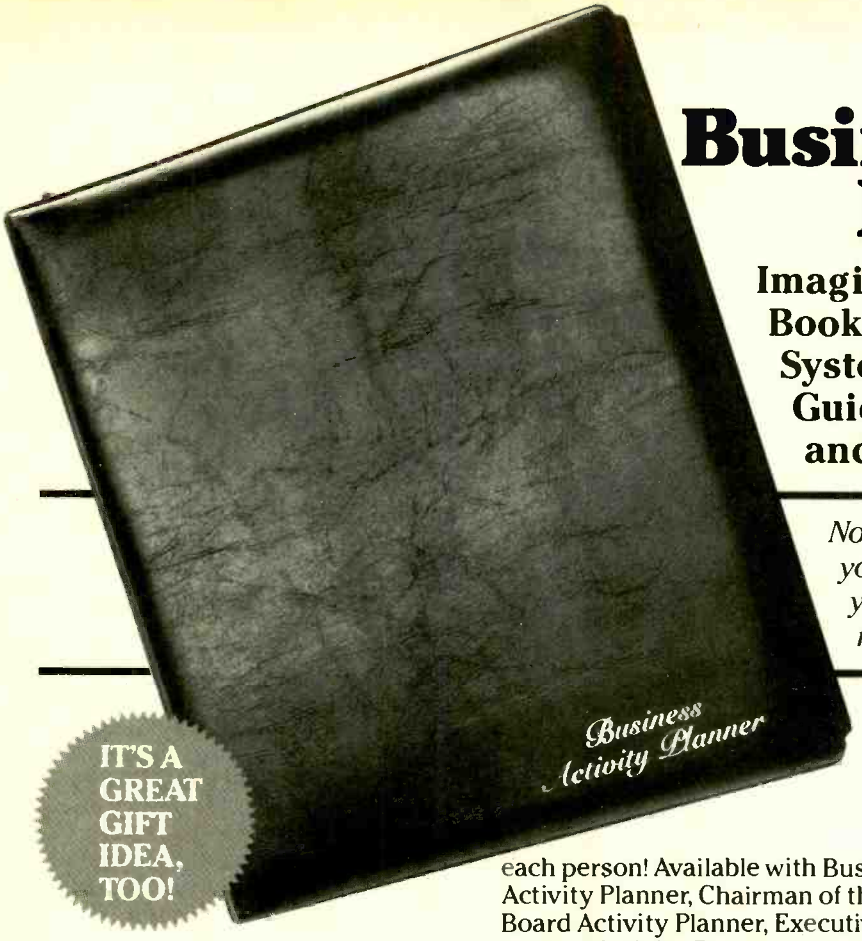
No explanation is given as to the function of the other switches. However, I discovered after trial and error and deciphering the schematics found in the optional technical manual, which incidentally is well done and complete, that the switch settings are more important than you are led to believe.

Should you want to do a great deal of development work, you might want to set switch 2 down to automatically enter Zapple, the machine language monitor, on bootup.

Switches 5, 6, 7 control the memory switching and should be in the down position to get the full advantage of the bank-switching function. If you follow the manual, bank select doesn't work as well. Switch number 8 provides the capability of downloading fonts to the printer if in the down or off position. I turned it on to let the FX-80 handle all

TABLE I—EXPANSION SLOT SIGNALS

Pin No.	Signal Symbol	Signal Direction	Description of Signal
1-2	GND	-	Ground
3-10	DTBO-7	In/Out	Databus
11-12	−12 V	-	−12 V
13-28	ADRO-15	Out	Address bus
29-30	GND	-	Ground
31	CLK	Out	System clock
32	GND	-	Ground
33	$\overline{\text{BSAK}}$	Out	Bus acknowledge
34	$\overline{\text{MEMX}}$	Out	External memory select
35	$\overline{\text{IRD}}$	Out	I/O read
36	$\overline{\text{IWR}}$	Out	I/O write
37	$\overline{\text{MRD}}$	Out	Memory read
38	$\overline{\text{MWR}}$	Out	Memory write
39	$\overline{\text{RSIN}}$	In	Reset input
40	$\overline{\text{INT(H)1}}$	In	High-priority external interrupt
41	$\overline{\text{INT(H)2}}$	In	High-priority external interrupt
42	$\overline{\text{INT(L)}}$	In	Low-priority external interrupt
43	+5 V	-	+5 V
44	$\overline{\text{RSET}}$	Out	Reset output
45-46	+5 V	-	+5 V
47	$\overline{\text{DRQ(F)}}$	In	DMA request
48	$\overline{\text{DRQ(S)}}$	In	DMA request
49	$\overline{\text{RDY(F)}}$	In	DMA ready
50	$\overline{\text{RDE(S)}}$	In	DMA ready
51	$\overline{\text{WAIT}}$	In	Wait
52	$\overline{\text{IWS}}$	Out	I/O write short
53	$\overline{\text{DAK(F)}}$	Out	DMA acknowledge
54	$\overline{\text{DAK(S)}}$	Out	DMA acknowledge
55	$\overline{\text{EOP(F)}}$	Out	End of process
56	$\overline{\text{EOP(S)}}$	Out	End of process
57-58	+12 V	-	+12 V
59-60	GND	-	Ground



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the work—this is important especially with screen dumps.

Comments. The QX-10 is not another me-too, 8-bit system. In fact, when it comes to hardware, I feel it is superior to just about any 8-bit microcomputer on the market today. I don't think, however, that either TPM or CP/M-80 really maximize the system's capabilities; and, though Valdocs may be all right for the noncomputerist without much experience, it is not quite satisfactory for the serious user.

The feel and arrangement of the keyboard are fine, but the unique escape sequences dreamed up for HASCI and the partial implementation of Televideo 920 display characteristics are bothersome. I do like the display; it is clean and easy to read.

Conclusions. The QX-10 is a good system; I can recommend it. Especially when you consider that, for under $3000, you get a complete computer, system software, a printer, and a set of Peachtree software. Even if you find the included software to be not entirely adequate for serious purposes (as I do), it is usable.

But, for serious applications, plan on purchasing other CP/M software. For example, I'm using Graphic Business Systems' Probase database manager and Scientific Marketing's MarketFax with the system. Since I'm a Wordstar fan I've installed the latest version 3.33 with modifications to take advantage of the printer.

By adding Crosstalk for communications, which I also use on the IBM PC, and a Giltronic RS-232C switch, I've connected the system into a very-low-cost LAN. Thus my secretary and other staff writers are able to share resources such as expensive printers.

Of course, Epson isn't just fielding the QX-10 and running away. It is preparing to offer an 8088 card and MS-DOS, which may be ready when you read this. Also in the works are a color card and monitor, 10M-byte hard disk, a light pen, and a baseband local-area network. (It would appear that the MAIL function was designed with this in mind.)

I have no doubt that, with the addition of the 8088 board, which will have an additional 256K of memory, the system will compete favorably with IBM PC and other compatibles. ◇

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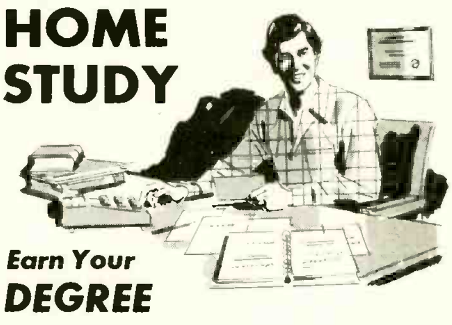

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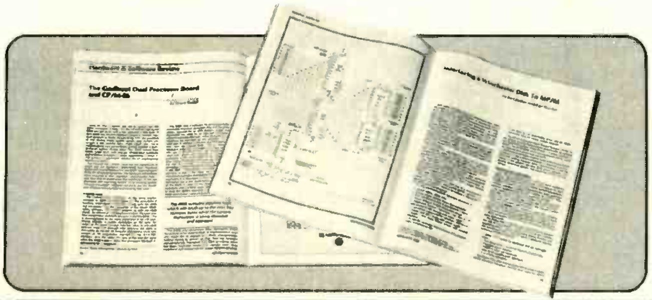

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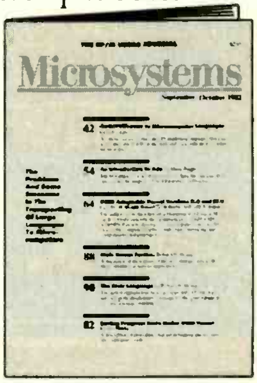

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(Continued from page 77)

row, and working horizontally, you would say "blank" for a1, "blank" for b1, "color" for c1, "color" for d1, "color" for e1, and continue to say "blank" for all remaining cells in the row. Then you would drop down to row 2 and repeat the procedure. You would continue dropping down, row by row, until you've finished describing the entire grid matrix. In this fashion, you could convey the entire picture with a minimum of vocabulary, but it would be very time-consuming. More to the point, your listener would have no idea that you were describing a rectangle and the letter Z until he filled in the squares.

The procedure we've just described is basically what occurs in the alphamosaic scheme proposed by the British.

Let's assume now that your friend has a slightly greater command of English. Then you could describe your picture more efficiently as follows: "color rectangle, 3 squares by 5 squares, starting at c1" and "color letter Z, 5 squares tall, starting at n9, ending at q13." This is the alphageometric approach, which directly describes the *geometry* of the figure in a much more concise and efficient manner than with the alphamosaic approach. The drawback of the alphageometric approach, however, is that it requires more interpretative ability on the part of your listener.

The strength of the alphamosaic scheme is that it can be decoded with very simple and, therefore, relatively inexpensive equipment. While this was an important consideration when Prestel was invented several years ago, it has recently become an only marginal advantage in light of the recent drop in prices for electronic parts. The result is that, by the time there was a reason to look for an American standard, the Canadian Telidon scheme's superior graphics and sophistication made it the natural choice.

The Telidon standard was adopted in 1982 by AT&T and is currently working its way through the various North American standards committees under the name NAPLPS.

NAPLPS Standard. The NAPLPS standard takes up where the ASCII standard leaves off. It starts with the ASCII codes to represent letters and numbers; and, in keeping with the ASCII standard, it is a 7-bit code (though there's also an 8-bit version), so that any equipment that can send and receive ASCII can do the same with NAPLPS-encoded graphics. The result is that graphics information can be moved about as easily as text, and any host computer can be used to manipulate the graphics.

With only 128 possible combinations available in a 7-bit code, and ASCII code characters taking up most of them for numbers and letters, it might appear that there's no room for graphics character codes. However, NAPLPS makes it possible for graphics codes to overlay the numbers and letters codes. To be

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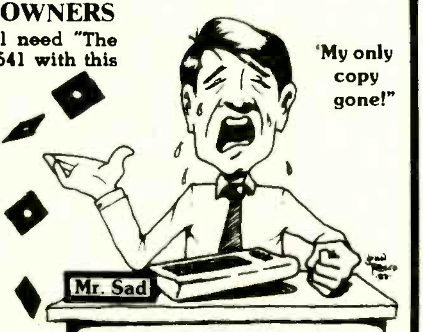

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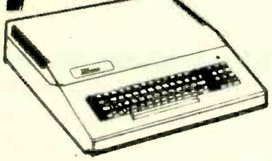

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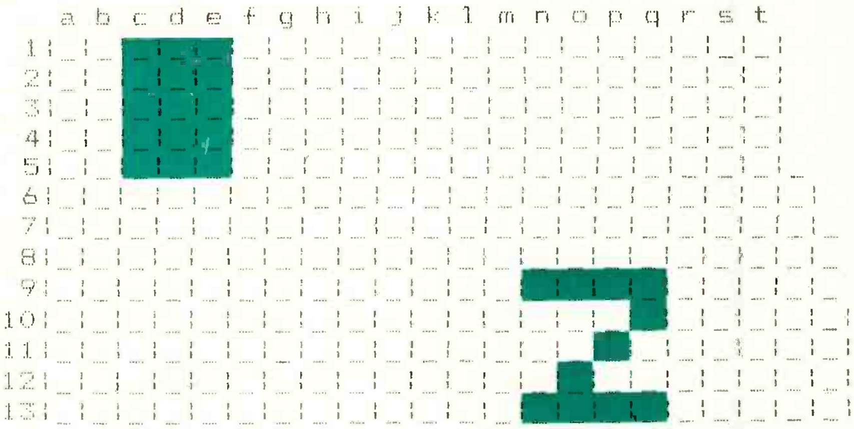
able to do this, NAPLPS redefines a couple of ASCII's 32 nonprinting codes, which represent such things as "carriage return" and "go to top of next page." The new definitions can be used to tell the system that what's coming next is either letters and numbers or graphics information. Consequently, the same 7-bit ASCII code does double duty, representing a letter in one context and a graphics element in another.

The NAPLPS standard describes all graphics images as combinations of points, arcs, lines, rectangles, and polygons. The graphics can be solid or outlines, and they can be any color desired.

The coding scheme cleverly permits colors and locations to be described to almost any degree of precision. So even if it's not yet worth having 64,000 colors available, because current video monitors can't distinguish among them anyway, or even if there's no point in describing a shape with a precision of 0.001", the standard can handle it. If, in the future, better monitors or faster decoders become available, the standard and any graphics already encoded under it, won't have to be altered. Hence, NAPLPS offers the same type of backward and forward compatibility for computer-stored graphics information



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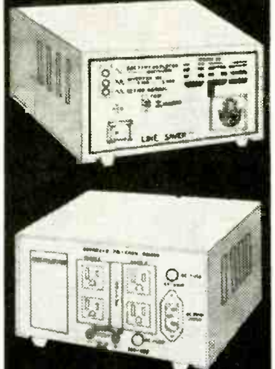

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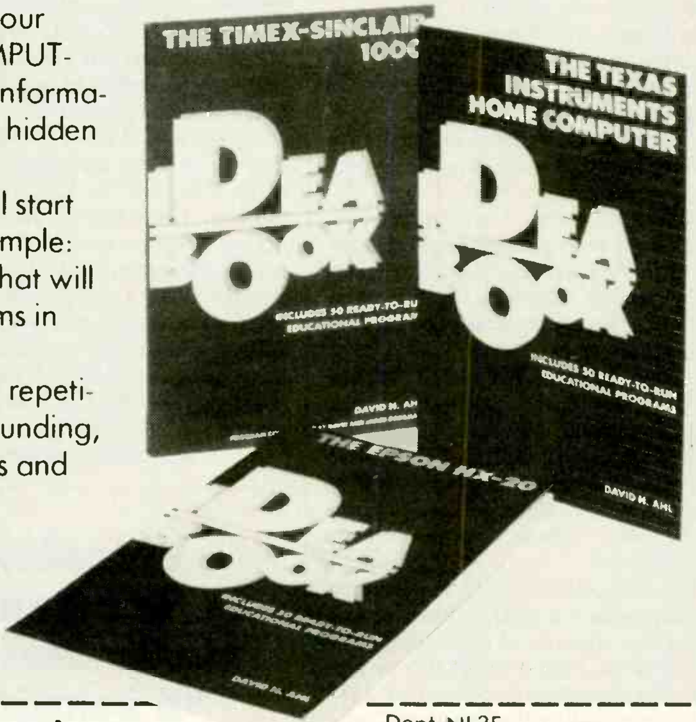
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that was established when color broadcasts became possible for television.

The Services. Now that you know that the technology for videotex exists and is quite refined, what about services? Does a videotex service actually exist to which you can subscribe? For most of the U.S.—and the rest of the world, for that matter—the answer is "no."

In Britain, the Prestel service has a few tens of thousands of subscribers, which gives it the largest subscriber base for any videotex system currently in existence. Most subscribers to Prestel are businesses that use the service for professional purposes.

Across the Channel in France, a system similar to Prestel is being tested for the ultimate purpose of replacing traditional printed telephone directories. It will also be used to provide other consumer services.

In Canada, a service called "Grassroots" offers both consumer-oriented and agricultural information in a rural area in southern Manitoba. Farther to the east, in Toronto, a couple of hundred terminals in hotel lobbies and other public places offer tourist information.

The only place in the U.S. where you can subscribe to a local videotex service is in three counties in and around Miami, Florida. Called Viewtron, the service was launched in November 1983 and is operated by the Viewdata Corp., a subsidiary of Knight-Ridder Newspapers, Inc. The Viewtron service is based on a Tandem Non Stop II computer located in Miami Beach. A subscriber reaches the computer with a local telephone call from anywhere in the three-county area. Cost for this service is $12 per month plus $1 per connected hour. Since in addition to subscribing to the Viewtron service, you need a videotex decoder, Viewdata is selling, through retail chains in its marketing area, the AT&T Sceptre videotex terminal for $600.

The Viewtron service offers both specialized and general-interest information, including stock quotations, local-area restaurant menus, and the American Academic Encyclopedia. It also offers services like electronic banking and shopping, and subscriber-to-subscriber electronic messaging. Some services simply use Viewtron's computer to access other computers. You can tell the system you want to order something from, say, J.C. Penney, and Viewtron's computer connects you to Penney's computer.

Another videotex service should be in operation by the middle of this year in Orange County, California. Called Gateway, it will be operated by Times-Mirror Videotex Services, a subsidiary of the *Los Angeles Times*. The range of services and the configuration of the hardware isn't very different from what Viewtron offers. The major difference is that Gateway plans to rent, rather than sell, decoders to subscribers.

If Gateway is successful, this service may be in your area sooner than you think. Through its Videotex America affiliate, Times-Mirror proposes to set up partnerships with local newspapers across the country for local videotex services. Each local service would run its own computer, rent out its own decoders, and do its own selling, both of advertising and of the service itself. Like network TV, some nationwide Gateway services would also be provided, as would some national advertising.

Videotex is often described as "a solution in search of a problem"

It's not necessary for you to be within the local marketing area of any of these services to be able to use them. All you need are a subscriber ID, a telephone line, and a videotex decoder. Of course, if you live outside the area the system is designed to service, you may not want to subscribe, since most of the information available on it will be of a local nature. Just how local the videotex service is has a lot more to do with marketing and the people who are launching the services (usually local newspapers), than it does with technology. Subscribers outside the service area will have to pay for toll calls to the computer.

Subscribers outside a given local area wouldn't have to use the prescribed terminal, at least not if terminals aren't included in the monthly subscription fee. This means you can use a personal computer, modem, and communication software as a videotex decoder. Canadian software developers, who have been working with the NAPLPS standard the longest, already have software for micros as inexpensive as the Commodore C-64 computer. And several software packages exist for Apples and the IBM PC. (Really inexpensive computers, like the Commodore VIC-20, aren't fast enough to be used as practical videotex decoders.)

Down the Road. You might want to keep on the alert for new developments in the near future. In particular, watch for AT&T to bring to your local area its Sceptre terminal and for really good decoding software to become available for the IBM PC*jr* computer.

Like the IBM PC and PC*jr* and a number of other very powerful 16-bit computers currently available, the Sceptre is an 8088-based system. If it were available right now, you couldn't use a Sceptre as a computer, since no way exists to permit you to load the necessary software into it. However, AT&T is likely to reveal a few hidden pathways into the Sceptre at about the time it wants to get into the home computer market.

If you live in the southern Florida area, watch for the stores selling the IBM PC*jr* to start stocking videotex decoding software. Since it already exists for the IBM PC, it will almost certainly be made available for the PC*jr* just about the time this new computer from IBM is delivered to dealers. Anyone who purchases an IBM PC*jr* could turn it into the equivalent of the Sceptre terminal, for a nominal cost of perhaps $200, and still have the PC*jr* for its computing power.

In Closing. Videotex is frequently described as a "solution in search of a problem." It's a new medium of communication that no one is quite sure what to do with and, consequently, has yet to be fully exploited. This situation is destined to change rapidly in the near future.

As paying, commercial videotex systems appear, with commitments from solid companies like AT&T and major newspaper chains, we may see videotex emerge as a truly useful home service. ◇

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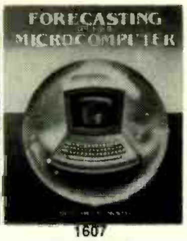
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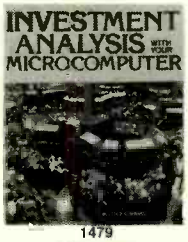
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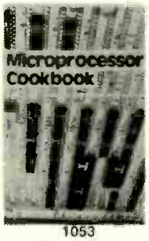
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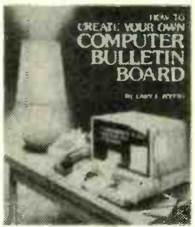
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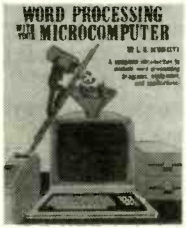
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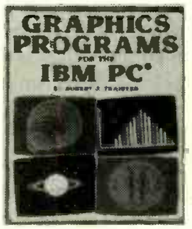
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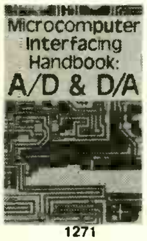
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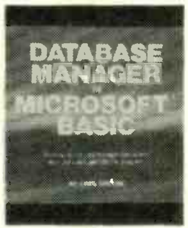
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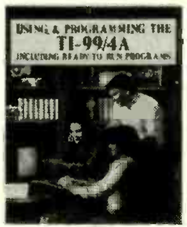
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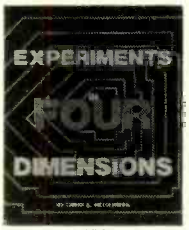
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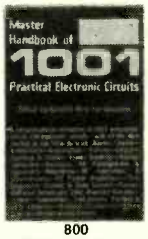
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Storage Oscilloscope

(Continued from page 66)

the sweep subroutine, y-axis (vertical) trace data is written into the data file if D$ is Y. The sweep delay per division (SD) is saved after the trace has been saved (line 4500). This allows a suitable plotter program to correctly annotate a hard copy version of the retrieved trace. (Omit line 4500 if you don't plan to use the plotter option described below.) Finally, the disk file is closed (line 4600) after the sweep is completed and saved.

