BYTE

the small systems journal

JANUARY 1981 Vol. 6, No. 1
$2.50 in USA/$2.95 in Canada
A McGraw-Hill Publication

HAND-HELD COMPUTERS

Cromemco accepts your challenge, Data General

Yes, Data General, we saw your ad.

So we realize you hope to win over some of our computer business.

And we can see you have reason to be pleased about your line of minicomputers. They _are_ MINIs though.

But Cromemco produces state-of-the-art MICROcomputers.

Powerful ones.

And our micros have some outstanding advantages.

For example, _Cromemco is the only microcomputer manufacturer to support a broad range of microcomputers with (a) 5-inch double-sided, double-density floppy disk drives and with (b) 8-inch double-sided, double-density floppy disk drives AS WELL AS (c) 8-inch Winchester hard disk drives._

That means, of course, that our customers have a wide choice of disk storage capability.

Reproduced from the July 31, 1980 issue of *Electronics* magazine.

Cromemco logo on computer board shown in original ad

UNEQUALLED SOFTWARE SUPPORT

OK. That was one point.

Here's another: our stunning selection of software support. _Cromemco is the only micro manufacturer to produce both single-user and multi-user multi-tasking computers with software like this:_

SYSTEM SOFTWARE

- CDOS (a CP/M-like operating system)
- CROMIX (a UNIX-like operating system)
- RPG-II (IBM-compatible)
- COBOL
- BASIC
- FORTRAN IV
- RATFOR
- LISP
- C
- Macro Assembler

APPLICATION SOFTWARE

- Word Processing System
- Data-Base Management
- General Ledger
- Accounts Receivable
- Accounts Payable
- Inventory

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So there you are, D.G.

You can see why we know our microcomputers will stand the test.

Cromemco eagerly accepts the challenge.

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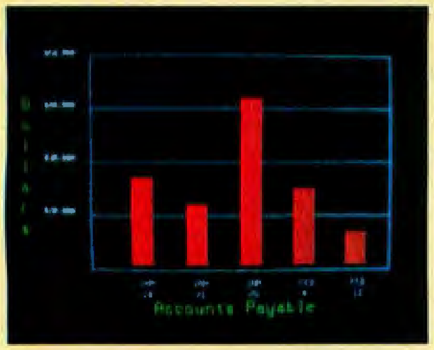
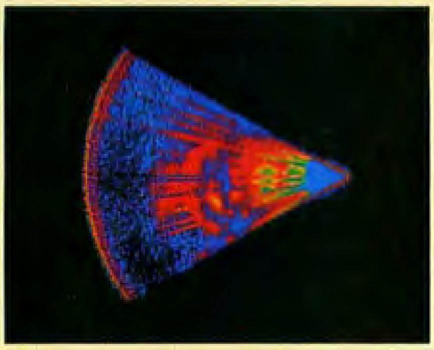


Management Information Display



Ultrasonic heart sector scan

High-resolution display with alphanumerics

Get the professional color display that has BASIC/FORTRAN simplicity

LOW-PRICED, TOO

Here's a color display that has everything: professional-level resolution, enormous color range, easy software, NTSC conformance, and low price.

Basically, this new Cromemco Model SDI* is a two-board interface that plugs into any Cromemco computer.

The SDI then maps computer display memory content onto a convenient color monitor to give high-quality, high-resolution displays (756 H x 482 V pixels).

When we say the SDI results in a high-quality professional display, we mean **you can't get higher resolution than this system offers in an** NTSC-conforming display.

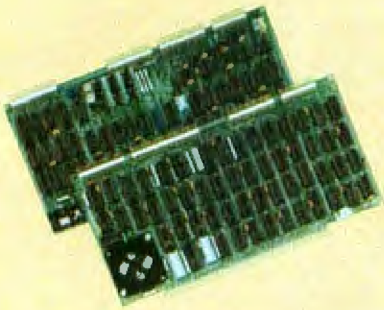
The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283



Model SDI High-Resolution Color Graphics Interface

HIGH RESOLUTION

The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

To achieve the high-quality display, a separate output signal is produced for each of the three component colors (red, green, blue). This yields a sharper image than is possible using an NTSC-composite video signal and color TV set. Full image quality is readily realized with our high-quality RGB Monitor or any conventional red/green/blue monitor common in TV work.