Traces which have been saved on disk can be retrieved and displayed with *or* without a graticule. This function is accomplished by the routine in lines 1000-1400. Line 1020 requests the name of the trace (N$) and line 1030 opens an input buffer (#1) for the disk. The remainder of the routine retrieves data from the disk and paints the trace on the monitor's screen. The retrieved trace is drawn using the sweep subroutine's method for painting a real-time trace. (See lines 4300-4350 and 1310-1340.) Saved traces can also be drawn on a plotter using the Scopeplt program described later.

How to Use Comscope. After loading the program (and saving it on disk if you have a disk drive), verify operation by moving the joystick handle during the display sweep phase. If the trace does not move up and down in response to joystick movements, check to make sure that the program was entered correctly.

Be sure to check all the menu options for proper operation. A displayed trace can be exited (while it's being painted or after it's frozen on the monitor) by pressing M. The screen will immediately clear and the main menu will be displayed. You can exit at other points in the program by pressing BREAK and restart by typing RUN.

Many different signal sources can be connected to the Color Computer's joystick ports as long as their output levels fall within the 0-5-volt "window." When no external amplifier is used, Comscope provides a sensitivity of about 0.4 volt per vertical division.

Low-level signals will require amplification and this is easily accomplished with a simple operational amplifier circuit such as the one described in this month's "The Electronics Scientist" column. This column also describes how to gain access to the Color Computer's joystick ports by soldering a pair of wires to terminals inside a joystick.

Three simple circuits whose outputs can be monitored with the Comscope program are shown in Fig. 2. Figure 2A shows an RC circuit that outputs a rapidly rising voltage followed by a slowly falling voltage as *C1* is charged through *R1* and then self-discharged through natural leakage paths within the circuit.

A photograph of the actual trace of the charge-discharge cycle as displayed on the computer's monitor (0.4 volt per vertical division and 0.35 second per horizontal division) is shown in Fig. 3. The trace begins automatically as soon as *S1* is closed. The switch was opened when the charge of *C1* approached maximum amplitude.

The circuit in Fig.2B is a very simple, yet ultra-sensitive, light sensor. The cadmium sulfide photoresistor, *PC1*, has a high dark resistance and a low light resistance (Radio Shack 276-116 or similar). The circuit's output voltage rises as the light level at the photoresistor increases.

Even economical printers have higher resolution than video monitors

A photograph of the monitor's screen showing two spikes produced by the light sensor when a flashlight was blinked twice in quick succession (0.4 volt per vertical division) is shown in Fig. 4. The spikes, which are easier to discern without the graticule, exhibit the very slow fall times characteristic of photoresistors. This is the so-called *memory effect*. While a small part of the delay is caused by the thermal lag of the lamp filament, note that the output from the sensor is still 0.4 volt when the second flash arrives about 2.5 seconds after the first.

A linear-response light sensor using a silicon solar cell and an op amp is shown in Fig. 2C. Using the values of *R1* and *R2* as shown, the gain of the op amp is 10. This can be increased (decreased) by increasing (decreasing) the value of *R2*.

A photograph of the monitor's screen showing the trace produced when the beam from a flashlight is slowly scanned past the solar cell is shown in Fig.5. The horizontal sweep is 1 second per division. Thanks to the X10 gain of the amplifier, the vertical scale is a sensitive 0.04 volt per division.

Earlier it was explained that traces saved on disk must have reduced resolution to avoid interruptions from the disk drive when the output buffer is filled. The display photograph in Fig.3 clearly shows an artifact resultant from a disk-drive interruption near the right end of the trace. Depending upon the signal, a similar artifact may appear at the same location on other traces.

Modifying Comscope. In using Comscope for serious applications, you may want to consider modifying or expanding the program to include custom features. Since the time per horizontal division is only approximate, you can refine the timing calibration. One possibility is to use the TIMER function.

If you can program in assembly language, you can greatly increase Comscope's sweep speed. This is done by substituting an assembly language subroutine for the sweep subroutine.

You may also wish to add sound effects, particularly if you intend to record traces over a period of minutes or hours. A simple BASIC line such as SOUND 200,50 appropriately placed will generate a tone to notify that the trace is complete or any other desired event has occured.

Using an X-Y Plotter. It's possible to use some dot-matrix printers to produce a hard-copy version of graphics displayed on a computer's monitor. This procedure is called a *screen dump*.

A better approach is to employ an x-y plotter. Even economical plotters have much higher resolution than the best available video monitors. This means very precise graticules and calibration marks can be superimposed on a plotted trace.

A program called Scopeplt that converts Comscope traces saved on disk into publication-quality hard copy is given in Listing 2. The program is designed for use with Hewlett-Packard's HP-7470A plotter and a Color Computer. With minor modifications it can also be used with other computers and any of the various plotters that understand HPGL (Hewlett-Packard Graphics Language).

LISTING 1—COMSCOPE

```
10 'COMSCOPE
20 'COPYRIGHT 1984 BY FORREST M. MIMS III
30 CLS
50 PRINT @ 34, "COLOR COMPUTER OSCILLOSCOPE"
100 PRINT @ 96, "A.SINGLE SWEEP STORAGE SCOPE."
110 PRINT @ 160, "B.CONTINUOUS SWEEP SCOPE."
120 PRINT @ 224, "C.RETRIEVE TRACE FROM DISK."
150 PRINT @ 320, "FOR GRATICULE ADD G TO SELECTION"
160 PRINT @ 384, "PRESS M TO RETURN TO MAIN MENU"
165 PRINT "":PRINT ""
170 INPUT "SELECTION";SE$
200 IF SE$="B" OR SE$="BG" THEN 340
210 IF SE$="C" OR SE$="CG" THEN 1000
300 CLS
310 INPUT "SAVE TRACE ON DISK (Y OR N)";D$
320 IF D$="Y" OR D$="N" THEN 330 ELSE 300
330 IF D$="Y" THEN INPUT "NAME OF TRACE";N$
340 INPUT "SECONDS PER DIVISION (0.35 MINIMUM)";SD
350 IF D$="Y" THEN M=4 ELSE M=16
360 SW=((SD-.34)*460)/M
370 IF D$="Y" THEN OPEN "O",#1,N$
380 PMODE 4,1:PCLS:SCREEN 1,0
400 IF SE$="AG" OR SE$="BG" THEN GOSUB 2000
450 GOSUB 4000
500 IF SE$="B" OR SE$="BG" THEN 380
1000 CLS
1020 INPUT "NAME OF COMSCOPE TRACE ON DISK";N$
1030 OPEN "I",#1,N$
1100 PMODE 4,1:PCLS:SCREEN 1,0
1200 IF SE$="CG" THEN GOSUB 2000
1300 LINE (0,191)-(0,191),PSET
1310 FOR X=0 TO 255 STEP 4
1320 INPUT #1,Y
1330 LINE -(X,Y),PSET
1340 NEXT X
1350 CLOSE #1
1400 IF INKEY$="M" THEN 30 ELSE 1400
2000 'DRAW GRATICULE
2010 FOR H=0 TO 255 STEP 16
2020 LINE (H,0)-(H,191),PSET
2030 NEXT H
2040 FOR T=0 TO 191 STEP 4
2050 PSET (127,T):PSET (129,T)
2060 NEXT T
2100 FOR V=16 TO 191 STEP 16
2110 LINE (0,V)-(255,V),PSET
2120 NEXT V
2130 FOR T=0 TO 255 STEP 4
2140 PSET (T,95):PSET (T,97)
2150 NEXT T
2160 RETURN
4000 IF D$="Y" THEN Q=4 ELSE Q=1
4100 LINE (0,191)-(0,191),PSET
4200 IF JOYSTK(0) > 0 THEN 4300 ELSE 4200
4300 FOR X=0 TO 255 STEP Q
4305 IF INKEY$="M" THEN 30
4310 Y=189-3*JOYSTK(0)
4320 IF D$="Y" THEN WRITE #1,Y
4330 LINE -(X,Y),PSET
4340 FOR T=1 TO SW:NEXT T
4350 NEXT X
4500 IF D$="Y" THEN WRITE #1, SD
4600 IF SE$="A" OR SE$="AG"
     THEN CLOSE #1 ELSE RETURN
4700 IF INKEY$="M" THEN 30 ELSE 4700
```

LISTING 2—SCOPEPLT

```
10 'SCOPEPLT
15 'COPYRIGHT 1984 BY FORREST M. MIMS III
20 PRINT #-2, "SP0;":CLS
25 PRINT @ 34, "COLOR COMPUTER OSCILLOSCOPE"
30 PRINT @ 69, "HP7470 PLOTTER DRIVER"
35 PRINT @ 288, "PRESS ANY KEY TO START..."
40 IF INKEY$="" THEN 40 ELSE CLS
45 PRINT "SCOPE DATA FILE MUST BE ON DISK."
47 PRINT "PRESS R TO RESTART PROGRAM.":PRINT ""
50 INPUT "SCOPE DATA FILE NAME";N$
60 INPUT "DO YOU WANT A GRATICULE (Y OR N)";G$
70 IF G$="N" THEN INPUT "DO YOU WANT
   BORDER TICK MARKS (Y OR N)";T$
80 OPEN "I",#1,N$
90 PRINT#-2, "SC0,255,0,191;SP2;"
110 PMODE 4,1:PCLS:SCREEN 1,0
120 IF G$="N" THEN 3000
230 FOR H=0 TO 271 STEP 16
240 LINE (H,0)-(H,191),PSET
250 PRINT#-2, "PA"H",0,PD,"H",191,PU;"
255 IF INKEY$="R" THEN 5000
260 NEXT H
270 PRINT#-2, "PA128,0;"
280 FOR T=0 TO 191 STEP 4
290 PRINT#-2, "PA128,"T";YT;"
295 IF INKEY$="R" THEN 5000
300 NEXT T
310 FOR Q=1 TO 1000:NEXT Q
320 FOR V=0 TO 207 STEP 16
330 LINE (0,V)-(255,V),PSET
340 PRINT#-2, "PA0,"V",PD,255,"V",PU;"
345 IF INKEY$="R" THEN 5000
350 NEXT V
360 PRINT#-2, "PA0,96;"
370 FOR T=0 TO 255 STEP 4
380 PRINT#-2, "PA"T",96;XT;"
385 IF INKEY$="R" THEN 5000
390 NEXT T
400 FOR Q=1 TO 1000:NEXT Q
420 FOR T=0 TO 191 STEP 4
430 PSET (127,T):PSET (129,T)
440 NEXT T
450 FOR T=0 TO 255 STEP 4
460 PSET (T,95):PSET (T,97)
470 NEXT T
480 PRINT #-2, "SP1;"
500 FOR X=0 TO 255 STEP 4
600 INPUT #1, Y
700 PSET (X,Y)
720 PRINT#-2, "PA"X,Y";PD;"
750 IF INKEY$="R" THEN 5000
800 NEXT X
900 PRINT#-2, "PU;SP2;"
910 PRINT#-2, "DR-1,0;SR5,-7;"
920 PRINT#-2, "PA0,220;LB"N$;CHR$(3)
925 PRINT #-2, "SR2.5,-4
927 INPUT#1, SD
930 PRINT #-2, "PA0,250;LB0.4 VOLT/DIV
    "SD"SEC/DIV"CHR$(3)
950 PRINT#-2, "PU;SP;"
990 CLOSE #1
1000 IF INKEY$="R" THEN 20 ELSE 1000
3000 PRINT#-2, "PA0,0,PD,0,191,
     255,191,255,0,0,0,PU;"
3100 IF T$="N" THEN 500
3200 FOR T=0 TO 191 STEP 16
3300 PRINT#-2, "PA0,"T";TL1,0;YT;"
3350 IF INKEY$="R" THEN 5000
3400 NEXT T
3500 FOR D=1 TO 1000:NEXT D
3600 FOR T=0 TO 191 STEP 16
3700 PRINT#-2, "PA255,"T";TL0,1;YT"
3750 IF INKEY$="R" THEN 5000
3800 NEXT T
3900 FOR D=1 TO 1000:NEXT D
4000 FOR T=0 TO 255 STEP 16
4100 PRINT#-2, "PA"T",0;TL1,0;XT;"
4150 IF INKEY$="R" THEN 5000
4200 NEXT T
4300 FOR D=1 TO 1000:NEXT D
4400 FOR T=0 TO 255 STEP 16
4500 PRINT#-2, "PA"T",191;TL0,1;XT;"
4550 IF INKEY$="R" THEN 5000
4600 NEXT T
4700 FOR D=1 TO 1000:NEXT D
4800 GOTO 500
5000 CLOSE #1:GOTO 20
```

The program combines instructions for the computer's video monitor *and* the plotter so that both form graticules (if so instructed by the user) before plotting the retrieved trace.

The program probably seems very complicated if you're not familiar with HPGL. Actually, HPGL is very easy to use, as you can readily see by referring to the keystone of the program, lines 500-800. These five short lines form a loop that plots the saved trace a point at a time on both the computer's monitor and the plotter. Here's what happens:

Line 500 establishes a loop of 256/4 events, 256 being the number of pixels across the screen of the monitor. The loop is stepped through each fourth pixel since the disk data is stored at 1/4 resolution.

Line 600 retrieves y-axis data (voltage) from the disk.

Line 700 moves the plotter pen to the appropriate position (PA or *P*lot *A*bsolute) and places the pen tip on the paper (PD or *P*en *D*own).

Line 800 repeats the cycle started at line 500.

As the loop executes, a stream of dots is "painted"on the video monitor, while simultaneously, the plotter pen draws a continuous line plot identical to the displayed trace.

While Scopeplt, like all graphics programs, is very meticulous in its detail, it's actually a relatively simple program. Look, for instance, at line 90. This line uses the plotter's SC (*SC*ale) instruction to establish a grid of 192 x 256 plotter units. This gives the plotter the same resolution as the Color Computer and allows the *x* and *y* values used for the computer to be used by the plotter.

The HPGL commands between lines 230 and 390 draw the graticule and insert tick marks. The HPGL commands between lines 3000 and 4800 draw a simulated CRT screen *without* a graticule and with or without border tick marks if either of these options is selected.

You may be wondering about the sprinkling of seemingly functionless time-wasting loops such as those in lines 310, 400, 3000, 3900, 4300, and 4700. These are included to prevent the buffer in the HP-7470A plotter from being filled by too rapid a stream of incoming instructions from the Color Computer.

To reduce execution time, experiment with the values in these timer loops.

How to Use Scopeplt. An HP-7470A (RS-232 version) plotter is connected to the serial port of a Color Computer as shown in Fig.6. While this arrangement does not permit the plotter to send data *to* the computer, it is satisfactory for most common plotting applications. Other computers offer better interfacing via "handshake" signals.

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Prior to running Scopeplt, the plotter's scaling points should be manually entered into the plotter. This is accomplished from the plotter's control panel by first directing the pen to the desired upper *left* corner of the plot and entering Pl. Next, move the pen to the desired lower *right* corner of the plot and enter P2. Be sure to leave room for the label which will be drawn under the plot.

Next, select the pens you wish the plotter to use. A fine tip (0.3 mm) black pen is excellent for the graticule or border (right stall) while a broad tip (0.7 mm) red, green or blue pen provides a highly visible trace (left stall).

Make sure the plotter is placed so the paper has an unimpeded path as it moves back and forth across the bed. Then place a sheet of paper in the plotter. (White typing bond is okay, but plotter paper provides publication-quality results.)

Now run Scopeplt. The program will ask you to enter the name of the trace you want to plot. (You'll get an NE error if the data file for the trace is not on the disk inserted in the drive.) The program will then ask if you want a graticule. If not, it will ask if you want tick marks inserted around the rectangle which will surround the plot.

After you have responded to the program, Scopeplt will take over and rapidly commence drawing the plot. After completing the graticule (or border) and trace, it will label the plot and insert the calibration factors. The program uses a fixed value of 0.4 volt per vertical division, with the value for the sweep speed retrieved from the disk file.

Be sure to keep your fingers away from the fast moving pen! Depending upon where you set P1 and P2, you can enter new locations for P1 and P2 and make additional plots on the same sheet.

A sample test plot showing voltage fluctuations generated by one axis of an analog (potentiometer voltage divider) joystick is shown in Fig. 7. The data for this oscillogram, which illustrates the border with tick marks option, was retrieved from a disk data file called JOYSTK-1.

Figures 8, 9, and 10 are plotter-generated oscillograms corresponding to the computer monitor photographs in, respectively, Figs. 3, 4 and 5. All three oscillograms illustrate the graticule option.

Various combinations of pen colors and widths can be used to dress up the oscillograms. You can plot an oscillogram anywhere you please on a sheet of paper simply by setting new P1 and P2 locations. You may wish to make light pencil marks for the new locations. Enter them after first moving a pen directly over each mark. Remember that you'll have to reenter the P1 and P2 points if you turn off the plotter.

Modifying Scopeplt. Experienced HPGL programmers will have little trouble revising Scopeplt to include additional features. With a little practice, even novice HPGL programmers can soon learn to expand the program.

The most obvious revision would be a menu of options to permit such a frill as keyboard control of the location, size, and orientation of the oscillograms. Other options might include user-selectable label size and graticule configuration. A text feature could also be included.

The programs can be revised to drive other computers and plotters

Incidentally, normally P1 and P2 are set, respectively, at the upper *left* and lower *right* corners of the paper. Scopeplt alters this arrangement in order to match the Color Computer coordinate system. Therefore, the labels are *reverse* printed so they will apppear normal (see line 910). Keep this in mind if you revise the program.

Going Further. Both Comscope and Scopeplt illustrate the use of moderately priced computer hardware to provide capabilities previously unavailable to engineers, technicians, and experimenters unable to afford expensive storage oscilloscopes and data loggers. Remember that, while these programs were developed for the Color Computer and HP-7470, they can both be revised to drive *other* computers and plotters. ◇

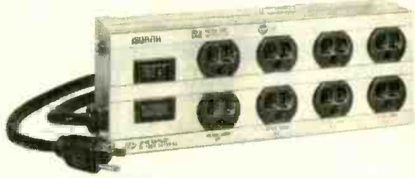
Sharp PC-5000

(Continued from page 63)

tem, no special procedure is required for using the bubble memory. Bubble cartridges are small enough to tuck into a shirt pocket and are quite a bit more rugged than floppy disks and data cassettes.

As I see it, the only drawbacks to the bubble-memory system are its limited 128K storage capacity and the relatively high price of additional cartridges. However, with a combination of disks and bubble memory, the one cartridge supplied with the computer should be sufficient for most users.

Closing Comment. Sharp has done a great job in designing the PC-5000. My main regret is that I didn't have a production model, complete with software and all options, to test. The fact that the computer uses MS-DOS as its operating system should mean that there will be many fine software packages available for the PC-5000 in a short time. If Sharp supports and services the computer, the PC-5000 should be a real winner. ◇



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4164 64K DYNAMIC 200 NS $\$5^{95}$ TMM2016 2KX8 STATIC 200 NS $\$4^{15}$

STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
TC5514	1024 x 4	(650ns) (cmos)	2.49
TC5516	2048 x 8	(250ns) (cmos)	9.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95
HM6264	8192 x 8	(150ns) (cmos)	49.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/7.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
MCM68764	8192 x 8	(450ns) (5v) (24 pin)	39.95
MCM68766	8192 x 8	(350ns) (5v) (24 pin)(pwr dn.)	42.95
27128	16384 x 8	(300ns) (5v)	29.95

5v = Single 5 Volt Supply 21vPGM = Program at 21 Volts

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

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32.768 khz	1.95
1.0 mhz	3.95
1.8432	3.95
2.0	2.95
2.097152	2.95
2.4576	2.95
3.2768	2.95
3.579545	2.95
4.0	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
32.0	2.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

CMOS

4000	.29
4001	.25
4002	.25
4006	.89
4007	.29
4008	.95
4009	.39
4010	.45
4011	.25
4012	.25
4013	.38
4014	.79
4015	.39
4016	.39
4017	.69
4018	.79
4019	.39
4020	.75
4021	.79
4022	.79
4023	.29
4024	.65
4025	.29
4026	1.65
4027	.45
4028	.69
4029	.79
4030	.39
4034	1.95
4035	.85
4040	.75
4041	.75
4042	.69
4043	.85
4044	.79
4046	.85
4047	.95
4049	.35
4050	.35
4051	.79
4053	.79
4060	.89
4066	.39
4068	.39
4069	.29
4070	.35
4071	.29
4072	.29
4073	.29
4075	.29
4076	.79
4078	.29
4081	.29
4082	.29
4085	.95
4086	.95
4093	.49
4098	2.49
4099	1.95
14409	12.95
14410	12.95
14411	11.95
14412	12.95
14419	7.95
14433	14.95
4502	.95
4503	.65
4508	1.95
4510	.85
4511	.85
4512	.85
4514	1.25
4515	1.79
4516	1.55
4518	.89
4519	.39
4520	.79
4522	1.25
4526	1.25
4527	1.95
4528	1.19
4531	.95
4532	1.95
4538	1.95
4539	1.95
4541	2.64
4543	1.19
4553	5.79
4555	.95
4556	.95
4581	1.95
4582	1.95
4584	.75
4585	.75
4702	12.95
74C00	.35
74C02	.35
74C04	.35
74C08	.35
74C10	.35
74C14	.59
74C20	.35
74C30	.35
74C32	.39
74C42	1.29
74C48	1.99
74C73	.65
74C74	.65
74C76	.80
74C83	1.95
74C85	1.95
74C86	.39
74C89	4.50
74C90	1.19
74C93	1.75
74C95	.99
74C107	.89
74C150	5.75
74C151	2.25
74C154	3.25
74C157	1.75
74C160	1.19
74C161	1.19
74C162	1.19
74C163	1.19
74C164	1.39
74C165	2.00
74C173	.79
74C174	1.19
74C175	1.19
74C192	1.49
74C193	1.49
74C195	1.39
74C200	5.75
74C221	1.75
74C244	2.25
74C373	2.45
74C374	2.45
74C901	.39
74C902	.85
74C903	.85
74C905	10.95
74C906	.95
74C907	1.00
74C908	2.00
74C909	2.75
74C910	9.95
74C911	8.95
74C912	8.95
74C914	1.95
74C915	1.19
74C918	2.75
74C920	17.95
74C921	15.95
74C922	4.49
74C923	4.95
74C925	5.95
74C926	7.95
74C928	7.95
74C929	19.95

6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	9.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	29.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

8000

8035	5.95
8039	5.95
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8080	3.95
8085	4.95
8085A-2	11.95
8086	24.95
8087	CALL
8088	29.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	29.95
8748	24.95
8755	24.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	19.95
CRT5037	24.95
TMS9918A	39.95
DP8350	49.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	3.95
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	3.95
Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95

4.0 Mhz

Z80A-CPU	4.49
Z80A-CTC	4.95
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.49
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95

6.0 Mhz

Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	19.95
Z80B-SIO/2	39.95

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Z6132	34.95
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MM5375	4.95
MM58167	12.95
MM58174	11.95
MSM5832	3.95

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AY5-3600	11.95
AY5-3600 PRO	11.95

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74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
74LS122	.45	74LS377	1.39
74LS123	.79	74LS378	1.18
74LS124	2.90	74LS379	1.35
74LS125	.49	74LS385	3.90
74LS126	.49	74LS386	.45
74LS132	.59	74LS390	1.19
74LS133	.59	74LS393	1.19
74LS136	.39	74LS395	1.19
74LS137	.99	74LS399	1.49
74LS138	.55	74LS424	2.95
74LS139	.55	74LS447	.95
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS640	2.20
74LS151	.55	74LS645	2.20
74LS153	.55	74LS668	1.69
74LS154	1.90	74LS669	1.89
74LS155	.69	74LS670	1.49
74LS156	.69	74LS674	14.95
74LS157	.65	74LS682	3.20
74LS158	.59	74LS683	3.20
74LS160	.69	74LS684	3.20
74LS161	.65	74LS685	3.20
74LS162	.69	74LS688	2.40
74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

74S00

74S00	.32	74S132	1.24	74S225	7.95
74S02	.35	74S133	.45	74S240	2.20
74S03	.35	74S134	.50	74S241	2.20
74S04	.35	74S135	.89	74S244	2.20
74S05	.35	74S138	.85	74S251	.95
74S08	.35	74S139	.85	74S253	.95
74S09	.40	74S140	.55	74S257	.95
74S10	.35	74S151	.95	74S258	.95
74S11	.35	74S153	.95	74S260	.79
74S15	.35	74S157	.95	74S273	2.45
74S20	.35	74S158	.95	74S274	19.95
74S22	.35	74S161	1.95	74S275	19.95
74S30	.35	74S162	1.95	74S280	1.95
74S32	.40	74S163	1.95	74S287	1.90
74S37	.88	74S168	3.95	74S288	1.90
74S38	.85	74S169	3.95	74S289	6.89
74S40	.35	74S174	.95	74S301	6.95
74S51	.35	74S175	.95	74S373	2.45
74S64	.40	74S181	3.95	74S374	2.45
74S65	.40	74S182	2.95	74S381	7.95
74S74	.50	74S188	1.95	74S387	1.95
74S85	1.99	74S189	6.95	74S412	2.98
74S86	.50	74S194	1.49	74S471	4.95
74S112	.50	74S195	1.49	74S472	4.95
74S113	.50	74S196	1.49	74S474	4.95
74S114	.55	74S197	1.49	74S482	15.25
74S124	2.75	74S201	6.95	74S570	2.95
				74S571	2.95

VOLTAGE REGULATORS

7805T	.75	7905T	.85
78M05C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75	7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM323K	4.95
78H05K	9.95	UA78S40	1.95
78H12K	9.95		

C, T = TO-220 K = TO-3
L = TO-92

7400

7400	.19	74123	.49
7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

INTERFACE

8T26	1.59
8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

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	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	5.95	call
24 pin ZIF	7.95	call
28 pin ZIF	8.95	call

ZIF = TEXTOCL
(Zero Insertion Force)

CENTRONICS

IDCEN36	Ribbon Cable	36 Pin Male	8.95
IDCEN36/F	Ribbon Cable	36 Pin Female	8.95
CEN36	Solder Cup	36 Pin Male	7.95

SOUND CHIPS

76477	3.95
76488	5.95
76489	8.95
AY3-8910	12.95
AY3-8912	12.95
MC3340	1.49

BYPASS CAPS

.01 UF DISC	100/6.00
.01 UF MONOLITHIC	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

CONNECTORS

RS232 Male	2.50
RS232 Female	3.25
RS232 Hood	1.25
S-100 ST	3.95

EXAR

XR 2206	3.75
XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

LINEAR

LM301	.34	LM340 (see 7800)		LM565	.99	LM1558H	3.10
LM301H	.79	LM348	.99	LM566	1.49	LM1800	2.37
LM307	.45	LM350K	4.95	LM567	.89	LM1812	8.25
LM308	.69	LM350T	4.60	NE570	3.95	LM1830	3.50
LM308H	1.15	LM358	.69	NE571	2.95	LM1871	5.49
LM309H	1.95	LM359	1.79	NE590	2.50	LM1872	5.49
LM309K	1.25	LM376	3.75	NE592	2.75	LM1877	3.25
LM310	1.75	LM377	1.95	LM709	.59	LM1889	1.95
LM311	.64	LM378	2.50	LM710	.75	LM1896	1.75
LM311H	.89	LM379	4.50	LM711	.79	ULN2003	2.49
LM312H	1.75	LM380	.89	LM723	.49	LM2877	2.05
LM317K	3.95	LM380N-8	1.10	LM723H	.55	LM2878	2.25
LM317T	1.19	LM381	1.60	LM733	.98	LM2900	.85
LM318	1.49	LM382	1.60	LM741	.35	LM2901	1.00
LM318H	1.59	LM383	1.95	LM741N-14	.35	LM3900	.59
LM319H	1.90	LM384	1.95	LM741H	.40	LM3905	1.25
LM319	1.25	LM386	.89	LM747	.69	LM3909	.98
LM320 (see 7900)		LM387	1.40	LM748	.59	LM3911	2.25
LM322	1.65	LM389	1.35	LM1014	1.19	LM3914	3.95
LM323K	4.95	LM390	1.95	LM1303	1.95	LM3915	3.95
LM324	.59	LM392	.69	LM1310	1.49	LM3916	3.95
LM329	.65	LM393	1.29	MC1330	1.69	MC4024	3.95
LM331	3.95	LM394H	4.60	MC1349	1.89	MC4044	4.50
LM334	1.19	LM399H	5.00	MC1350	1.19	RC4136	1.25
LM335	1.40	NE531	2.95	MC1358	1.69	RC4151	3.95
LM336	1.75	NE555	.34	MC1372	6.95	LM4250	1.75
LM337K	3.95	NE556	.65	LM1414	1.59	LM4500	3.25
LM337T	1.95	NE558	1.50	LM1458	.59	RC4558	.69
LM338K	6.95	NE561	24.95	LM1488	.69	LM13080	1.29
LM339	.99	NE564	2.95	LM1489	.69	LM13600	1.49
				LM1496	.85	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

LED DISPLAYS

HP 5082-7760	.43"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49
TIL-311 4x7	.270"	HEX W/LOGIC	9.95

LED LAMPS

	1-99	100-up
JUMBO RED	.10	.09
JUMBO GREEN	.18	.15
JUMBO YELLOW	.18	.15
LED MOUNTING HARDWARE	.10	.09

DATA ACQUISITION

ADC0800	15.55	DAC0808	2.95
ADC0804	3.49	DAC1020	8.25
ADC0809	4.49	DAC1022	5.95
ADC0817	9.95	MC1408L6	1.95
DAC0800	4.95	MC1408L8	2.95

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

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INTEGRATED CIRCUITS

7400 TTL

Part	Price
7400N	.41
7401N	.41
7402N	.41
7403N	.41
7404N	.42
7405N	.45
7406N	.72
7407N	.72
7408N	.42
7409N	.43
7410N	.41
7411N	.41
7413N	.54
7414N	.61
7416N	.45
7417N	.45
7420N	.41
7423N	.44
7425N	.43
7426N	.41
7427N	.41
7430N	.41
7432N	.43
7437N	.43
7438N	.56
7440N	.41
7441AN	1.25
7442N	.61
7443N	.81
7444N	.81
7445N	1.01
7446N	1.03
7447N	1.03
7448N	1.03
7450N	.41
7451N	.41
7453N	.42
7454N	.41
7460N	1.02
7470N	.46
7472N	.46
7473N	.45
7474N	.45
7475N	.54
7476N	.52
7483N	.80
7485N	.88
7486N	.45
7489N	3.39
7490N	.54
7491N	.89
7492N	.64
7493N	.54
7495N	.63
7496N	.69
74107N	.56
74109N	.56
74121N	.54
74123N	.72
74125N	.70
74126N	.70
74132N	.74
74141N	1.25
74145N	.99
74147N	1.63
74148N	1.14
74150N	1.48
74151N	.65
74153N	.65
74154N	1.32
74155N	.67
74156N	.73
74157N	.65
74160N	.79
74161N	.79
74162N	.79
74163N	.79
74164N	.79
74165N	.94
74166N	1.03
74170N	1.59
74173N	1.08
74174N	.74
74175N	.74
74176N	.95
74177N	.95
74180N	1.02
74181N	2.38
74182N	1.07
74184N	3.06
74185N	3.06
74190N	.89
74191N	.89
74192N	.89
74193N	.88
74194N	.88
74195N	.68
74197N	.96
74198N	1.70
74199N	1.70
74251N	1.03
74365N	.68
74366N	.68
74367N	.68
74368N	.68
8093N	.70
8094N	.70
8095N	.74
8096N	.74
8097N	.74
8098N	.74
8334N	2.03

74LS00 TTL

Part	Price
74LS00N	.41
74LS01N	.41
74LS02N	.41
74LS03N	.41
74LS04N	.43
74LS05N	.43
74LS08N	.43
74LS09N	.43
74LS10N	.41
74LS11N	.41
74LS12N	.41
74LS13N	.54
74LS14N	.59
74LS15N	.41
74LS20N	.41
74LS21N	.41
74LS22N	.43
74LS26N	.43
74LS27N	.43
74LS30N	.41
74LS32N	.43
74LS37N	.43
74LS38N	.43
74LS40N	.41
74LS42N	.69
74LS47N	1.25
74LS48N	1.25
74LS49N	1.24
74LS51N	.41
74LS54N	.41
74LS55N	.41
74LS73N	.50
74LS74N	.50
74LS75N	.52
74LS76N	.51
74LS78N	.50
74LS83AN	.80
74LS85N	.96
74LS86N	.43
74LS90N	.65
74LS93N	.65
74LS107N	.50
74LS109N	.50
74LS112N	.51
74LS113N	.50
74LS114N	.50
74LS122N	.57
74LS123N	.87
74LS125N	.61
74LS126N	.61
74LS132N	.82
74LS136N	.47
74LS138N	.70
74LS139N	.70
74LS151N	.68
74LS153N	.68
74LS154N	1.25
74LS155N	.77
74LS156N	.77
74LS157N	.68
74LS158N	.68
74LS160N	.81
74LS161N	.81
74LS162N	.81
74LS163N	.81
74LS164N	.81
74LS168N	1.45
74LS169N	1.36
74LS170N	1.81
74LS173N	.86
74LS174N	.74
74LS175N	.77
74LS190N	.96
74LS191N	1.03
74LS192N	.98
74LS193N	.98
74LS195AN	.80
74LS196N	1.13
74LS197N	1.13
74LS221N	1.09
74LS240N	1.21
74LS241N	1.21
74LS242N	1.20
74LS243N	1.20
74LS244N	1.21
74LS247N	1.36
74LS248N	1.36
74LS249N	1.36
74LS251N	.67
74LS253N	.70
74LS257N	.94
74LS258N	.71
74LS266N	.50
74LS279N	.55
74LS283N	.91
74LS290N	.96
74LS293N	1.04
74LS295N	1.26
84LS298N	1.14
74LS352N	1.45
74LS353N	1.45
74LS365N	.62
74LS366N	.62
74LS367N	.62
74LS368N	.62
74LS373N	1.25
74LS374N	1.25
74LS386N	.52
74LS670N	1.70
74LS95N	1.70
81LS96N	1.70
81LS97N	1.70
81LS98N	1.70

74S00 TTL

Part	Price
74S00N	.49
74S02N	.49
74S03N	.49
74S04N	.51
74S05N	.51
74S08N	.49
74S09N	.49
74S10N	.49
74S11N	.49
74S15N	.49
74S20N	.49
74S22N	.49
74S30N	.49
74S32N	.51
74S40N	.51
74S51N	.49
74S64N	.49
74S65N	.49
74S74N	.66
74S86N	.66
74S112N	.69
74S113N	.69
74S114N	.68
74S133N	.57
74S134N	.71
74S135N	1.09
74S136N	1.83
74S138N	1.14
74S139N	1.14
74S140N	.61
74S151N	1.17
74S153N	1.17
74S157N	1.17
74S158N	1.17
74S160N	2.77
74S161N	2.77
74S162N	2.77
74S163N	2.77
74S174N	1.26
74S175N	1.07
74S181N	3.26
74S182N	2.05
74S188N	2.42
74S189N	3.02
74S194N	1.81
74S195N	1.81
74S196N	2.29
74S197N	2.29
74S240N	2.39
74S241N	2.39
74S242N	3.37
74S243N	3.37
74S244N	2.61
74S251N	1.26
74S253N	1.26
74S257N	1.26
74S258N	1.26
74S280N	2.06
74S283N	2.22
74S287N	2.30
74S288N	2.66
74S289N	3.02
74S373N	2.78
74S374N	2.78
74S387N	2.30
74S472AN	5.78
74S473AN	5.78
74S474AN	6.50
74S475AN	6.50
74S570N	4.46
74S571N	4.46
74S572N	5.66
74S573N	5.66
74S940N	3.38
74S941N	3.38

74C00 CMOS

Part	Price
74C00N	.41
74C02N	.41
74C04N	.46
74C08N	.41
74C10N	.41
74C14N	.79
74C20N	.41
74C30N	.41
74C32N	.43
74C42N	.96
74C48N	1.21
74C73N	.59
74C74N	.57
74C76N	.60
74C83N	1.45
74C85N	1.45
74C86N	.57
74C89N	4.51
74C90N	1.11
74C93N	1.11
74C95N	1.36
74C107N	.69
74C150N	3.59
74C151N	2.35
74C154N	3.59
74C157N	2.35
74C160N	1.25
74C161N	1.25
74C162N	1.25
74C163N	1.25
74C164N	1.11
74C165N	1.12
74C173N	1.48
74C174N	1.25
74C175N	1.25
74C192N	1.59
74C193N	1.59
74C195N	1.59
74C200N	8.45
74C221N	1.36
74C240N	1.79
74C244N	1.79
74C373N	2.02
74C374N	2.02
74C901N	.50
74C902N	.50
74C903N	.50
74C904N	.50
74C905N	7.44
74C906N	.50
74C907N	.50
74C908N	1.20
74C909N	2.22
74C910N	6.20
74C911N	9.45
74C912N	9.45
74C914N	.86
74C915N	1.48
74C917N	9.45
74C918N	1.45
74C922N	3.82
74C923N	3.82
74C925N	5.75
74C926N	5.75
74C927N	5.75
74C928N	5.75
74C932N	1.11
74C941N	1.79
80C95N	.51
80C96N	.51
80C97N	.69
80C98N	.51
82C19N	3.59
88C29N	.21
88C30N	1.96

A/D& D/A

Part	Price
9028B	2.50
ADC0803LCN	7.82
ADC0804LCN	4.53
ADC0805LCN	5.66
ADC0808CCN	11.80
ADC0809CCN	5.92
ADC0816CCN	18.69
ADC0817CCN	11.32
ADC0833CCN	5.00
ADC1001CCN	32.00
ADC1021CCN	33.75
ADC3511CCN	8.27
ADC3711CCN	8.27
ADD3501CCN	8.30
ADD3701CCN	8.92
DAC0800LCN	2.77
DAC0807LCN	2.07
DAC0808LCN	2.27
DAC0830LCN	6.93
DAC0832LCN	3.91
DAC1020LCN	10.52
DAC1022LCN	6.77
MM5314N	3.89
MM5369N	2.80
MM5837N	2.30

Micro.

Part	Price
COP402N	7.17
COP404LSN	12.06
COP444LR	66.00
COP452N	5.17
COP470N	3.99
COP472N	5.19
COP498N	5.17
COP499N	5.17
DP8212N	1.48
DP8216N	1.20
DP8224N	1.41
DP8226N	1.27
DP8228N	2.83
DP8238N	2.83
DP8303N	2.38
DP8304BN	2.15
DP8307N	2.72
DP8308N	2.72
DP8310N	5.30
DP8311N	5.30
INS8035LN-6	7.67
INS8035N 11	6.44
INS8039N 6	3.69
INS8039N 11	6.57
INS8060N	18.82
INS8073N	45.06
INS8080AN	4.65
INS8154N	15.81
INS8251N	4.99
INS8259N	9.24
ISP 8F 352	32.75
MM58167AN	9.60
MM58174AN	9.25
MSM5832	9.38
NSC800N	20.81
NSC800N 1	11.58
NSC810N 1	13.11

Interface

Part	Price
DS1488N	1.01
DS1489AN	1.01
DS1489N	1.01
75450N	.83
75451N	.88
75452N	.88
75453N	.88
75454N	.88
75491N	.83
75492N	1.01
75493N	1.01
75494N	1.01

Memory

Part	Price
93410PC	3.13
1702	5.48
MM2102AN-4L	1.82
MM2114N	2.33
MM2114N 3L	2.53
MM2114N L	2.43
MM2147N	14.03
MM2716Q	5.98
MM2716Q 5	4.28
4116N 200	1.95
5290N 200	1.95
MM5257N	5.43
MM5280N-056	2.82
MM5314N	3.89
MM5369N	2.80
MM5837	2.30
74C200N	8.45
74C910N	6.20
74S188N	2.42
74S189N	3.02
74S287N	2.30
74S288N	2.66
74S289N	3.02
74S387N	2.30
74S472AN	5.78
74S473AN	5.78
74S474AN	6.50
74S475AN	6.50
74S570N	4.46
74S571N	4.46
74S572N	5.66
74S573N	5.66

DIGI-KEY Volume Discount Compare the Discount when comparing Prices

INTEGRATED CIRCUITS

4000 CMOS

Part	Price
4000	.46
4001B	.46
4002B	.46
4006A	1.36
4007A	.46
4008B	1.36
4009A	.69
4010A	.69
4011B	.46
4012B	.46
4013B	.69
4014B	1.36
4015B	1.36
4016B	.68
4017B	1.43
4018B	1.25
4019B	.89
4020B	1.66
4021B	1.36
4022B	1.36
4023B	.46
4024B	1.02
4025B	.46
4027B	.89
4028B	1.03
4029B	1.36
4030A	.57
4031B	2.04
4034B	2.72
4035B	1.59
4040B	1.36
4041A	1.24
4042B	1.09
4043B	1.03
4044B	1.03
4046B	1.48
4047B	1.49
4048B	.68
4049A	.73
4050B	.73
4051B	1.25
4052B	1.25
4053B	1.47
4060B	1.70
4066B	.68
4069A	.46
4070B	.67
4071B	.46
4073B	.46
4075B	.46
4076B	1.48
4081B	.46
4082B	.46
4089B	2.26
4093B	.75
4099B	1.59
40106B	.79
40160B	1.25
40161B	1.03
40162B	1.25
40163B	1.25
40174B	1.25
40175B	1.25
40192B	1.48
40193B	1.48
40195B	1.36
4503B	.69
4510B	1.36
4511B	1.36
4512	1.36
4514B	2.27
4515B	2.27
4516B	1.48
4518B	1.36
4519B	.69
4520B	1.36
4522B	1.59
4526B	1.59
4527B	1.48
4528B	1.58
4529B	1.70
4541B	2.03
4543B	2.04
4584B	.79
4723B	1.30
4724B	1.30