Model SDI plugs into Z-2H 11-megabyte hard disk computer or any Cromemco computer

DISPLAY MEMORY

Along with the SDI we also offer an optional fast and novel **two-port** memory that gives independent high-speed access to the computer memory. The two-port memory stores one full display, permitting fast computer operation even during display.

CONTACT YOUR REP NOW

The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.

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In The Queue

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In This Issue

This month's cover photograph by Ed Crabtree highlights three examples of a new phenomenon in the personal computer field: the HHC (hand-held computer). Shown are (from top to bottom): the Panasonic HHC; the Quasar HHC; and the Radio Shack HHC. All three units are discussed in this issue. Other articles this month describe two other miniature computers: the Sinclair ZX80 and the Hewlett-Packard HP-41C.

Elsewhere in this issue, Steve Ciarcia describes electromagnetic interference; we describe some of the exciting capabilities of Atari graphics; and we review an intriguing new Japanese computer: the NEC 8001; plus a new regular section of hardware and software reviews.

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Editorial

The Hand-Held Computer

Chris Morgan, Editor-in-Chief

There's a new trend in personal computing today—the HHC (hand-held computer). For years computer aficionados have dreamed of a computer small enough to fit in one's pocket, yet powerful enough to do the sorts of jobs that full-size microcomputers do today.

Amazingly enough, the dream is coming true. There are now no less than four models (the Radio Shack/Sharp, the Panasonic/Quasar, the Hewlett-Packard HP-41C, and the Sinclair ZX80) that fall roughly into the ultra-small computer category. One might quibble with calling the HP-41C a "computer" rather than a programmable calculator, but it has all the necessary elements to qualify: memory, processor, I/O (input/output), and a full line of peripherals. Each of these computers is discussed in this issue.

Among the new crop of HHCs, the Panasonic/Quasar (reviewed on page 34) is perhaps the most impressive in terms of engineering innovations; it sports some features that many full-size personal computers don't have, such as the ability to run for long periods from battery power alone—an impressive achievement when you realize that the unit uses, not a CMOS (complementary metal-oxide semiconductor) processor, but a standard 6502! It also has such niceties as user-definable keys, a built-in real-time clock, uninterruptible storage of user programs, and the ability to produce color images on a color television (with the addition of an optional interface unit).

The Radio Shack HHC has its own attractions, including its (relatively) low price of $250 and its surprisingly complete BASIC interpreter. The first time I saw the Radio Shack unit was at the West Coast Computer Faire last spring, where it was being shown in its original form from Sharp. I was intrigued, but I quickly concluded it was just a passing fad. Not until I used the computer at length did I begin to realize its potential. Here was a machine capable of running complex BASIC programs—and it was truly portable! (I have to admit that a lot of the fun connected with these units is taking them out of one's pocket and showing them to noncomputer people.)

What about the practical considerations of typing programs on such a tiny keyboard? Well, at first it felt awkward, but I quickly adjusted to it. (The Panasonic/Quasar is a bit better in this regard, because the keys are spaced more widely apart.)

Speaking of attractive prices, the Sinclair ZX80, for $200 or so, has its own appeal. Strictly speaking, it's not a hand-held computer because it uses a separate AC adapter. Still, it's tiny and can be easily transported. It has become an overnight sensation in England. As our review on page 94 points out, the ZX80 has some bad characteristics, such as screen blankout during execution of programs. Even so, a student or other beginner in computer programming could learn a lot with this machine in conjunction with its introductory BASIC book (included in the purchase price), which seems to be very good.

Why all the sudden interest in miniaturization? In part, it's the logical culmination of the never-ending battle to put more and more capability into less and less space. Combine that with the recent Japanese trend toward miniature hi-fi components, and you begin to see the driving forces involved.

"For reliable data storage, I recommend systems with Shugart disk drives."

Tom Knight, President—
Nycom, Los Altos, California

"The last thing you need when you put your personal computer or small business system to work is a disk drive that you can't rely on. If the drive quits, your system is out of business."