Linear

Part	Price
LF347N	1.76
LF351N	.67
LF353N	.99
LF355N	1.22
LF356N	1.29
LF357N	1.42
LF398N	4.52
LF411CN	.98
LF412CN	1.76
LF441CN	.88
LF444CN	2.51
LF13741N	.67
LM10CLN	3.76
LM11CLN	2.13
LM301AN	.54
LM307N	.54
LM308N	.82
LM311N	.64
LM317K	4.17
LM317LZ	.81
LM317MP	1.25
LM317T	1.26
LM318N	1.89
LM319N	2.89
LM320LZ 5.0	4.00
LM320LZ-12	.75
LM320LZ 15	.75
LM320MP-5	1.90
LM320MP-6	1.69
LM320MP 8	1.69
LM320MP-9	1.69
LM320MP-12	2.52
LM320MP-15	2.52
LM320MP 24	1.69
LM322N	2.01
LM323K	6.92
LM324N	.64
LM325N	4.14
LM326N	4.14
LM327N	3.41
LM329D2	.75
LM331N	5.27
LM334Z	1.50
LM335Z	1.75
LM336Z-2.5	1.25
LM336Z-5.0	1.25
LM337K	6.42
LM337MP	1.52
LM337T	2.14
LM338K	6.55
LM339N	.64
LM340KC 5	1.92
LM340KC-12	1.92
LM340KC-15	1.92
LM340T 5	.89
LM340T 12	.89
LM340T-15	.89
LM341P 5	.77
LM341P 6	.77
LM341P-12	.77
LM341P 15	.77
LM346N	2.02
LM348N	.59
LM349N	1.51
LM350K	6.30
LM350T	3.89
LM358N	.59
LM359N	2.01
LM376N	.64
LM377N	3.01
LM378N	3.76
LM379S	5.01
LM380N	1.26
LM380N-8	1.27
LM381N	2.19
LM382N	1.56
LM383AT	3.43
LM384N	2.14
LM386N 1	.72
LM387N	1.39
LM388N 3	1.21
LM389N	1.27
LM390N	1.11
LM391N60	1.15
AN7805	.90
AN7806	.90
AN7807	.90
AN7808	.90

Linear

Part	Price
LM381N80	1.77
LM392N	.64
LM393N	.59
LM395K	8.80
LM395P	2.02
LM395T	3.76
LM396K	20.00
LM555CN	.59
LM556CN	1.01
LM565CN	1.64
LM566CN	1.64
LM567CN	1.39
LM709CN	.89
LM723CN	.64
LM725CN	3.01
LM733CN	.81
LM741CN	.54
LM747CN	.89
LM748CN	.64
LM1310N	1.08
LM1458N	.57
LM1496N	1.26
LM1800N	1.64
LM1801N	1.14
LM1812N	10.29
LM1830N	2.14
LM1848N	6.26
LM1870N	5.03
LM1871N	2.04
LM1872N	3.04
8029B	2.00
LM1889N	2.04
LM2111N	1.54
LM2900N	1.26
LM2901N	.94
LM2902N	.69
LM2903N	.59
LM2904N	.77
LM2905N	3.26
LM2907N	3.14
LM2907N-8	3.01
LM2917N	2.26
LM2917N-8	2.26
LM2924N	2.19
LM3046N	1.14
LM3080N	1.07
LM3086N	.71
LM3089N	2.15
LM3301N	.84
LM3302N	.71
LM3401N	.86
LM3524N	3.15
LM3900N	.66
LM3905N	1.52
LM3909N	1.27
LM3911N	1.89
LM3914N	2.42
LM3915N	2.42
LM3916N	2.42
LM4250CN	1.63
LM7805CK	1.92
LM7812CK	1.92
LM7815CK	1.92
LM7805CT	.89
LM7812CT	.89
LM7815CT	.89
LM78L05ACZ	.45
LM78L12ACZ	.45
LM78L15ACZ	.45
LM78L24ACZ	.45
LM7905CT	.94
LM7912CT	.94
LM7915CT	.94
LM79L05ACZ	.60
LM79L12ACZ	.60
LM79L15ACZ	.60
LM13080N	1.52
LM13600N	1.25
MF10CN	3.50
MF10DS	1.00
AN7809	.90
AN7810	.90
AN7812	.90
AN7815	.90
AN7818	.90
AN7820	.90
AN7824	.90

* * *

4116 200 nsec 16,384x1 D Ram

Prime Parts As Low As $1.365 Each.

Part No.	Price Per Pak Of 8	32	128	512	1024
4116N-ND	15.12	57.12	215.00	806.40	1397.75
5290N-ND	15.12	57.12	215.00	806.40	1397.75
Price Each	1.89	1.785	1.68	1.575	1.365

NSC Data Books

Book Title	Part No	Price
1982 Transistor Databook	9070B	$ 6.00
1981 Logic Databook	9054B	9.00
1982 Linear Databook	9068B	12.00
1980 Interface Databook	9064B	6.00
1980 Memory Book	9059B	6.00
1982 COPS Microcontroller Data Book	9089B	8.50
1979 Special Function Databook	9057B	6.00
NSC 800 Microprocessor Family Handbook-1981	9053B	5.00
Linear Applications Handbook	9062B	16.00
Microprocessor Applications In Business, Science and Industry	9055B	4.00
1980 Audio/Radio Handbook	9065B	5.00
Voltage Regulator Handbook-1982	9063B	7.00

MOLEX I.C. SOCKET PINS

1.25 C 11.25/M 52.50/5M 500.00 /M

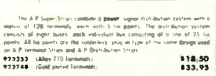
SUPER-STRIPS

UNIVERSAL BREADBOARDING ELEMENTS
WITH SOLDERLESS PLUG-IN TIE POINTS

The A P Super Strips combine a power signal distribution system with a matrix of 128 terminals each with 5 tie points. The distribution system consists of eight buses each individual bus consisting of a line of 25 tie points. All tie points are the solderless plug-in type of the same design used on A P Terminal Strips and A P Distribution Strips.

923252	(Alloy 770 terminals)	$18.50
923748	(Gold plated terminals)	$33.95

POWERACE



For faster and easier prototyping. They have built in power supplies.

Powerace 101
With plus 5 to plus 15 VDC adj power supply No 923101 $ 96.95

Powerace 102
Triple output power supply for digital & linear No 923102 $149.95
Other equipment too numerous to mention, available

Powerace 103
A digital lab including a logic probe & clock No 923107 $149.95

DIGI-KEY Stocks Most A.P. Products

TEXAS INSTRUMENTS I.C. SOCKETS

Body — 94 V-O polyester with Copper Alloy contacts. Accommodates standard IC leads up to .014" thick and .025" wide. Contact is designed and oriented to the insulator to grasp the broad "face" of the IC lead, allowing for low insertion and high retention forces. Socket is designed to achieve maximum density on boards.

SOLDER TAIL DIP SOCKETS

- Single beam
- Low profile
- YOUR CHOICE: TIN OR GOLD* (Minimum 30 microinch gold inlay on gold sockets)

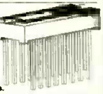
TIN PLATED SOLDER TAIL Min. 200 Microinches Tin -40° to +70°C

Part No.	Description	1	10	100
C8908	8 pin solder tail, tin	.13	1.15	10.50
C8914	14 pin solder tail, tin	.15	1.45	12.00
C8916	16 pin solder tail, tin	.17	1.60	13.00
C8918	18 pin solder tail, tin	.20	1.90	17.00
C8920	20 pin solder tail, tin	.23	2.10	20.00
C8922	22 pin solder tail, tin	.25	2.25	21.00
C8924	24 pin solder tail, tin	.28	2.50	24.00
C8928	28 pin solder tail, tin	.32	2.90	27.00
C8940	40 pin solder tail, tin	.46	4.20	39.00

GOLD INLAY SOLDER TAIL Min. 30 Microinches Gold -40° to +120°C

Part No.	Description	1	10	100
C9808	8 pin solder tail, gold	.34	3.20	30.00
C9814	14 pin solder tail, gold	.44	4.20	40.00
C9816	16 pin solder tail, gold	.50	4.70	46.00
C9818	18 pin solder tail, gold	.57	5.40	52.00
C9820	20 pin solder tail, gold	.63	5.90	57.00
C9822	22 pin solder tail, gold	.70	6.60	64.00
C9824	24 pin solder tail, gold	.76	7.20	70.00
C9828	28 pin solder tail, gold	.79	7.50	73.00
C9840	40 pin solder tail, gold	1.12	9.90	97.00

WIRE WRAP DIP SOCKETS



- Standard profile
- Universal mounting and packaging capabilities
- Contacts accommodate .015" through .021" rec. or round dual-in-line leads.
- Wire wrap posts held to true position of .015" providing a true position of .020" on boards for efficient automatic wire wrapping
- YOUR CHOICE: TIN OR GOLD* (Minimum 30 microinch gold inlay on gold sockets)
- TEXAS INSTRUMENTS QUALITY

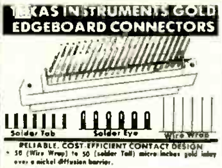
TIN PLATED WIRE WRAP Min. 200 Microinches Tin

Part No.	Description	1	10	100
C8108	8 pin wire wrap, tin	.38	3.60	34.00
C8114	14 pin wire wrap, tin	.50	4.90	48.00
C8116	16 pin wire wrap, tin	.57	5.60	56.00
C8118	18 pin wire wrap, tin	.69	6.70	65.00
C8120	20 pin wire wrap, tin	.76	7.50	74.00
C8122	22 pin wire wrap, tin	.83	8.20	81.00
C8124	24 pin wire wrap, tin	.91	8.90	88.00
C8128	28 pin wire wrap, tin	1.04	10.30	102.00
C8140	40 pin wire wrap, tin	1.42	13.90	138.00

GOLD INLAY WIRE WRAP Min. 30 Microinches Gold

Part No.	Description	1	10	100
C9108	8 pin wire wrap, gold	.59	5.80	57.00
C9114	14 pin wire wrap, gold	.79	7.80	77.0
C9116	16 pin wire wrap, gold	.86	8.40	83.00
C9118	18 pin wire wrap, gold	.99	9.80	97.00
C9120	20 pin wire wrap, gold	1.19	11.80	117.00
C9122	22 pin wire wrap, gold	1.29	12.80	127.00
C9124	24 pin wire wrap, gold	1.39	13.80	137.00
C9128	28 pin wire wrap, gold	1.69	16.80	167.00
C9140	40 pin wire wrap, gold	2.29	22.80	227.00

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS



RELIABLE, COST-EFFICIENT CONTACT DESIGN
- 50 (Wire Wrap) to 50 (solder Tail) micro inches gold inlay over a nickel diffusion barrier.
- Copper nickel tin CA 725 alloy.
- Bifurcated contact points.
- Preloaded, cantilever spring design.
- Contacts are user removable.

NOTE: Dimensions below are the pin center to center measurement followed by the distance separating the two pin rows.

H4 SERIES .100"x.200" EDGEBOARD CONNECTORS

Positions Contacts	Part No Wire Wrap	1	10	Part No. Solder Tail	1	10
10/20	C6-10	3.85	37.60	C5-10	2.95	28.00
15/30	C6-15	4.50	43.40	C5-15	3.40	32.50
17/34	C6-17	4.70	45.80	C5-17	3.60	34.30
18/36	C6-18	4.60	44.40	C5-18	3.55	33.90
20/40	C6-20	5.30	49.30	C5-20	3.90	37.40
22/44	C6-22	5.60	53.50	C5-22	4.20	40.40
25/50	C6-25	5.95	57.90	C5-25	4.50	43.30
28/56	C6-28	6.30	61.40	C5-28	4.80	46.00
30/60	C6-30	6.40	62.60	C5-30	4.95	48.20
31/62	C6-31	6.70	65.70	C5-31	5.20	49.35
35/70	C6-35	7.80	76.30	C5-35	5.80	56.10
36/72	C6-36	7.50	73.80	C5-36	5.70	55.50
40/80	C6-40	8.60	84.10	C5-40	6.30	61.70
43/86	C6-43	9.30	90.20	C5-43	6.80	65.60
49/98	C6-49	10.80	104.60	C5-49	7.80	76.80
50/100	C6-50	9.90	98.30	C5-50	7.40	72.10

For Polarizing Keys Order P/N CR1164-2 1 10/ea., 17.80/100

H4 SERIES .125" x .250" EDGEBOARD CONNECTORS

Positions Contacts	Part No Wire Wrap	1	10	Part No Solder Tail	1	10
10/20	C4-10	4.35	42.20	C3-10	2.95	28.40
15/30	C4-15	5.20	49.50	C3-15	3.40	33.40
18/36	C4-18	5.50	53.30	C3-18	3.70	35.90
20/40	C4-20	5.90	57.10	C3-20	3.95	38.70
22/44	C4-22	6.20	59.10	C3-22	4.20	40.90
25/50	C4-25	6.60	64.30	C3-25	4.70	45.70
28/56	C4-28	6.70	65.70	C3-28	4.85	47.40
30/60	C4-30	6.90	67.70	C3-30	4.95	48.60
31/62	C4-31	7.30	70.60	C3-31	5.25	51.70
35/70	C4-35	8.30	80.60	C3-35	6.10	59.10
36/72	C4-36	8.35	80.70	C3-36	6.10	59.10
40/80	C4-40	8.90	87.10	C3-40	6.55	64.20
44/88	C4-44	9.95	98.90	C3-44	7.40	72.50
50/100	C4-50	10.90	107.50	C3-50	7.90	77.90

For Polarizing Keys Order P/N CR1164-2 1 10/ea., 17.80/100

H4 SERIES .156" x .200" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Solder Tail	1	10	Part No. Solder Eye	1	10
10/20	C1-10	2.56	23.80	C2-10	4.11	38.36
12/24	C1-12	2.90	27.50			
15/30	C1-15	3.03	28.28	C2-15	4.77	44.52
18/36	C1-18	3.27	30.52	C2-18	5.07	47.82
22/44	C1-22	3.69	34.44			
25/50	C1-25	4.25	40.40	C2-25	6.18	57.68
28/56	C1-28	4.47	41.72			

For Polarizing Keys Order P/N CR1164-1 1 10/ea., 17.80/100

ELECTRONIC HARDWARE KIT

CAT. NO. 1600 KIT
$14.95

PANASONIC ELECTROLYTIC KIT

150 CAPACITORS

Price includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 15 POPULAR CAPACITORS

Cat. No. P6200-Kit
ONLY
$35.95

Panasonic LS Series
Miniature Aluminum Electrolytic Capacitors

Value UF	WV D.C.	Axial 1	10	100	Radial 1	10	100
22	/6.3	.18	1.54	12.83	—	—	—
33	/6.3	.20	1.68	14.04	.14	1.12	9.31
47	/6.3	.21	1.74	14.48	.14	1.16	9.59
100	/6.3	.22	1.83	15.22	.16	1.33	11.05
220	/6.3	.28	2.34	19.53	.21	1.78	14.80
330	/6.3	.29	2.46	20.48	.23	1.92	15.95
470	/6.3	.33	2.78	23.15	.23	1.97	16.34
1000	/6.3	.49	4.20	35.00	.36	3.08	25.62
2200	/6.3	.60	5.13	42.75	.54	4.56	37.95
3300	/6.3	.81	6.94	57.83	.75	6.38	53.10
4700	/6.3	1.04	8.89	74.07	.93	7.95	66.20
6800	/6.3	1.27	10.87	90.58	1.13	9.68	80.62
10000	/6.3	1.54	13.17	109.77	1.54	13.13	109.40
22	/10	.18	1.54	12.83	.13	1.08	8.94
33	/10	.21	1.74	14.48	.14	1.16	9.59
47	/10	.21	1.77	14.78	.14	1.19	9.90
100	/10	.24	2.00	16.65	.17	1.39	11.58
220	/10	.29	2.46	20.48	.23	1.92	15.95
330	/10	.33	2.78	23.15	.24	2.06	17.10
470	/10	.44	3.72	30.97	.35	2.97	24.69
1000	/10	.55	4.63	38.62	.41	3.42	28.45
2200	/10	.78	6.63	55.28	.70	5.93	49.42
3300	/10	.99	8.45	70.38	.90	7.71	64.72
4700	/10	1.28	10.94	91.18	1.13	9.68	80.62
6800	/10	1.55	13.26	110.52	1.54	13.20	109.40
10000	/10	1.99	17.00	141.63	—	—	—
10	/16	.18	1.54	12.83	.13	1.08	8.94
22	/16	.21	1.74	14.48	.14	1.15	9.52
33	/16	.21	1.77	14.77	.14	1.19	9.90
47	/16	.24	2.00	16.65	.18	1.36	11.31
100	/16	.28	2.34	19.53	.21	1.78	14.80
220	/16	.33	2.78	23.15	.24	2.06	17.10
330	/16	.44	3.72	30.97	.35	2.97	24.69
470	/16	.50	4.22	35.14	.38	3.19	26.58
1000	/16	.60	5.09	42.45	.50	4.21	35.08
2200	/16	.92	7.85	65.39	.87	7.46	62.10
3300	/16	1.16	9.91	82.62	1.17	10.01	83.48
4700	/16	1.57	13.40	111.68	1.57	13.43	111.87
6800	/16	1.99	17.00	141.63	—	—	—
2.2	/25	.18	1.54	12.83	—	—	—
3.3	/25	.18	1.54	12.83	.13	1.08	8.94
4.7	/25	.18	1.54	12.83	.13	1.08	8.94
10	/25	.18	1.54	12.83	.14	1.15	9.52
22	/25	.22	1.83	15.22	.15	1.22	10.17
33	/25	.24	2.00	16.65	.17	1.38	11.50
47	/25	.28	2.34	19.53	.21	1.73	14.42
100	/25	.33	2.78	22.15	.23	1.90	15.77
220	/25	.44	3.75	31.24	.40	3.42	28.45
330	/25	.50	4.26	35.47	.52	4.45	37.08
470	/25	.58	4.95	41.24	.64	5.42	45.13
1000	/25	.84	7.18	59.84	.83	7.06	58.78
2200	/25	1.16	9.91	82.62	1.17	10.02	83.47
3300	/25	1.61	13.77	114.77	1.66	14.17	118.03
4700	/25	1.99	17.00	141.63	—	—	—
2.2	/35	.18	1.54	12.83	—	—	—
3.3	/35	.18	1.54	12.83	.13	1.11	9.20
4.7	/35	.18	1.54	12.83	.13	1.11	9.20
10	/35	.21	1.77	14.78	.14	1.19	9.90
22	/35	.24	2.00	16.65	.19	1.60	13.30
33	/35	.28	2.34	19.53	.21	1.78	14.80
47	/35	.33	2.78	23.15	.23	1.90	15.77
100	/35	.43	3.65	30.40	.24	2.06	17.10
220	/35	.51	4.34	36.17	.40	3.42	28.45
330	/35	.57	4.85	40.40	.52	4.45	37.08
470	/35	.65	5.51	45.89	.64	5.42	45.13
1000	/35	.98	8.38	69.80	.92	7.84	65.32
2200	/35	1.61	13.77	114.71	1.66	14.17	118.03
3300	/35	1.99	17.00	141.63	—	—	—
4700	/35	2.61	22.31	185.88	—	—	—
0.47	/50	.18	1.54	12.83	.13	1.08	8.94
1	/50	.18	1.54	12.83	.13	1.08	8.94
1	/50	.18	1.54	12.83	.13	1.08	8.94
2.2	/50	.18	1.54	12.83	.13	1.08	8.94
3.3	/50	.18	1.54	12.83	.14	1.15	9.52
4.7	/50	.21	1.77	14.77	.14	1.18	9.78
10	/50	.24	2.00	16.65	.16	1.35	11.20
22	/50	.28	2.34	19.53	.22	1.83	15.19
33	/50	.32	2.69	27.43	.23	1.90	15.77
47	/50	.36	3.04	25.33	.24	2.05	17.03
100	/50	.45	3.78	31.54	.36	3.08	25.62
220	/50	.61	5.18	43.15	.52	4.45	37.08
330	/50	.76	6.50	54.14	.83	7.06	58.78
470	/50	.92	7.87	65.55	.92	7.84	65.32
1000	/50	1.25	10.71	89.27	1.31	11.16	92.93
2200	/50	1.99	17.00	141.63	—	—	—
0.47	/63	.18	1.54	12.83	.13	1.12	9.32
1	/63	.18	1.54	12.83	.13	1.12	9.32
2.2	/63	.18	1.54	12.83	.14	1.15	9.52
3.3	/63	.21	1.77	14.77	.15	1.25	10.35
4.7	/63	.24	2.00	16.65	.16	1.34	11.13
10	/63	.28	2.34	19.53	.18	1.50	12.43
22	/63	.33	2.78	23.15	.24	2.02	16.79
33	/63	.37	3.12	26.04	.27	2.24	18.60
47	/63	.53	4.51	37.62	.38	3.18	26.45
100	/63	.56	4.76	39.64	.50	4.24	35.27
220	/63	.76	6.50	54.14	.78	6.61	55.02
330	/63	.92	7.87	65.55	.92	7.84	65.32
470	/63	1.05	8.94	74.52	.99	8.43	70.19
1000	/63	1.64	13.99	116.55	1.66	14.17	118.03
2200	/63	2.61	22.31	185.89	—	—	—
0.47	/100	.18	1.54	12.83	.14	1.19	9.90
1	/100	.18	1.54	12.83	.14	1.19	9.90
2.2	/100	.22	1.83	15.22	.15	1.25	10.35
3.3	/100	.24	2.00	16.65	.17	1.38	11.50
4.7	/100	.28	2.34	19.53	.17	1.41	11.70
10	/100	.33	2.78	23.15	.22	1.83	15.19
22	/100	.43	3.65	30.40	.27	2.27	18.90
33	/100	.45	3.85	32.12	.34	2.88	24.00
47	/100	.54	4.62	38.49	.41	3.50	29.14
100	/100	.74	6.29	52.43	.57	4.83	40.27
220	/100	1.09	9.26	77.18	.96	8.22	68.47
330	/100	1.30	11.10	92.53	1.25	10.70	89.13
470	/100	1.81	15.46	128.80	1.78	15.25	127.04
1000	/100	3.16	27.09	225.72	—	—	—

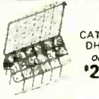
PANASONIC V-SERIES
Stacked Metallized Film Capacitors

Parameter	V-SERIES
Operating Temperature Range	-40°C to +85°C
Capacity Range	0.01µF to 1.0µF
Temperature Coefficient Δc/c	±2.5%
Standard Capacity Tolerance	±5%
Dissipation Factor (Max.)	1.0%
Insulation Resistance (25°C)	1000MΩ µF
Voltage Coefficient (DC)	Negligible
Aging Rate	Negligible
Electrodes	Met. film
Lead Spacing	200, 300
Self Healing	Yes
WVdc	50V

DIGI-KEY Part No.	Cap. µF	1	10	Price 100	1,000
P4501	0.001	.11	.91	7.89	57.40
P4502	0.0012	.11	.91	7.89	57.40
P4503	0.0015	.11	.91	7.89	57.40
P4504	0.0018	.11	.91	7.89	57.40
P4505	0.0022	.11	.91	7.89	57.40
P4506	0.0027	.11	.91	7.89	57.40
P4507	0.0033	.11	.91	7.89	57.40
P4508	0.0039	.11	.91	7.89	57.40
P4509	0.0047	.11	.91	7.89	57.40
P4510	0.0056	.11	.91	7.89	57.40
P4511	0.0068	.11	.91	7.89	57.40
P4512	0.0082	.11	.91	7.89	57.40
P4513	0.01	.11	.91	7.89	57.40
P4514	0.012	.11	.94	8.09	58.90
P4515	0.015	.11	.98	8.47	61.80
P4516	0.018	.11	1.01	8.75	63.70
P4517	0.022	.12	1.06	9.15	66.60
P4518	0.027	.12	1.12	9.66	70.20
P4519	0.033	.13	1.19	10.23	74.40
P4520	0.039	.14	1.24	10.71	77.90
P4521	0.047	.15	1.32	11.39	82.90
P4522	0.056	.16	1.42	12.28	89.20
P4523	0.068	.17	1.53	13.19	95.90
P4524	0.082	.18	1.63	14.03	102.10
P4525	0.1	.18	1.68	14.49	105.40
P4526	0.12	.20	1.81	15.62	113.80
P4527	0.15	.24	2.21	19.00	138.20
P4528	0.18	.24	2.21	19.00	138.20
P4529	0.22	.27	2.42	20.83	151.50
P4530	0.27	.30	2.70	23.23	169.00
P4531	0.33	.33	3.00	25.79	187.60
P4532	0.39	.36	3.33	28.82	208.20
P4533	0.47	.41	3.75	32.29	234.90
P4534	0.56	.46	4.21	36.24	263.60
P4535	0.68	.52	4.72	40.56	295.00
P4536	0.82	.58	5.32	45.78	333.00
P4537	1.0	.68	6.02	51.75	376.00

DISC CAPACITORS
Panasonic Ceramic Disc Capacitors

***NEW!* KIT**
310 DISC CAPACITORS
Prices include convenient divided plastic box with bin guide for easy storage and quick access.
ASSORTMENT OF 18 POPULAR VALUES PANASONIC QUALITY



CAT. NO. DH-KIT
ONLY
$24.95

DIGI-KEY now has an expanded line of Panasonic Ceramic Disc Capacitors, including (listed after NPO banner)

NPO TYPE

For Complete Specs on Physical Size and Electrical Characteristics, consult your *FREE* DIGI-KEY Catalog.

Part No.	Cap.	Volt.	Price 10	100	1,000
P4000	10 pf	500	.75	6.49	48.71
P4002	15 pf	500	.75	6.49	48.71
P4003	18 pf	500	.75	6.49	48.71
P4004	22 pf	500	.75	6.49	48.71
P4005	27 pf	500	.75	6.49	48.71
P4006	33 pf	500	.75	6.49	48.71
P4007	39 pf	500	.75	6.49	48.71
P4008	47 pf	500	.75	6.49	48.71
P4009	56 pf	500	.75	6.49	48.71
P4010	68 pf	500	.84	7.23	54.22
P4011	82 pf	500	.84	7.23	54.22
P4100	100 pf	500	.63	5.43	40.72
P4102	150 pf	500	.63	5.43	40.72
P4103	180 pf	500	.63	5.43	40.72
P4104	220 pf	500	.63	5.43	40.72
P4105	270 pf	500	.63	5.43	40.72
P4106	330 pf	500	.63	5.43	40.72
P4107	390 pf	500	.63	5.43	40.72
P4108	470 pf	500	.80	6.91	51.86
P4109	560 pf	500	.80	6.91	51.86
P4110	680 pf	500	.80	6.91	51.86
P4111	820 pf	500	.80	6.91	51.86
P4112	1000 pf	500	1.00	8.58	64.36
P4114	1500 pf	500	1.00	8.58	64.36
P4115	1800 pf	500	1.31	11.26	84.37
P4200	1000 pf	100	.58	5.01	37.57
P4202	1500 pf	100	.58	5.01	37.57
P4203	2200 pf	100	.58	5.01	37.57
P4206	3300 pf	100	.58	5.01	37.57
P4208	4700 pf	100	.58	5.01	37.57
P4209	6800 pf	100	.70	6.00	45.00
P4300	.01 uf	25	.56	4.83	36.23
P4303	.022 uf	25	.68	5.91	44.32
P4305	.033 uf	25	.82	7.08	53.10
P4307	.047 uf	25	.89	7.68	57.60
P4311	.1 uf	25	1.79	15.37	115.31

NPO NPO NPO NPO NPO NPO NPD NPD

Part No.	Cap.	Volt.	10	100	1,000
P4400	10 pf	500	.73	6.28	47.13
P4402	15 pf	500	.81	6.97	52.31
P4403	18 pf	500	.81	6.97	52.31
P4404	22 pf	500	.81	6.97	52.31
P4405	27 pf	500	.81	6.97	52.31
P4406	33 pf	500	1.03	8.89	66.71
P4407	39 pf	500	1.03	8.89	66.71
P4408	47 pf	500	1.37	11.80	88.53
P4409	56 pf	500	1.37	11.80	88.53
P4410	68 pf	500	1.56	13.38	100.35
P4411	82 pf	500	2.05	17.68	131.96

See The DIGI-KEY Catalog For Low OEM Prices On Disc Capacitors

PANASONIC METALLIZED POLYESTER CAPACITORS

***NEW!* KIT**
170 METALLIZED POLYESTER CAPACITORS
Price includes convenient divided plastic box with bin guide for easy storage and quick access.
ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY

CAT. NO. E KIT
ONLY
$54.95

DIGI KEY Part No.	Working Voltage	µF	Pak Of 1	Pak Of 10	Pak Of 100	Pak Of 1,000
E1104	100	1	.23	1.99	18.53	148.73
E1124	100	12	.25	2.12	17.83	158.73
E1154	100	.15	.27	2.28	18.95	170.55
E1184	100	.18	.29	2.49	20.73	186.53
E1224	100	.22	.32	2.68	22.27	200.37
E1274	100	27	.34	2.91	24.25	218.25
E1334	100	33	.37	3.18	28.45	236.05
E1394	100	.39	.41	3.44	28.65	257.85
E1474	100	47	.43	3.68	30.65	275.85
E1564	100	56	.47	4.02	33.45	301.05
E1684	100	68	.52	4.44	36.93	332.35
E1824	100	.82	.58	4.94	41.13	370.13
E1105	100	1.0	.63	5.35	44.52	400.82
E1125	100	1.2	.68	5.82	48.50	436.50
E1155	100	1.5	.86	7.32	60.97	548.67
E1185	100	1.8	1.01	8.64	71.99	647.89
E1225	100	2.2	1.04	8.85	73.70	663.08
E1275	100	2.7	1.04	8.85	73.70	663.08
E1335	100	3.3	1.35	11.50	95.85	862.54
E1395	100	3.9	1.35	11.50	95.85	862.54
E1475	100	4.7	1.75	14.96	124.55	1120.73
E1565	100	5.6	1.95	16.65	138.70	1248.06
E1685	100	6.8	2.35	20.14	167.85	1510.43
E1825	100	8.2	2.86	24.45	203.70	1833.30
E1106	100	10.0	3.23	27.69	230.75	2076.41
E2103	250	.01	.19	1.64	13.88	123.08
E2123	250	.012	.19	1.64	13.88	123.08
E2153	250	.015	.19	1.64	13.88	123.08
E2183	250	.018	.19	1.64	13.68	123.08
E2223	250	.022	.18	1.84	13.68	123.08
E2273	250	.027	.19	1.84	13.68	123.08
E2333	250	.033	.19	1.64	13.68	123.08
E2393	250	.039	.19	1.64	13.88	123.08
E2473	250	.047	.19	1.84	13.68	123.08
E2563	250	.056	.22	1.85	15.43	138.83
E2683	250	.068	.22	1.85	15.43	138.83
E2823	250	.082	.22	1.85	15.43	138.83
E2104	250	.10	.23	1.94	16.13	145.13
E2124	250	.12	.25	2.12	17.63	158.63
E2154	250	.15	.27	2.28	18.95	170.55
E2184	250	.18	.29	2.49	20.73	186.53
E2224	250	.22	.32	2.68	22.28	200.48
E2274	250	.27	.34	2.91	24.25	218.25
E2334	250	.33	.37	3.18	28.47	238.17
E2394	250	.39	.41	3.44	28.65	257.85
E2474	250	.47	.43	3.68	30.65	275.85
E2564	250	.56	.47	4.02	33.45	301.05
E2684	250	.68	.52	4.43	36.93	332.33
E2824	250	.82	.58	4.94	41.13	370.13
E2105	250	1.0	.63	5.35	44.52	400.82
E2125	250	1.2	.68	5.82	48.50	436.50
E2155	250	1.5	.86	7.32	60.97	548.67
E2185	250	1.8	1.01	8.64	72.00	648.00
E2225	250	2.2	1.03	8.85	73.88	663.08
E4103	400	.01	.34	2.93	24.40	219.15
E4123	400	.012	.34	2.93	24.40	219.15
E4153	400	.015	.34	2.93	24.40	219.15
E4183	400	.018	.34	2.93	24.40	219.15
E4223	400	.022	.34	2.93	24.40	219.15
E4273	400	.027	.34	2.93	24.40	219.15
E4333	400	.033	.34	2.93	24.40	219.15
E4393	400	.039	.14	2.93	24.40	219.15
E4473	400	.047	.34	2.93	24.40	219.15
E4563	400	.056	.34	2.93	24.40	219.15
E4683	400	.068	.34	2.93	24.40	219.15
E4823	400	.082	.44	3.78	31.28	281.48
E4104	400	.10	.45	3.83	31.92	287.21
E4124	400	.12	.47	4.04	33.60	302.40
E4154	400	.15	.49	4.18	34.80	313.20
E4184	400	.18	.55	4.68	38.98	350.78
E4224	400	.22	.57	4.88	40.73	366.53
E4274	400	.27	.69	5.85	48.73	438.53
E4334	400	.33	.75	6.38	53.15	478.35
E4394	400	.39	.82	7.02	58.48	526.28
E4474	400	.47	.91	7.78	64.80	583.20
E4564	400	.56	1.07	9.14	76.12	685.00
E4684	400	.68	1.21	10.37	86.42	777.75
E4824	400	.82	1.29	11.03	91.90	828.98
E4105	400	1.0	1.35	11.50	95.83	862.43
E4125	400	1.2	1.47	12.60	105.00	945.00
E4155	400	1.5	1.59	13.58	112.98	1016.80
E4185	400	1.8	1.88	16.10	134.13	1207.15
E4225	400	2.2	2.15	18.34	152.85	1375.55

PLESSEY "MINI BOX"
Metallized Poly Cap Kit

140 CAPACITORS

Price includes convenient divided plastic box with bin guide for easy storage and quick access

ASSORTMENT OF 10 POPULAR "MINI BOX" CAPACITORS

CAT. NO. 3050P-Kit
ONLY
$35.95

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

***NEW!* KIT**
180 TANTALUM CAPACITORS
Prices includes convenient divided plastic box with bin guide for easy storage and quick access
ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY

CAT. NO. F-KIT
ONLY
$54.95

DIGI KEY Part No.	Cap. (µF)	Volt. DC	Price 1	10	100	1000
P2000	3.3	3.15	.31	2.70	22.50	202.50
P2001	6.8	3.15	.31	2.70	22.50	202.50
P2002	10	3.15	.31	2.70	22.50	202.50
P2003	15	3.15	.42	3.66	30.58	275.08
P2004	22	3.15	.52	4.46	37.22	335.02
P2005	33	3.15	.63	5.40	45.00	405.00
P2006	47	3.15	.66	5.67	47.25	425.25
P2007	68	3.15	.78	6.75	56.25	506.25
P2008	100	3.15	.97	8.37	69.75	627.75
P2009	150	3.15	2.27	19.50	162.50	1462.50
P2010	220	3.15	2.74	23.56	196.25	1766.25
P2011	4.7	6	.31	2.70	22.50	202.50
P2012	6.8	6	.37	3.21	26.81	241.31
P2013	10	6	.50	4.29	35.81	322.31
P2014	15	6	.52	4.53	37.75	339.75
P2015	22	6	.66	5.67	47.28	425.25
P2016	33	6	.68	5.85	48.75	438.75
P2017	47	6	.72	6.21	51.75	465.75
P2018	68	6	1.14	9.80	81.72	736.62
P2019	100	6	2.56	21.88	182.36	1641.26
P2020	150	6	2.74	23.49	195.81	1762.31
P2021	1.0	10	.31	2.70	22.50	202.50
P2022	2.2	10	.31	2.70	22.50	202.50
P2023	3.3	10	.31	2.70	22.50	202.50
P2024	4.7	10	.34	2.94	24.50	220.50
P2025	6.8	10	.39	3.36	28.00	252.00
P2026	10	10	.47	4.05	33.75	303.75
P2027	15	10	.59	5.10	42.50	382.50
P2028	22	10	.66	5.70	47.50	427.50
P2029	33	10	.83	7.14	59.50	535.50
P2030	47	10	1.29	11.08	92.17	829.57
P2031	68	10	2.27	19.50	162.50	1462.50
P2032	100	10	2.76	23.70	197.50	1777.50
P2033	1.5	16	.31	2.70	22.50	202.50
P2034	2.2	16	.31	2.70	22.50	202.50
P2035	3.3	16	.34	2.94	24.50	220.50
P2036	4.7	16	.39	3.36	28.00	252.00
P2037	6.8	16	.45	3.90	32.50	292.50
P2038	10	16	.61	5.31	44.25	398.25
P2039	15	16	.68	5.85	48.75	438.75
P2040	22	16	.82	7.05	58.75	528.75
P2041	33	16	1.54	13.20	110.00	990.00
P2042	47	16	2.27	19.50	162.50	1462.50
P2043	68	16	2.76	23.70	197.50	1777.50
P2044	1.5	25	.31	2.70	22.50	202.50
P2045	2.2	25	.34	2.94	24.50	220.50
P2046	3.3	25	.39	3.36	28.00	252.00
P2047	4.7	25	.47	4.05	33.75	303.75
P2048	6.8	25	.59	5.10	42.50	382.50
P2049	10	25	.82	7.05	58.75	528.75
P2050	15	25	1.29	11.10	92.50	832.50
P2051	22	25	1.80	15.45	128.75	1158.75
P2052	33	25	2.56	21.90	182.50	1642.50
P2053	0.1	35	.29	2.55	21.25	191.25
P2054	0.15	35	.31	2.70	22.50	202.50
P2055	0.22	35	.31	2.70	22.50	202.50
P2056	0.33	35	.31	2.70	22.50	202.50
P2057	0.47	35	.31	2.70	22.50	202.50
P2058	0.68	35	.31	2.70	22.50	202.50
P2059	1.0	35	.31	2.70	22.50	202.50
P2060	1.5	35	.44	3.82	31.87	286.87
P2061	2.2	35	.47	4.05	33.75	303.75
P2062	3.3	35	.52	4.50	37.50	337.50
P2063	4.7	35	.56	4.80	40.00	360.00
P2064	6.8	35	.79	6.78	56.50	508.50
P2065	10	35	1.05	9.00	75.00	675.00
P2066	15	35	2.38	20.40	170.00	1530.00
P2067	0.1	50	.31	2.70	22.50	202.50
P2068	0.15	50	.31	2.70	22.50	202.50
P2069	0.22	50	.31	2.70	22.50	202.50
P2070	0.33	50	.31	2.70	22.50	202.50
P2071	0.47	50	.39	3.39	28.32	254.92
P2072	0.68	50	.44	3.78	31.50	283.50
P2073	1.0	50	.54	4.65	38.75	348.75
P2074	1.5	50	.63	5.40	45.00	405.00
P2075	2.2	50	.74	6.36	53.00	477.00
P2076	3.3	50	.81	7.02	58.50	528.50
P2077	4.7	50	1.01	8.73	72.75	654.75
P2078	6.8	50	2.06	17.70	147.50	1327.50

TANTALUM SUBSTITUTES PANASONIC K-SERIES CAPACITORS

New Panasonic K-Series are miniature, low cost aluminum electrolytic capacitors. Their size and performance characteristics make them viable alternatives to tantalums in many applications.

CAPACITANCE TOLERANCE 20%
D.C. LEAKAGE CURRENT, MAX. 0.01 C V or 3uA
All K SERIES CAPACITORS We Carry Are Radial

DIGI KEY Part No.	Cap. UF	Working Voltage DC	1	10 Pak	100 Pak	1000 Pak
P800	22	6.3	.16	1.42	11.85	106.65
P801	33		.17	1.49	12.42	111.82
P802	47		.17	1.52	12.72	114.62
P803	100		.20	1.79	14.95	134.55
P804	22	10	.17	1.49	12.42	111.82
P805	33		.18	1.56	13.00	117.00
P806	47		.19	1.66	13.90	125.10
P807	10	16	.16	1.45	12.11	109.01
P808	22		.18	1.59	13.32	119.92
P809	33		.20	1.71	14.28	128.58
P810	47		.22	1.90	15.87	142.87
P811	3.3	17	.16	1.42	11.85	106.65
P812	4.7		.16	1.42	11.85	106.65
P813	10		.17	1.49	12.42	111.82
P814	22		.20	1.71	14.28	128.58
P815	33		.22	1.93	16.16	145.46
P816	3.3	35	.16	1.43	11.97	107.77
P817	4.7		.16	1.45	12.11	109.01
P818	10		.18	1.56	13.00	117.00
P819	22		.22	1.90	15.87	142.87
P820	.1	50	.16	1.42	11.85	106.65
P821	.22		.16	1.42	11.85	106.65
P822	.33		.16	1.42	11.85	106.65
P823	.47		.16	1.42	11.85	106.65
P824	1.0		.16	1.42	11.85	106.65
P825	2.2		.16	1.42	11.85	106.65
P826	3.3		.16	1.42	12.11	109.01
P827	4.7		.17	1.49	12.42	111.82
P828	10		.19	1.66	13.90	125.10

Panasonic TSW Series
Large Aluminum Electrolytic Capacitors

DIGI-KEY Part No.	Working Voltage (W.V.)	Cap. (µF)	Prices 1	10	100
P6500	16	3300	$1.20	$ 9.29	$ 84.00
P6501		4700	1.46	11.17	101.00
P6502		6800	1.91	14.73	133.00
P6503		10000	2.40	18.50	167.00
P6504		15000	3.41	26.29	237.00
P6505	25	2200	1.23	9.63	86.00
P6506		3300	1.51	11.64	105.00
P6507		4700	1.89	14.58	131.00
P6508		6800	2.50	19.23	173.00
P6509		10000	3.22	24.79	223.00
P6510		15000	4.14	31.91	287.00
P6511	35	1000	1.03	7.94	71.00
P6512		2200	1.38	10.67	96.00
P6513		3300	1.86	14.36	129.00
P6514		4700	2.38	18.41	166.00
P6515		6800	3.07	23.61	213.00
P6516		10000	4.62	35.56	320.00
P6517	50	1000	1.25	9.64	87.00
P6518		2200	1.92	14.82	133.00
P6519		3300	2.66	20.44	184.00
P6520		4700	3.46	26.81	240.00
P6521		6800	4.20	32.38	291.00
P6522	100	470	1.44	11.14	100.00
P6523		1000	2.43	18.76	169.00
P6524		2200	3.91	30.11	271.00
P6525	200	220	1.91	14.70	132.34
P6526		330	2.88	22.20	200.00
P6527		470	3.36	25.91	233.00
P6528	250	150	2.58	19.86	179.00
P6529		220	2.60	20.00	180.00
P6530		330	3.02	23.28	209.00
P6531		470	3.90	30.00	270.00

The Digi-Key volume discount and Service charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the handling charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when payment accompanies order.

WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701

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$ 25.00-$49.99	Add $0.50
$ 50.00-$99.99	Add $0.25
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VOLUME DISCOUNT	
$ 0.00-$ 99.99	NET
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DIGI-KEY CORPORATION

800-346-5144

In Mn., Ak., Hi. Call 218-681-6674

VISA

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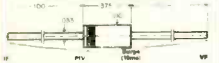
The Big DIGI-KEY Discount makes a Big Price Difference (SEE BELOW)

SILICON RECTIFIERS ZENER DIODES

3 AMP SILICON RECTIFIER



IF	PIV	Surge (10ms)	VF
3A	60V	100A	1.1V

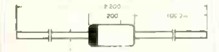
Part No	1	10	100	1000
PR5400	.35	3.00	27.50	250.00

RECTIFIERS

2.405
.205
.100

Cat. No.	Description	Pkg.	10	100	1000	10,000
1N4001	1 Amp 50 PIV	DO 41	.80	7.00	60.00	515.00
1N4002	1 Amp 100 PIV	DO 41	.80	7.00	60.00	540.00
1N4003	1 Amp 200 PIV	DO-41	.80	7.50	64.00	563.00
1N4004	1 Amp 400 PIV	DO-41	.80	7.90	68.00	588.00
1N4005	1 Amp 600 PIV	DO 41	1.00	8.00	74.00	625.00
1N4006	1 Amp 800 PIV	DO 41	1.00	9.00	80.00	661.00
1N4007	1 Amp 1000 PIV	DO 41	1.50	12.00	100.00	710.00
1N4148	Ultra Fast Switching Diode (1N914 equiv.)	DO-41	.60	5.00	32.00	276.80

SILICON ZENER DIODES



Catalog Number	Description	Unit Price	10
1N5226B	3.3 V 5% 500mW Zener (1N746A equiv.)	.24	1.80
1N5227B	3.6 V 5% 500mW Zener (1N747A equiv.)	.24	1.80
1N5228B	3.9 V 5% 500mW Zener (1N748A equiv.)	.24	1.80
1N5229B	4.3 V 5% 500mW Zener (1N749A equiv.)	.24	1.80
1N5230B	4.7 V 5% 500mW Zener (1N750A equiv.)	.24	1.80
1N5231B	5.1 V 5% 500mW Zener (1N751A equiv.)	.24	1.80
1N5232B	5.6 V 5% 500mW Zener (1N752A equiv.)	.24	1.80
1N5233B	6.0 V 5% 500mW Zener	.24	1.80
1N5234B	6.2 V 5% 500mW Zener (1N753A equiv.)	.24	1.80
1N5235B	6.8 V 5% 500mW Zener (1N957B equiv.)	.24	1.80
1N5236B	7.5 V 5% 500mW Zener (1N958B equiv.)	.24	1.80
1N5237B	8.2 V 5% 500mW Zener (1N959B equiv.)	.24	1.80
1N5238B	8.7 V 5% 500mW Zener	.24	1.80
1N5239B	9.1 V 5% 500mW Zener (1N960B equiv.)	.24	1.80
1N5240B	10 V 5% 500mW Zener (1N961B equiv.)	.24	1.80
1N5241B	11 V 5% 500mW Zener (1N962B equiv.)	.24	1.80
1N5242B	12 V 5% 500mW Zener (1N963B equiv.)	.24	1.80
1N5243B	13 V 5% 500mW Zener (1N964B equiv.)	.24	1.80
1N5244B	14 V 5% 500mW Zener	.24	1.80
1N5245B	15 V 5% 500mW Zener (1N965B equiv.)	.24	1.80
1N5246B	16 V 5% 500mW Zener (1N966B equiv.)	.24	1.80
1N5247B	17 V 5% 500mW Zener	.24	1.80
1N5248B	18 V 5% 500mW Zener (1N967B equiv.)	.24	1.80
1N5249B	19 V 5% 500mW Zener	.24	1.80
1N5250B	20 V 5% 500mW Zener (1N968B equiv.)	.24	1.80
1N5251B	22 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5252B	24 V 5% 500mW Zener (1N970B equiv.)	.24	1.80
1N5253B	25 V 5% 500mW Zener	.24	1.80
1N5254B	27 V 5% 500mW Zener (1N971B equiv.)	.24	1.80
1N5255B	28 V 5% 500mW Zener	.24	1.80
1N5256B	30 V 5% 500mW Zener (1N972B equiv.)	.24	1.80
1N5257B	33 V 5% 500mW Zener (1N973B equiv.)	.24	1.80

Littlefuse Fuses

3AG "NORMAL-BLO" FUSES

DIGI-KEY Part No.	Amp Rtg.	5	100	1,000
F100 ND	.010	13.70	208.00	926.00/M
F101 ND	.031	11.00	165.00	741.00/M
F102 ND	.062	4.00	60.00	270.00/M
F103 ND	.100	4.00	60.00	270.00/M
F104 ND	.125	4.00	60.00	270.00/M
F105 ND	.150	4.00	60.00	270.00/M
F106 ND	.175	4.00	60.00	270.00/M
F107 ND	.187	4.00	60.00	270.00/M
F108 ND	.200	4.00	60.00	270.00/M
F109 ND	.250	2.42	36.30	163.00/M
F110 ND	.300	2.42	36.30	163.00/M
F111 ND	.375	2.42	36.30	163.00/M
F112 ND	.500	2.42	36.30	163.00/M
F113 ND	.600	2.42	36.30	163.00/M
F114 ND	.750	2.42	36.30	163.00/M
F115 ND	1	1.24	18.60	84.00/M
F116 ND	1.250	1.24	18.60	84.00/M
F117 ND	1.500	1.24	18.60	84.00/M
F118 ND	1.600	1.24	18.60	84.00/M
F119 ND	2	1.24	18.60	84.00/M
F120 ND	2.500	1.24	18.60	84.00/M
F121 ND	3	1.24	18.60	84.00/M
F122 ND	4	1.98	29.70	134.00/M
F123 ND	5	1.98	29.70	134.00/M
F124 ND	6	1.98	29.70	134.00/M
F125 ND	7	2.14	42.80	321.00/M
F126 ND	8	2.74	41.10	185.00/M
F127 ND	10	2.74	41.10	185.00/M

3AG SLO-BLO" FUSES

DIGI-KEY Part No.	Amp Rtg.	5	100	1,000
F300 ND	.010	6.90	104.00	467.00/M
F301 ND	.031	6.90	104.00	467.00/M
F302 ND	.040	6.90	104.00	467.00/M
F303 ND	.062	4.86	72.90	328.00/M
F304 ND	.100	4.86	72.90	328.00/M
F305 ND	.125	4.86	72.90	328.00/M
F306 ND	.150	4.86	72.90	328.00/M
F307 ND	.175	4.86	72.90	328.00/M
F308 ND	.187	4.86	72.90	328.00/M
F309 ND	.200	4.86	72.90	328.00/M
F310 ND	.250	4.86	72.90	328.00/M
F311 ND	.300	4.86	72.90	328.00/M
F312 ND	.375	4.86	72.90	328.00/M
F313 ND	.400	4.86	72.90	328.00/M
F314 ND	.500	4.86	72.90	328.00/M
F315 ND	.600	4.86	72.90	328.00/M
F316 ND	.700	4.86	72.90	328.00/M
F317 ND	.750	4.86	72.90	328.00/M
F318 ND	.800	4.86	72.90	328.00/M
F319 ND	1	4.86	72.90	328.00/M
F320 ND	1.200	4.42	66.30	298.00/M
F321 ND	1.250	4.42	66.30	298.00/M
F322 ND	1.500	4.42	66.30	298.00/M
F323 ND	1.600	4.42	66.30	298.00/M
F324 ND	1.800	4.42	66.30	298.00/M
F325 ND	2	4.42	66.30	298.00/M
F326 ND	2.250	4.42	66.30	298.00/M
F327 ND	2.500	4.42	66.30	298.00/M
F328 ND	2.800	4.42	66.30	298.00/M
F329 ND	3	4.42	66.30	298.00/M
F330 ND	3.200	4.42	66.30	298.00/M
F331 ND	4	4.42	66.30	298.00/M
F332 ND	5	4.42	66.30	298.00/M
F333 ND	6.250	3.54	7.08	53.10/M
F334 ND	7	3.54	53.10	239.00/M
F335 ND	8	3.54	53.10	239.00/M
F336 ND	10	3.54	53.10	239.00/M
F337 ND	12	3.54	53.10	239.00/M
F338 ND	15	3.54	53.10	239.00/M
F339 ND	20	3.54	53.10	239.00/M
F340 ND	25	3.54	53.10	239.00/M
F341 ND	30	3.54	53.10	239.00/M

3AG Panel Fuseholder

Black phenolic conforming to MIL M-14, type CFG. Rated at 20 amps for any voltage to 250. Includes neoprene washer, hex nut, and lock washer.

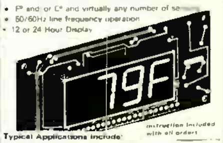
Part No	1	10	100
F004-ND	1.89	15.00	94.50

National Semiconductor

MA1026 Time-Temp. Clock Module

Giant .7 Inch 4-Digit LED Display

- F° and/or C° and virtually any number of sensors
- 50/60Hz line frequency operation
- 12 or 24 Hour Display



Typical Applications include: Clock Radio Timers, Alarm Clock, Desk Clock, TV and Stereo Timer, Instrument Panel Clock, Digital Thermometer and much more.

Part No.	Description	Price
MA1026M	MA1026 clock module only	$30.60
MA1026P	Digi-Key switch panel kit (P.C. Board, 12 switches, two LM334Z temp. sensors, two KOA32 potentiometers, instructions).	11.95
MA1026T	110 VAC transformer for MA1026M	3.10
MA1026B	Alarm buzzer for MA1026M	3.36
MA1026K	MA1026M, P, T, B	45.95

For additional sensor units, you will need:

LM334Z	Temperature Sensor	1.51
K4A32	300 ohm Potentiometer	.32
502PB	Normally open SPST Switch	.56

Programmable Clock Modules

0.7" or 0.84" Red 4-Digit LED Display

User Programmable For:

- 12 or 24 hour display
- 50/60 Hz line frequency
- Fixed or flashing dot (colon indicator)
- Display, hours and minutes, minute and seconds, alarm time, and sleep time
- Battery back up in case of power failure
- Typical applications include: clock radio timer, alarm clock, desk clock, instrument panel clock, and many more

MA1020 — 0.84 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1020M	MA1020 Clock Module only	$18.55
MA1020P	Digi-Key switching panel (includes P.C. board, switches, hardware and instructions.)	7.95
MA1020T	110 VAC Transformer for MA1020M	3.10
MA1020B	Buzzer for MA1020M alarm output	3.36
MA1020K	MA1020M, P, B and T	31.95

MA1023 — 0.7 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1023M	MA1023 Clock Module only	$12.95
MA1023P	Digi-Key switching panel (includes P.C. board, switches, hardware and instructions.)	6.95
MA1023T	110 VAC Transformer for MA1023M	3.10
MA1023B	Buzzer for MA1023 alarm output	3.36
MA1023K	MA1023M, P, B and T	25.10

.5" 4-Digit LCD Clock

National Semiconductor MA1032 Clock Module

- One year use on a 90mA hour battery (typ.)
- Buffered alarm and sleep outputs
- AC or DC alarm output
- Hold function

- Seconds display
- Backlighted display
- 12 or 24 hour time display

Cat. No.	Description	Price
MA1032M	MA1032 Clock Module only	$17.95
MA1032C	Switches for MA1032	2.85
MA1032R	MA1032M, C, and AA battery holder	21.20

DIGI-CLOCK KIT

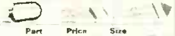
- 12 VDC — Ideal for Car, Van or Boat!

- Trouble free Module!
- 270° Swivel Mount
- Inlaid Walnut Chrome Trim Bezel
- Ideal for Car, Van or Boat!
- 3 3/4" x 2 3/16" Tall x 2 1/8" Deep
- Quick and Easy to Install

Part No. 5001K
ONLY $17.95

LED's — Red, Green, Amber, Orange

3 mm, 4 mm, 5 mm, Round, Rectangular Arrow



Color	Part No.	Price 10	100	Size MM	Shape
Red Diffused	P300	2.20	19.50	5	Round
Red Clear	P301	2.20	19.50	5	Round
Green Clear	P302	2.20	19.50	5	Round
Green Diffused	P303	2.20	19.50	5	Round
Amber Clear	P304	2.20	19.50	5	Round
Orange Clear	P305	2.20	19.50	5	Round
Amber Diffused	P306	2.20	19.50	5	Round
Orange Diffused	P307	2.20	19.50	5	Round
Red Clear	P308	2.20	19.50	3	Round
Green Clear	P309	2.20	19.50	3	Round
Amber Clear	P310	2.20	19.50	3	Round
Red Clear	P311	2.20	19.50	4	Round
Green Clear	P312	2.20	19.50	4	Round
Amber Diffused	P314	2.20	19.50	4	Round
Red Diffused	P315	2.20	19.50	3x5	Rectangle
Green Diffused	P316	3.12	26.00	3x5	Rectangle
Amber Diffused	P317	3.12	26.00	3x5	Rectangle
Red Diffused	P318	2.20	19.50	4x4.5	Arrow
Green Diffused	P319	3.12	26.00	4x4.5	Arrow
Amber Diffused	P320	3.12	26.00	4x4.5	Arrow

Panasonic LED Numeric Displays

Red, Green, Amber and Orange Colors — Direct Drive

Part No. Comm Anode	Comm Cath.	Digits	Color	In.	1	10	100
P322	P343	8	Red	.3	1.25	11.50	105.00
P323	P344		Green	.3	1.58	14.50	132.00
P324	P345		Amber	.3	1.93	17.70	162.00
P325	P346		Orange	.3	1.93	17.70	162.00
P326	P347		Red	.43	1.45	13.30	122.00
P327	P348		Green	.43	1.78	16.30	149.00
P328	P349		Amber	.43	1.93	17.70	162.00
P329	P350		Orange	.43	2.10	19.32	176.00
P330	P351	8	Red	.57	1.58	14.50	132.00
P331	P352		Green	.57	1.90	17.50	159.00
P332	P353		Amber	.57	1.93	17.70	162.00
P333	P354		Orange	.57	2.25	20.70	188.00
P334	P355	88	Red	.43	2.10	19.30	175.00
P335	P356		Green	.43	2.45	22.50	205.00
P336	P357		Amber	.43	3.08	28.30	257.00
P337	P358		Red	.57	2.10	19.30	175.00
P338	P359		Green	.57	2.45	22.50	205.00
P339	P360		Amber	.57	3.58	32.90	299.00
P340*	P361*	8888	Red	.28	5.35	49.20	448.00
P341*	P362*		Green	.28	6.15	56.60	515.00

* Multiplexed Display

Silicon Transistors

DIGI-KEY Part No	1	10	100	1,000
2N3055	1.44	12.00	108.00	960.00
2N3904	.23	2.20	18.90	173.25
2N3906	.23	2.20	18.90	173.25
2N4124	.24	2.27	19.50	178.75
2N4126	.24	2.27	19.50	178.75
2N4401	.23	2.20	18.90	173.25
2N4403	.23	2.20	18.90	173.25
2N4410	.33	3.15	27.00	247.50
2N5087	.24	2.20	20.00	180.00
2N5089	.30	2.80	24.00	220.00
2N5210	.23	2.20	18.90	173.25
2N5457	.67	6.30	54.00	495.00
92PU01A	.45	4.20	36.00	330.00
92PU10	.45	4.20	36.00	330.00
92PU45A	.48	4.56	39.00	357.50
92PU51A	.45	4.20	36.00	330.00
MJ2955	2.75	25.72	220.50	2021.75
MJE172	.67	6.30	54.00	495.00
MJE182	.71	6.65	57.00	522.50
MJE3439	.71	6.65	57.00	522.50
MJE344	.67	6.30	54.00	495.00
MJE370	.78	7.35	63.00	577.50
MJE371	.97	9.10	78.00	716.00
MJE520	.75	7.00	60.00	550.00
MJE521	.86	8.05	69.00	632.50
MJE703	.78	7.35	63.00	577.50
MJE712	.78	7.35	63.00	577.50
MJE722	.86	8.05	69.00	632.50
MJE803	.97	9.10	78.00	715.00
MPF102	.56	5.25	45.00	412.50
MPS2222A	.23	2.20	18.90	173.25
MPS2369A	.23	2.20	18.90	173.25
MPS2907A	.23	2.20	18.90	173.25
MPS3392	.23	2.20	18.90	173.25
MPS3393	.24	2.20	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.28	2.62	22.50	206.25
MPS3565	.23	2.20	18.90	173.25
MPS3638A	.23	2.20	18.90	173.25
MPS3641	.23	2.20	18.90	173.25
MPS3643	.23	2.20	18.90	173.25
MPS918	.28	2.62	22.50	206.25
MPSA13	.33	3.15	27.00	247.50
TIP112	1.08	10.15	87.00	797.50
TIP117	1.12	10.50	90.00	825.00
TIP120	1.01	9.45	81.00	742.50
TIP122	1.01	9.45	81.00	742.50
TIP127	1.05	9.80	84.00	770.00
TIP132	1.05	9.80	84.00	770.00
TIP135	1.35	9.80	84.00	770.00
TIP29C	.78	7.35	63.00	577.50
TIP30C	.78	7.35	63.00	577.50
TIP31C	.78	7.35	63.00	577.50
TIP32C	.75	7.00	60.00	550.00
TIP61C	.75	7.00	60.00	550.00
TIP62C	.75	7.00	60.00	550.00

1% Metal Film Resistors

¼ Watt • Temperature Coefficient: 100 ppm/°C
Max. RC WV: 250V Max. Voltage: 500V
Dielectric Withstanding Voltage: 5KV

Standard Resistor Values from 10 to 1.00M ohms
STANDARD RESISTOR VALUE TABLE

STANDARD RESISTOR VALUE							(E 96 Series)
10.0	13.3	17.8	23.7	31.6	42.2	56.2	75.0
10.2	13.7	18.2	24.3	32.4	43.2	57.6	76.8
10.5	14.0	18.7	24.9	33.2	44.2	59.0	78.7
10.7	14.3	19.1	25.5	34.0	45.3	60.4	80.6
11.0	14.7	19.6	26.1	34.8	46.4	61.9	82.5
11.3	15.0	20.0	26.7	35.7	47.5	63.4	84.5
11.5	15.4	20.5	27.4	36.5	48.7	64.9	86.6
11.8	15.8	21.0	28.0	37.4	49.9	66.5	88.7
12.1	16.2	21.5	28.7	38.3	51.1	68.1	90.9
12.4	16.5	22.1	29.4	39.2	52.3	69.8	93.1
12.7	16.9	22.6	30.1	40.2	53.6	71.5	95.3
13.0	17.4	23.2	30.9	41.2	54.9	73.2	97.6

How To Order: Take any standard resistor value (2.32K) and add an "X" (2.32KX), this is the DIGI-KEY part number. Order by quantity and price listed below.

	5 for	100 for	1000 for
¼ Watt 1% Metal Film	50¢	$3.90	$30.00

For large quantities and prices as low as $9.25/M, contact DIGI-KEY.

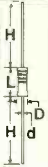
5% Carbon Film Resistors

Specifications

Rating Wattage	¼ W	½ W
Max. Working Voltage	250V	350V
Rated Ambient Temp.	70°C	
Operating Temp. Range	-55°C to +155°C	
Resistance Range	2.2Ω to 5.1MΩ	
Resistance Tolerance	±5%	
Series	E24	

Dimensions:

Style		¼ W	½ W
Body	Length (L)	6.5 ± 0.4	9.8 ± 0.5
	Diameter (D)	2.3 ± 1.0	3.7 ± 0.2
Lead Wire	Length (H)	28 ± 1.0	28 ± 1.0
	Diameter (d)	0.6	0.7



5% Carbon Film Resistor Values In Ohms

-1.0	-9.1	-82	-750	-6.8K	-62K	-560K
-1.1	-10	-91	-820	-7.5K	-68K	-620K
-1.2	-11	-100	-910	-8.2K	-75K	-680K
-1.3	-12	-110	-1.0K	-9.1K	-82K	-750K
-1.5	-13	-120	-1.1K	-10K	-91K	-820K
-1.6	-15	-130	-1.2K	-11K	-100K	-910K
-1.8	-16	-150	-1.3K	-12K	-110K	-1.0M
-2.0	-18	-160	-1.5K	-13K	-120K	-1.1M
-2.2	-20	-180	-1.6K	-15K	-130K	-1.2M
-2.4	-22	-200	-1.8K	-16K	-150K	-1.3M
-2.7	-24	-220	-2.0K	-18K	-160K	-1.5M
-3.0	-27	-240	-2.2K	-20K	-180K	-1.6M
-3.3	-30	-270	-2.4K	-22K	-200K	-1.8M
-3.6	-33	-300	-2.7K	-24K	-220K	-2.0M
-3.9	-36	-330	-3.0K	-27K	-240K	-2.2M
-4.3	-39	-360	-3.3K	-30K	-270K	-2.4M
-4.7	-43	-390	-3.6K	-33K	-300K	-2.7M
-5.1	-47	-430	-3.9K	-36K	-330K	-3.0M
-5.6	-51	-470	-4.3K	-39K	-360K	-3.3M
-6.2	-56	-510	-4.7K	-43K	-390K	-3.6M
-6.8	-62	-560	-5.1K	-47K	-430K	-3.9M
-7.5	-68	-620	-5.6K	-51K	-470K	-4.3M
-8.2	-75	-680	-6.2K	-56K	-510K	-4.7M

When ordering individual resistors, place a "Q" after the ohms value for ¼W and an "H" for ½W resistors.

¼ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS125	5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc. to 1M ohm of the ¼W 5% resistor for a total of 365 pieces	$9.90
RS225	5 each of 72 values in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 910K ohm of the ¼W 5% resistor for a total of 360 pieces	$9.90

½ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS150	5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc. to 1M ohm of the ½W 5% resistor for a total of 365 pieces	$9.90
RS250	5 each of 72 values in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 910K ohm of the ½W 5% resistor for a total of 360 pieces	$9.90

Remember a "Q" after the resistance value indicates a ¼ watt, an "H" indicates a ½ watt (i.e., 10KQ or 10KH). Prices are for single values.

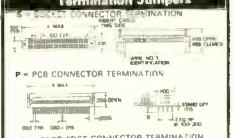
¼ Watt	5 for 25¢, 200 for $3.40; 1000 for $13.00
½ Watt	5 for 25¢, 200 for $3.60, 1000 for $16.00

In order to receive the pricing below, the resistor part number must be followed by a "ND" (i.e., 10KQ ND) and ordered in multiples of 1,000 only.

Price /1000	1M	10M	50M	100M	500M	1000M
¼W	9.00/M	8.00/M	6.50/M	6.00/M	5.00/M	4.50/M
½W	13.60/M	11.40/M	10.60/M	9.90/M	8.25/M	7.40/M

ROBINSON NUGENT, INC.

Termination Jumpers



Number After Dash Is Cable Length In Feet

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
10	S	R300 ND	1.15	10.26	94.90	872.10
14	S	R301 ND	1.40	12.52	115.81	1064.20
16	S	R302 ND	1.61	14.32	132.46	1217.20
20	S	R303 ND	1.86	16.56	153.18	1407.60
26	S	R304 ND	2.43	21.60	199.80	1836.00
34	S	R305-ND	3.15	28.00	259.00	2380.00
40	S	R306 ND	3.73	33.20	307.10	2822.00
50	S	R307 ND	4.65	41.40	382.95	3519.00
10	P	R400 ND	1.01	9.00	83.25	765.00
20	P	R401 ND	1.21	10.84	100.27	921.40
26	P	R402 ND	1.52	13.52	125.06	1149.20
34	P	R403 ND	1.86	16.56	153.18	1407.60
40	P	R404 ND	2.11	18.82	174.08	1599.70
50	P	R405 ND	2.65	23.60	218.30	2006.00
20	X	R500-ND	2.36	21.00	194.25	1785.00
26	X	R501 ND	2.65	23.60	218.30	2006.00
34	X	R502 ND	3.26	29.00	268.25	2465.00
40	X	R503 ND	3.80	33.80	312.65	2873.00
50	X	R504 ND	4.74	42.20	390.35	3587.00

1A SOCKET CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
10	1A	R309 36 ND	2.13	18.01	175.87	1616.19
14	1A	R310 36 ND	2.78	24.73	228.80	2102.56
16	1A	R311 36 ND	3.18	28.33	262.05	2408.05
20	1A	R312 36-ND	3.83	34.06	315.12	2895.78
26	1A	R313 36 ND	4.98	44.36	410.36	3770.94
34	1A	R314 36 ND	6.49	57.78	534.33	4910.11
40	1A	R316 36 ND	7.67	68.21	630.99	5798.38
50	1A	R317 36 ND	9.58	85.17	787.82	7239.45

2A PCB CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
10	2A	R406 36 ND	1.99	17.75	164.22	1509.09
20	2A	R407 36 ND	3.18	28.34	262.21	2409.58
26	2A	R408 36 ND	4.08	36.28	335.62	3084.14
34	2A	R409 36 ND	5.21	46.32	428.51	3937.71
40	2A	R410 36 ND	6.05	53.83	497.98	4576.08
50	2A	R411-36 ND	7.57	67.37	623.17	5726.45

3A CARD EDGE CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
20	3A	R505 36 ND	4.33	38.50	356.19	3273.16
26	3A	R506 36-ND	5.21	46.36	428.86	3940.94
34	3A	R507 36-ND	6.61	58.78	543.66	4994.94
40	3A	R509 36 ND	7.74	68.81	636.54	5849.36
50	3A	R510 36 ND	9.87	85.87	795.22	7307.45

1B SOCKET CONNECTOR — SOCKET CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
10	1B	R319-6 ND	2.47	21.97	203.29	1688.13
10	1B	R319 18 ND	2.80	24.89	230.29	2116.24
10	1B	R319 36 ND	3.29	29.27	270.78	2488.28
14	1B	R320-6 ND	3.04	27.08	250.50	2301.97
14	1B	R320 18 ND	3.50	31.16	288.28	2649.11
14	1B	R320 36-ND	4.18	37.25	344.61	3166.76
16	1B	R321-6 ND	3.48	30.97	286.51	2632.87
16	1B	R321 18 ND	4.01	35.64	329.71	3029.82
16	1B	R321-36 ND	4.79	42.65	394.51	3625.25
20	1B	R322 6-ND	4.05	36.03	333.35	3063.23
20	1B	R322 18 ND	4.71	41.87	387.33	3559.28
20	1B	R322 36-ND	5.69	50.62	468.30	4303.38
26	1B	R323-6 ND	5.28	46.99	434.69	3994.49
26	1B	R323 18-ND	6.14	54.58	504.88	4639.47
26	1B	R323 36 ND	7.42	65.98	610.18	5606.94
34	1B	R324 6-ND	6.85	60.96	563.88	5181.66
34	1B	R324 18 ND	7.97	70.88	655.66	6025.05
34	1B	R324 36 ND	7.39	65.76	608.33	5590.11
40	1B	R325-6 ND	8.12	72.23	668.18	6140.06
40	1B	R325 18 ND	9.43	83.90	776.14	7132.18
40	1B	R325 36 ND	11.40	101.41	938.08	8620.36
50	1B	R326 6 ND	10.13	90.08	833.37	7658.07
50	1B	R326 18 ND	11.77	104.68	968.33	8898.22
50	1B	R326 36 ND	14.23	126.57	1170.77	10758.45

2B PCB CONNECTOR — PCB CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
10	2B	R412 6 ND	2.18	19.45	179.99	1654.01
10	2B	R412 18 ND	2.51	22.37	206.98	1902.04
10	2B	R412 36 ND	3.00	26.75	247.47	2274.08
20	2B	R413 6 ND	2.76	24.59	227.53	2090.83
20	2B	R413 18 ND	3.42	30.43	281.51	2586.88
20	2B	R413 36 ND	4.40	39.16	362.48	3330.98
26	2B	R414 6 ND	3.46	30.83	285.21	2620.89
26	2B	R414 18 ND	4.32	38.42	355.40	3265.87
26	2B	R414 36 ND	5.60	49.80	460.88	4233.34
34	2B	R415 6 ND	4.28	38.08	352.24	3236.88
34	2B	R415 18 ND	5.40	43.00	444.02	4080.25
34	2B	R415 36 ND	7.07	62.88	581.69	5345.31
40	2B	R416 6-ND	4.89	43.47	402.15	3695.46
40	2B	R416 18 ND	6.20	55.14	510.11	4687.58
40	2B	R416 36 ND	8.17	72.65	672.06	6175.76
50	2B	R417 6 ND	6.13	54.49	504.07	4632.07
50	2B	R417 18 ND	7.77	69.08	639.03	5872.22
50	2B	R417 36 ND	10.23	90.97	841.47	7732.45

3B CARD EDGE CONNECTOR — CARD EDGE CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
20	3B	R511 6 ND	5.05	44.91	415.48	3818.03
20	3B	R511 18 ND	5.70	50.75	469.47	4314.09
20	3B	R511 36 ND	6.69	59.50	550.44	5058.18
26	3B	R512 6 ND	5.73	50.99	471.69	4334.49
26	3B	R512 18 ND	6.59	58.58	541.98	4978.47
26	3B	R512 36-ND	7.87	69.96	647.18	5946.94
34	3B	R513 6 ND	7.08	62.96	582.38	5351.88
34	3B	R513 18 ND	8.19	72.88	674.16	6195.05
34	3B	R513 36 ND	9.87	87.75	811.81	7459.94
40	3B	R514 6 ND	8.26	73.43	679.28	6242.06
40	3B	R514 18 ND	9.57	85.10	787.24	7234.18
40	3B	R514 36 ND	11.54	102.61	949.19	8722.36
50	3B	R515 6 ND	10.31	91.69	848.17	7794.07
50	3B	R515 18 ND	11.95	106.28	983.13	9034.22
50	3B	R515-36 ND	14.41	128.17	1185.57	10894.45

C SOCKET CONNECTOR — PCB CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
10	C	R328 6 ND	2.33	20.71	191.65	1761.11
10	C	R328-18 ND	2.65	23.63	218.64	2009.14
10	C	R328-36 ND	3.15	28.01	259.12	2381.19
20	C	R329 6 ND	3.41	30.31	280.44	2577.03
20	C	R329 18 ND	4.06	36.15	334.42	3073.09
20	C	R329 30 ND	5.05	44.90	415.39	3817.18
26	C	R330 6 ND	4.37	38.91	359.95	3307.69
26	C	R330 18 ND	5.23	46.50	430.14	3952.87
26	C	R330 36-ND	6.51	57.88	535.42	4920.14
34	C	R331 6 ND	5.57	49.52	458.06	4209.28
34	C	R331 18 ND	6.68	59.44	549.84	5052.65
34	C	R331 36 ND	8.36	74.32	687.51	6317.71
40	C	R332 6 ND	6.50	57.85	535.16	4917.76
40	C	R332 18 ND	7.82	69.52	643.13	5909.88
40	C	R332-36-ND	9.79	87.03	805.08	7398.08
50	C	R333-6 ND	8.13	72.29	668.72	6145.07
50	C	R333 18 ND	9.77	86.88	803.68	7385.22
50	C	R333 36 ND	12.23	108.77	1006.12	9245.45

E PCB CONNECTOR — CARD EDGE CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
20	E	R418 6-ND	3.91	34.75	321.51	2954.43
20	E	R418 18 ND	4.56	40.59	375.49	3450.49
20	E	R418 36 ND	5.55	49.34	456.46	4194.58
26	E	R419 6 ND	4.60	40.91	378.45	3477.68
26	E	R419 18-ND	5.45	48.50	448.64	4122.67
26	E	R419 36 ND	6.73	59.88	553.92	5090.14
34	E	R420 6 ND	5.68	50.52	467.31	4294.28
34	E	R420 18 ND	6.79	60.44	559.08	5137.65
34	E	R420 36 ND	8.47	75.32	696.76	6402.71
40	E	R421 6 ND	6.57	58.45	540.71	4968.76
40	E	R421 18-ND	7.88	70.12	648.68	5960.88
40	E	R421-36-ND	9.85	87.63	810.63	7449.06
50	E	R422-6-ND	8.22	73.09	676.12	6213.07
50	E	R422 18 ND	9.86	87.68	811.08	7453.22
50	E	R422 36 ND	12.32	109.57	1013.52	9313.45

D SOCKET CONNECTOR — CARD EDGE CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
20	D	R516 6 ND	4.55	40.47	374.42	3440.83
20	D	R516 18 ND	5.21	46.31	428.40	3936.89
20	D	R516 36 ND	6.19	55.06	509.37	4680.78
26	D	R517 6 ND	5.51	48.99	453.19	4164.49
26	D	R517 18 ND	6.38	56.58	523.38	4809.47
26	D	R517 36 ND	7.64	67.96	628.86	5778.94
34	D	R518 6 ND	6.97	61.96	573.13	5266.68
34	D	R518 18 ND	8.08	71.88	664.91	6110.05
34	D	R518 36-ND	9.76	86.78	802.58	7375.11
40	D	R519-6 ND	8.19	72.83	673.73	6191.08
40	D	R519 18 ND	9.50	84.50	781.69	7183.18
40	D	R519-36 ND	11.47	102.01	943.64	8671.36
50	D	R520-6 ND	10.22	90.89	840.77	7726.07
50	D	R520-18 ND	11.86	105.48	975.73	8966.22
50	D	R520 36 ND	14.32	127.37	1178.17	10826.45

1H SOCKET CONNECTOR — SOCKET CONNECTOR — SOCKET CONNECTOR

Contacts	Style	Part No.	1	10	100	1,000
10	1H	R334 6-ND	3.62	32.23	298.23	2740.23
14	1H	R335 6-ND	4.45	39.60	366.34	3366.17
16	1H	R336 6 ND	5.09	45.29	418.97	3850.07
20	1H	R337 6 ND	5.91	52.58	486.51	4470.83
26	1H	R338 6 ND	7.71	68.58	634.40	5830.49
34	1H	R339 6 ND	10.00	88.96	822.88	7561.88
40	1H	R340 6 ND	11.86	105.43	975.24	8962.06
50	1H	R341 6 ND	14.79	131.49	1216.32	11177.07

2H PCB CONNECTOR — PCB CONNECTOR — PCB CONNECTOR

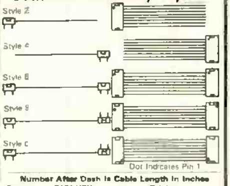
Contacts	Style	Part No.	1	10	100	1,000
10	2H	R423 6 ND	3.20	28.45	263.24	2419.01
20	2H	R424 6 ND	3.98	35.43	327.80	3012.23
26	2H	R425 6-ND	4.98	44.35	410.27	3770.09
34	2H	R426-6 ND	6.14	54.64	505.42	4644.48
40	2H	R427 6 ND	7.00	62.29	576.21	5295.16
50	2H	R428 6 ND	8.78	78.09	722.37	6638.07

3H CARD EDGE — CARD EDGE — CARD EDGE

Contacts	Style	Part No.	1	10	100	1,000
20	3H	R521 6 ND	7.41	65.91	609.74	5603.03
26	3H	R522 6 ND	8.39	74.58	689.99	6340.40
34	3H	R523 6 ND	10.34	91.98	850.63	7816.68
40	3H	R524 6 ND	12.06	107.23	991.99	9115.06
50	3H	R525 6 ND	15.06	133.89	1238.53	11381.07

DIP Jumper Cable Assembly

Standard Assembly Styles



Number After Dash Is Cable Length In Inches

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
14	2	R102 6 ND	1.58	14.08	130.25	1196.97
14	2	R102-12-ND	1.81	16.12	149.14	1370.54
14	2	R102-18-ND	2.04	18.16	168.03	1544.11
14	2	R102 24-ND	2.27	20.20	186.92	1717.68
14	2	R102-36-ND	2.73	24.29	224.70	2064.82
14	4	R104-6-ND	1.58	14.08	130.25	1196.97
14	4	R104-12-ND	1.81	16.12	149.14	1370.54
14	4	R104-18-ND	2.04	18.16	168.03	1544.11
14	4	R104-24-ND	2.27	20.20	186.92	1717.68
14	4	R104-36-ND	2.73	24.29	224.70	2064.82
14	6	R106-6-ND	2.93	26.12	241.62	2220.37
14	6	R106-12-ND	3.16	28.16	260.51	2393.94
14	6	R106-18-ND	3.39	30.20	279.40	2567.51
14	6	R106-24-ND	3.62	32.24	298.29	2741.08
14	6	R106-36-ND	4.08	36.33	336.07	3088.22
14	8	R108-6-ND	2.93	26.12	241.62	2220.37
14	8	R108 12 ND	3.16	28.16	260.51	2393.94
14	8	R108-18-ND	3.39	30.20	279.40	2567.51
14	8	R108-24-ND	3.62	32.24	298.29	2741.08
14	8	R108-36-ND	4.08	36.33	336.07	3088.22
14	0	R110-6 ND	2.93	26.12	241.62	2220.37
14	0	R110-12-ND	3.16	28.16	260.51	2393.94
14	0	R110-18-ND	3.39	30.20	279.40	2567.51
14	0	R110-24-ND	3.62	32.24	298.29	2741.08
14	0	R110-36-ND	4.08	36.33	336.07	3088.22
16	2	R112-6-ND	1.67	14.87	137.60	1264.48
16	2	R112-12-ND	1.93	17.21	159.19	1462.85
16	2	R112-18-ND	2.19	19.54	180.80	1661.41
16	2	R112-24-ND	2.46	21.88	202.39	1859.80
16	2	R112-36-ND	2.98	26.55	245.58	2256.75
16	4	R114-6-ND	1.67	14.87	137.60	1264.48
16	4	R114 12 ND	1.93	17.21	159.19	1462.85
16	4	R114-18-ND	2.19	19.54	180.80	1661.41
16	4	R114-24-ND	2.46	21.88	202.39	1859.80
16	4	R114-36-ND	2.98	26.55	245.58	2256.75
16	6	R116-6-ND	3.30	29.41	272.09	2500.36
16	6	R116-12-ND	3.57	31.75	293.68	2698.75
16	6	R116-18-ND	3.83	34.08	315.29	2897.31
16	6	R116-24-ND	4.09	36.42	336.88	3095.70
16	6	R116-36-ND	4.62	41.09	380.08	3492.65
16	8	R118-6-ND	3.30	29.41	272.09	2500.36
16	8	R118-12-ND	3.57	31.75	293.68	2698.75
16	8	R118-18-ND	3.83	34.08	315.29	2897.31
16	8	R118-24-ND	4.09	36.42	336.88	3095.70
16	8	R118-36-ND	4.62	41.09	380.08	3492.65
16	0	R120-6-ND	3.30	29.41	272.09	2500.36
16	0	R120-12-ND	3.57	31.75	293.68	2698.75
16	0	R120-18-ND	3.83	34.08	315.29	2897.31
16	0	R120-24-ND	4.09	36.42	336.88	3095.70
16	0	R120-36-ND	4.62	41.09	380.08	3492.65
24	2	R122 6 ND	2.63	23.38	216.28	1987.47
24	2	R122 12-ND	3.02	26.88	248.67	2285.14
24	2	R122 18-ND	3.41	30.38	281.07	2582.81
24	2	R122 24 ND	3.81	33.88	313.46	2880.48
24	2	R122 36-ND	4.60	40.89	378.25	3475.82
24	4	R124-6 ND	2.63	23.38	216.28	1987.47
24	4	R124 12 ND	3.02	26.88	248.67	2285.14
24	4	R124 18-ND	3.41	30.38	281.07	2582.81
24	4	R124-24-ND	3.81	33.88	313.46	2880.48
24	4	R124-36-ND	4.60	40.89	378.25	3475.82
24	6	R126-6 ND	4.86	43.26	400.17	3677.27
24	6	R126 12-ND	5.26	46.76	432.56	3974.94
24	6	R126-18-ND	5.65	50.26	464.96	4272.61
24	6	R126-24-ND	6.04	53.76	497.35	4570.28
24	6	R126-36-ND	6.83	60.77	562.14	5165.62
24	8	R128-6-ND	4.86	43.26	400.17	3677.27
24	8	R128-12-ND	5.26	46.76	432.56	3974.94
24	8	R128-18-ND	5.65	50.26	464.96	4272.61
24	8	R128-24-ND	6.04	53.76	497.35	4570.28
24	8	R128-36-ND	6.83	60.77	562.14	5165.62
24	0	R130-6-ND	4.86	43.26	400.17	3677.27
24	0	R130-12-ND	5.26	46.76	432.56	3974.94
24	0	R130-18-ND	5.65	50.26	464.96	4272.61
24	0	R130-24-ND	6.04	53.76	497.35	4570.28
24	0	R130-36 ND	6.83	60.77	562.14	5165.62
40	2	R132-6-ND	3.26	29.03	268.58	2468.06
40	2	R132-12-ND	3.92	34.87	322.56	2964.12
40	2	R132 18-ND	4.57	40.70	376.54	3460.18
40	2	R132-24-ND	5.23	46.54	430.53	3956.24
40	2	R132-36 ND	6.54	58.21	538.49	4948.36
40	4	R134-6-ND	3.26	29.03	268.58	2468.06
40	4	R134 12-ND	3.92	34.87	322.56	2964.12
40	4	R134 18 ND	4.57	40.70	376.54	3460.18
40	4	R134 24-ND	5.23	46.54	430.53	3956.24
40	4	R134-36-ND	6.54	58.21	538.49	4948.36
40	6	R136 6 ND	5.87	52.23	483.18	4440.06
40	6	R136 12-ND	6.53	58.07	537.16	4936.12
40	6	R136 18 ND	7.18	63.90	591.14	5432.18
40	6	R136 24 ND	7.84	69.74	645.13	5928.24
40	6	R136-36-ND	9.15	81.41	753.09	6920.36
40	8	R138-6-ND	5.87	52.23	483.18	4440.06
40	8	R138-12 ND	6.53	58.07	537.16	4936.12
40	8	R138-18-ND	7.18	63.90	591.14	5432.18
40	8	R138-24 ND	7.84	69.74	645.13	5928.24
40	8	R138-36-ND	9.15	81.41	753.09	6920.36
40	0	R140-6-ND	5.87	52.23	483.18	4440.06
40	0	R140 12 ND	6.53	58.07	537.16	4936.12
40	0	R140-18 ND	7.18	63.90	591.14	5432.18
40	0	R140-24 ND	7.84	69.74	645.13	5928.24
40	0	R140 36 ND	9.15	81.41	753.09	6920.36

alpha wire cable tubing

Hookup Wire, Stranded, PVC Insulated

4 Color MIL-W-16878D Type B 600 Volt -55° to +105°C

White	Black	Green	Red	Price 100 Ft.	AWG
W100W ND	W100B ND	W100G ND	W100R ND	8.01	32
W101W ND	W101B ND	W101G-ND	W101R ND	6.57	30
W102W ND	W102B ND	W102G ND	W102R ND	6.26	28
W103W ND	W103B ND	W103G ND	W103R ND	6.24	26
W104W ND	W104B ND	W104G ND	W104R ND	6.37	24
W105W ND	W105B-ND	W105G ND	W105R ND	6.97	22
W106W ND	W106B ND	W106G ND	W106R ND	8.57	20
W107W ND	W107B-ND	W107G ND	W107R ND	9.15	18
W108W ND	W108B ND	W108G ND	W108R ND	11.85	16
W109W ND	W109B ND	W109G ND	W109R ND	28.85	14

Hookup Wire, Solid, PVC Insulated

4 Color MIL-W-76B Type MW 1,000 Volt -40° to +80°C

White	Black	Green	Red	Price 100 Ft.	AWG
W110W ND	W110B ND	W110G ND	W110R ND	6.01	24
W111W ND	W111B ND	W111G ND	W111R ND	5.82	22
W112W ND	W112B ND	W112G ND	W112R ND	6.92	20
W113W ND	W113B ND	W113G ND	W113R ND	9.21	18

Multiconductor, Solid, PVC Insulated Cable

Color Coded Gray Jacket Tinned Copper Conductors

DIGI-KEY Part No	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. Of Cond.	Conductor AWG	Strand	Voltage Rating
W140 X ND	16.73	59.31	110.00	2	22	1	150V
W141 X ND	38.37	133.52	252.95	2	18	1	300V
W142 X ND	41.15	159.69	338.05	3	18	1	300V
W143 X ND	55.47	208.91	397.65	4	18	1	300V

Multipair, Individually Foil Shielded Cable

UL2464 CSA Certified Drain Wire 20° to +80°C 300 Volts
22 AWG 7/30 X = Number of Feet Per Roll

DIGI-KEY Part No	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Pairs	Nom. O.D. Inches	mm
W170-X ND	39.44	139.94	233.25	2	.316	8.03
W171 X ND	52.03	185.63	300.00	3	.331	8.41
W172 X ND	64.43	240.30	400.00	4	.360	9.14
W173 X ND	103.86	388.14	629.00	6	.431	10.95
W174 X ND	121.85	528.50	925.00	9	.500	12.70
W175 X ND	145.50	626.25	1100.00	11	.551	14.00
W176 X ND	192.39	831.00	1459.00	15	.606	15.39
W177 X ND	251.03	1080.00	1898.00	19	.646	16.41
W178 X ND	362.79	1649.42	2749.00	27	.776	19.71
W179 X ND	704.25	3202.35	5181.00	51	.970	24.64

Multiconductor, Stranded, PVC Insulated Cable

UL2576 Color Coded Gray Jacket 150 Volts 20° to +80°C
Conductor 22 AWG 7/30 — X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Cond.	Nominal O.D. Inches	mm
W120 X ND	10.47	38.49	56.70	2	.164	4.17
W121 X ND	12.19	44.77	69.60	3	.169	4.29
W122 X ND	16.38	61.24	101.00	4	.194	4.93
W123 X ND	19.20	72.98	113.40	5	.199	5.05
W124 X ND	30.19	110.00	174.24	6	.209	5.31
W125 X ND	31.07	110.00	177.75	7	.214	5.44
W126 X ND	36.87	110.00	206.55	8	.224	5.69
W127 X ND	40.68	132.60	250.05	9	.249	6.32
W128 X ND	45.77	154.28	291.00	10	.259	6.58
W129 X ND	51.32	175.35	330.75	12	.279	7.09
W130 X ND	80.99	269.78	508.95	15	.304	7.72
W131 X ND	105.43	359.78	657.60	20	.324	8.23
W132 X ND	110.00	436.50	823.50	25	.364	9.25
W133 X ND	124.20	517.50	945.00	30	.379	9.63
W134-X ND	164.33	684.75	1251.00	40	.439	11.15
W135 X ND	193.41	858.00	1566.00	50	.500	12.70
W136 X ND	313.85	1332.87	2386.94	60	.530	13.46

See Your FREE DIGI-KEY Catalog For Color Codes

Twisted Pair, Solid, Comm. and Control Cable

22 AWG Color Coded Gray Jacket UL2576 150 Volt
X = Number of Feet Per Roll

DIGI-KEY Part No	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Pairs	No. of Cond.
W150 X ND	9.74	33.22	66.36	1	2
W151 X ND	18.04	64.06	110.00	2	4
W152 X ND	23.67	88.29	147.17	3	6
W153 X ND	30.85	110.00	171.00	4	8
W154 X ND	34.40	117.11	208.00	5	10
W155 X ND	38.37	129.51	229.00	6	12
W156 X ND	55.51	193.58	343.00	9	18
W157 X ND	70.34	249.45	441.00	11	22
W158 X ND	78.83	281.55	499.00	13	26
W159 X ND	95.18	333.38	591.00	15	30
W160 X ND	110.00	505.43	810.00	16	32
W161 X ND	110.00	417.00	740.00	19	38
W162 X ND	122.63	506.25	899.00	23	46
W163 X ND	134.99	578.25	1025.00	27	54

See Your FREE DIGI-KEY Catalog For Color Codes

Shrinkable Tubing, Polyolefin: Black

UL and CSA Accepted · Flame Retarded
Self Extinguishing Non Dripping

DIGI-KEY Part No.	Price Per Roll 5 Ft.	10 Ft.	50 Ft.	100 Ft.	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W180 ND	2.51	4.18	18.83	33.48	.046	.023
W181 ND	2.67	4.45	20.05	35.65	.063	.031
W182 ND	3.03	5.05	22.75	40.40	.093	.046
W183 ND	3.20	5.35	24.07	42.78	.125	.062
W184 ND	3.90	6.50	29.22	51.94	.187	.093
W185 ND	4.93	8.22	36.99	65.75	.250	.125
W186 ND	5.50	9.16	41.21	73.26	.375	.187
W187 ND	6.20	10.33	46.49	82.65	.500	.250
W188 ND	8.26	13.80	62.10	110.40	.750	.375
W189 ND	11.61	19.35	87.09	154.82	1.000	.500
W190 ND	20.83	34.72	156.22	277.73	1.500	.750
W191 ND	28.74	47.90	215.58	383.25	2.000	1.000
W192 ND	45.54	75.90	341.54	607.18	3.000	1.5000
W193 ND	66.35	110.59	497.68	—	4.000	2.000

Adhesive Wall Shrinkable Tubing: Black

MIL-I-23053/4B Class 2 Flame Retarded
Self Extinguishing Waterproof

DIGI-KEY Part No.	Price 4 Ft.	Pak/Ft.	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W200 ND	10.18	203.00/100	.250	.125
W201 ND	11.34	226.00/100	.375	.187
W202 ND	13.50	54.00/20	.500	.250
W203 ND	20.50	82.00/20	.750	.375
W204 ND	25.20	102.00/20	1.000	.500
W205 ND	36.00	144.00/20	1.500	.750

Self-Encapsulating Caps: Black

Inexpensive Method of Encapsulating Electrical Connections or Sensors

DIGI-KEY Part No.	Price/Pak Of 10	100	1,000	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W210 ND	1.00	8.30	49.79	.125	.023
W211 ND	1.34	11.17	67.00	.187	.060
W212 ND	2.30	19.17	115.00	.250	.080
W213 ND	4.16	34.67	208.00	.375	.090
W214 ND	6.98	58.18	[illegible]	.500	.080

D-Subminiature Connectors

9, 15, 25, 37, and 50 contact solder pot contacts
Accommodates up to 20 AWG standard wire
Current Rating of 5 Amps
Contacts: Pin, copper, alloy, gold over nickel plate. Socket, phosphore bronze, gold over nickel plate.
Temperature Range: -55° to +120°C

DIGI-KEY Part No.	Style	1	10	100	1,000
1S9P ND	9 Pin Male	1.65	13.50	120.00	900.00
1S9S ND	9 Pin Female	2.18	17.78	158.00	1185.00
1S15P ND	15 Pin Male	2.20	18.00	160.00	1200.00
1S15S ND	15 Pin Female	3.03	24.75	220.00	1650.00
1S25P ND	25 Pin Male	3.00	24.53	218.00	1635.00
1S25S ND	25 Pin Female	4.42	36.23	322.00	2415.00
1S37P ND	37 Pin Male	4.13	33.75	300.00	2250.00
1S37S ND	37 Pin Female	6.19	50.63	450.00	3375.00
1S50P ND	50 Pin Male	5.25	42.98	382.00	2865.00
1S50S ND	50 Pin Female	8.20	67.05	596.00	4470.00
HD9 ND	9 Pin Hood	1.62	13.50	108.00	810.00
HD15-ND	15 Pin Hood	1.62	13.50	108.00	810.00
HD25 ND	25 Pin Hood	1.62	13.50	108.00	810.00
HD37 ND	37 Pin Hood	1.80	15.00	120.00	900.00
HD50 ND	50 Pin Hood	2.01	16.75	134.00	1005.00

The Digi-Key volume discount and handling charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the handling charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when check or money order accompanies order.

WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701

You may pay by check, money order, Master Charge, VISA or C.O.D. ***DIGI-KEY GUARANTEE:*** Any parts or products purchased from Digi-Key that prove to be defective will be replaced or refunded if returned within 90 days from receipt with a copy of your invoice. Prices subject to change without notice.

HANDLING CHARGES

$ 0.00-$ 9.99	Add $2.00
$ 10.00-$25.00	Add $0.75
$ 25.00-$49.99	Add $0.50
$ 50.00-$99.99	Add $0.25
$100.00 & Up	No Charge

VOLUME DISCOUNT

$ 0.00-$ 99.99	NET
$ 100.00-$249.99	Less 10%
$ 250.00-$499.99	Less 15%
$ 500.00-$999.99	Less 20%
$1000.00 & Up	Less 25%

Circle No. 14 on Free Information Card

7400

**Number of Pins of each I.C. for easy Socket purchase

Part No.	**Pins	Price
SN7400N	14	.25
SN7401N	14	.25
SN7402N	14	.25
SN7403N	14	.25
SN7404N	14	.25
SN7405N	14	.25
SN7406N	14	.45
SN7407N	14	.29
SN7408N	14	.25
SN7409N	14	.25
SN7410N	14	.25
SN7411N	14	.25
SN7412N	14	.49
SN7413N	14	.39
SN7414N	14	.49
SN7416N	14	.25
SN7417N	14	.25
SN7420N	14	.19
SN7421N	14	.49
SN7422N	14	.49
SN7423N	16	.59
SN7425N	14	.29
SN7426N	14	.29
SN7427N	14	.25
SN7428N	14	.59
SN7430N	14	.25
SN7432N	14	.29
SN7437N	14	.25
SN7438N	14	.29
SN7439N	14	.59
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	1.25
SN7444N	16	1.25
SN7445N	16	.69
SN7446N	16	.69
SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459N	14	.25
SN7460N	14	.39
SN7470N	14	.29

Part No.	**Pins	Price
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.89
SN7482N	14	1.49
SN7483N	16	.59
SN7485N	16	.59
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.79
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.89
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	3.25
SN74100N	24	1.95
SN74104N	14	1.19
SN74105N	14	1.19
SN74107N	14	.29
SN74109N	16	.39
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.69
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.89
SN74142N	16	3.95
SN74143N	24	3.95
SN74144N	24	3.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59

Part No.	**Pins	Price
SN74156N	16	.59
SN74157N	16	.59
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.95
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	1.19
SN74184N	16	2.49
SN74185N	16	2.49
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	2.49
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

74LS00	14	.25
74LS01	14	.25
74LS02	14	.29
74LS03	14	.25
74LS04	14	.35
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	14	.29
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.39
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	14	.75
74LS51	14	.25
74LS54	14	.25
74LS55	14	.29
74LS73	14	.39
74LS74	14	.49
74LS75	16	.39
74LS76	16	.39
74LS78	14	.39
74LS83	16	.65
74LS85	16	.89
74LS86	14	.39
74LS90	14	.55

74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.89
74LS125	14	.59
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.89
74LS139	16	.79
74LS151	16	.59
74LS153	16	.59
74LS154	24	1.29
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.95
74LS190	16	.89
74LS191	16	.89

74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.49
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.49
74LS374	20	1.49
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	2.49
74S86	14	.55
74S112	16	.55
74S113	14	.55

74S114	14	.55
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	1.19
74S175	16	1.19
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49

74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	1.19
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

CA3010H		1.35
CA3039H		1.35
CA3046N	14	1.35
CA3059N	14	2.95
CA3060N	16	2.95
CA3065E	14	1.49
CA3080E	8	.89

CA3081N	16	.99
CA3082N	16	1.19
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.49

CA3130E	8	.89
CA3140E	8	.79
CA3160H		1.95
CA3161E	16	2.95
CA3162E	16	6.95
CA3189E	16	1.59
CA3401N	14	.59

CD—CMOS

CD4000	14	.29
CD4001	14	.29
CD4002	14	.29
CD4006	14	1.19
CD4007	14	.29
CD4009	16	.59
CD4010	16	.59
CD4011	14	.29
CD4012	14	.29
CD4013	14	.39
CD4014	16	1.19
CD4015	16	.39
CD4016	14	.49
CD4017	16	1.19
CD4018	16	.99
CD4019	16	.59
CD4020	16	1.19
CD4021	16	1.19
CD4022	16	1.19
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	1.29
CD4030	14	.39
CD4034	24	2.49
CD4035	16	1.49

(More in Catalog)

CD4040	16	1.19
CD4041	14	1.19
CD4042	16	.89
CD4043	16	.79
CD4044	16	.79
CD4046	16	1.19
CD4047	14	1.29
CD4048	16	.59
CD4049	16	.39
CD4050	16	.39
CD4051	16	.99
CD4052	16	.99
CD4053	16	.99
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	1.49
CD4066	14	.59
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	1.19
CD4078	14	.49
CD4081	14	.29
CD4082	14	.29
CD4093	14	.49

CD4098	16	1.95
CD4506	16	1.19
CD4507	14	1.19
CD4508	24	3.95
CD4510	16	1.29
CD4511	16	1.19
CD4512	16	1.19
CD4514	24	2.49
CD4515	24	2.49
CD4516	16	1.19
CD4518	16	1.19
CD4519	16	.59
CD4520	16	1.19
CD4526	16	1.49
CD4528	16	1.49
CD4529	16	1.69
CD4543	16	1.95
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.69
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$2.95
MCS6502	40	MPU w/Clock	5.95
MCS6502B	40	MPU w/Clock at 3MHz	9.95
6809	40	CPU—8-bit (Internal Clock) 1MHz	14.95
6809E	40	CPU—8-bit (External Clock) 1MHz	14.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N	40	CPU-Sgl. chip 8-bit (128bts Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	9.95
INS8070N	40	CPU (64 bytes RAM)	29.95
INS8073N	40	CPU w/Basic Micro Interpreter	29.95
P8085A	40	CPU	4.95
8086	40	CPU 16-bit 5MHz	24.95
8088	40	CPU 8/16-bit	29.95
8155	40	HMOS RAM I/O Port-Timer	6.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$3.95
Z80-CTC	28	Counter Timer Circuit	3.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	10.95
Z80-DMA	40	Direct Memory Access Circuit	9.95
Z80-P10	40	Parallel I/O Interface Controller	3.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	12.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80-S10/9	40	Serial I/O	12.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	4.49
Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-P10	40	Parallel I/O Interface Controller	3.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	12.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80A-S10/9	40	Serial I/O	12.95
Z80B	40	CPU (MK3880N-6) 6MHz	9.95
Z80B-CTC	28	Counter Timer Circuit	12.95
Z80B-DART	40	Dual Asynch. Receiver/Transmitter	19.95
Z80B-P10	40	Parallel I/O Interface Controller	12.95
Z8001	48	CPU Segmented	44.95
Z8002	40	CPU Non-Segmented	34.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6500/6800/68000 SERIES

MC6502A	40	MPU with clock and RAM (2MHz)	6.95
MC6520	40	Peripheral Inter. Adapter	4.95
MC6800	40	MPU	2.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6809E	40	CPU (1MHz) External (Locking)	14.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	2.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8 bit ROM (MC68A30-8)	9.95
MC6850	24	Asynchronous Comm. Adapter	3.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	7.95
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC68488P	40	General Purpose Int. Adapter	9.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

INS8080A	40	CPU	2.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	2.95
DP8216	16	Bi-Directional Bus Driver	1.95
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.95
DP8307	20	8-bit Bi-Directional Receiver	2.95
DP8308	20	8-bit Bi-Directional Receiver	2.95
DP8310	20	Octal Latched Peripheral Driver	4.95
8741	40	8-bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1793	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95
6843P	40	Floppy Disk Controller (1MHz)	29.95

SPECIAL FUNCTION

DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	32-seg VAC Fluor. Drvr (20-pin pkg.)	3.25
MM5369AA/N	8	Prog. Oscillator/Divider (60Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

Part No.	**Pins	DYNAMIC RAMS	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	6.95 - 8/49.95
4164N-200	16	65,536x1 (200ns)	5.95 - 8/44.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	22	2048x1 (365ns)	.49 - 8/1.95
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	1.95
2114	18	1024x4 (450ns)	1.49 - 8/9.95
2114L	18	1024x4 (450ns) L.P.	1.95 - 8/13.95
2114-2	18	1024x4 (200ns)	1.75 - 8/11.95
2114L-2	18	1024x4 (200ns) L.P.	2.25 - 8/14.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	4.95
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	2.95
5101	22	256x4 (450ns) CMOS	2.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	5.95
HM6116-4	24	2048x8 (200ns) CMOS	4.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8 (150ns) CMOS	39.95
27LS00	16	256x1 (80ns) L.P.	9.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

PROMS / EPROMS

1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	5.95
TMS2532	24	4096x8 (450ns) NMC2532	6.95
TMS2564	28	8192x8 (450ns)	14.95
TMS2716	24	2048x8 (450ns) 3 voltage	9.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	5.95
2716Q-5	24	2048x8 (550ns)	4.49
2732	24	4096x8 (450ns)	6.95
2732A-3	24	4096x8 (300ns)	7.95
2732A-4	24	4096x8 (450ns) 21V	6.95
2732Q-4	24	4096x8 (550ns)	5.95
2758Q-A	24	1024x8 (450ns)	2.95
2764-4	28	8192x8 (450ns)	9.95
2764-3	28	8192x8 (300ns)	14.95
MM5204Q	24	512x8 (1us)	4.95
MCM68764	24	8192x8 (450ns)	24.95
27128	28	16,384x8 (450ns) 128K EPROM	59.95
74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	18	1024x4 PROM T.S.	6.95
74S478	24	1024x8 PROM T.S.	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
82S190	24	2048x8 (80ns)	14.95
82S191	24	2048x8 (80ns)	14.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4 PROM O.C. (82S190)	14.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	14.95

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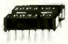
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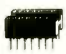
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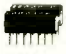
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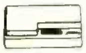

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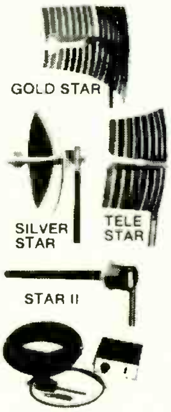

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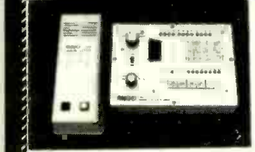

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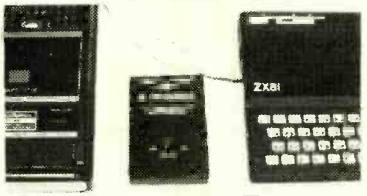

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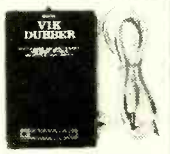

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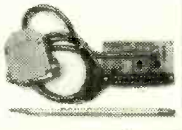

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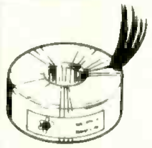

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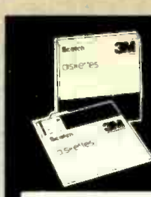

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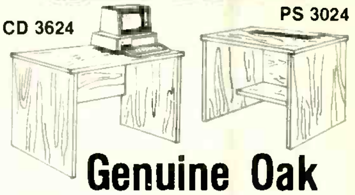

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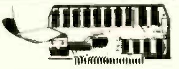

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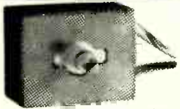

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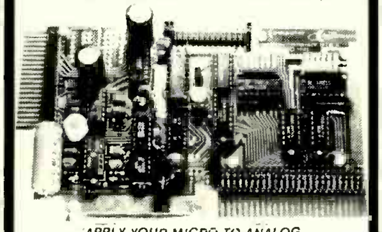

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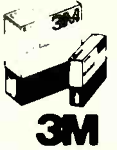

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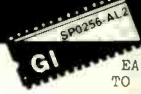

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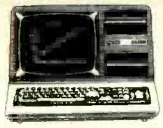

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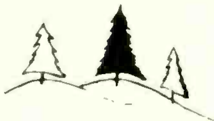

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