That's why more and more manufacturers and dealers depend on Shugart disk drives for reliable data storage. These professionals don't want disk drive problems any more than you do. Shugart has a large family of drives, too—in all sizes and capacities to suit your system storage needs. For the smaller system, the original 5¼-inch Minifloppy™ stores 250 to 500 kilobytes (single or double-sided)—that's about 50 to 100 pages of printed material. Our single and double-sided 8-inch floppys store 800 to 1600 kilobytes. And for systems that need a larger data base, our 8-inch or 14-inch fixed disk drives store from 5 to 58 megabytes. No other manufacturer offers such a wide variety of disk storage for personal computer and small business systems.

Word processing, general business, accounting—big system or small, you can rely on Shugart drives. We're known as the Headstrong company for good reason. We're Headstrong about reliability, quality, and value. Ask your dealer. He knows us.

Rely on the Headstrong Company.

Shugart

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TM—Minifloppy is a trademark of Shugart Associates.

Editorial

The Japanese are going to continue to assert themselves in the personal-computer market with both large and small personal computers. Seiko is rumored to be working on a hand-held computer to be released later this year—and that will be just the beginning, our sources tell us. Interestingly, Commodore had until recently been planning to market a hand-held computer, but abandoned the plan to concentrate on the new VIC 20 color computer. (We saw this $299 (!) unit recently, and will be reporting on it soon. The color quality is remarkable for the price.) Look for additional entries into the hand-held-computer market from US companies later this year.

Miniature Intelligent Terminals

One of the most important trends now going on behind the scenes is the pocket-size intelligent terminal being developed by Bob Doyle and Jeff Rochliss. The unit, called the Microterminal, will be battery operated and the size of a pocket calculator. It will contain an intelligent terminal with single-line liquid-crystal display, a modem, a repertory dialer, and a printer. With this unit (which will probably retail for under $300), the user can plug into any modular phone jack and access data bases all around the country, pay bills, get news, send and receive messages, and so on. The implications of this technology are enormous. We'll have a full report on this unit in an upcoming issue of BYTE.

• • •

Our New Look

You may have already noticed some of the layout and design changes in this issue of BYTE. It's all part of our continuing effort to make the magazine easier to read and more useful to our readers. The major change is the addition of a new section in the magazine devoted to hardware and software reviews. This is in response to our reader surveys that show your increasing interest in the many new products flooding the market. This new section will give you a variety of unbiased, detailed reviews each month.

We have redesigned the table-of-contents, or "In The Queue," page to make room for the additional new material. We have *not* decreased the number of articles. They will continue to be the mainstay of BYTE, as will the many popular features in the "Nucleus" section. We have

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more formal description of procedures and requirements, potential authors should send a large (9 by 12 inch, 30.5 by 22.8 cm), self-addressed envelope, with 28 cents US postage affixed, to BYTE Author's Guide, POB 372, Hancock NH 03449.

Articles which are accepted are purchased with a rate of up to $50 per magazine page, based on technical quality and suitability for BYTE's readership. Each month, the authors of the two leading articles in the reader poll (BYTE's Ongoing Monitor Box or "BOMB") are presented with bonus checks of $100 and $50. Unsolicited materials should be accompanied by full name and address, as well as return postage.

Circle 4 on inquiry card.

Outside of the garden you need a computer that can grow.

For the average garden-variety home and hobby operation, a high quality personal computer is a real temptation. But let's face it: in the world of business, engineering and scientific applications you need a system that can keep up with bigger ideas.

Bigger ideas today mean the power and flexibility to move the micro up to and beyond the level of yesterday's minis. More memory to hold bigger data bases. More flexibility to handle a variety of data entry devices. More programming and computing power for numbercrunching and applications development. And easy upgrade to 16 bit operation when you need it.

Intersystems has that, and more. The power and flexibility of the versatile S-100 bus, with 20 slots of expandability for up to 16 individually-addressable DMA devices and up to 1 Megabyte of memory, fully accessible to all users via our unique memory management system. Plus reliable Intersystems design and manufacture, and the support of our PASCAL/Z™...the most powerful Z-80™ compiler ever.

For really serious computing, our front panel provides a powerful diagnostic tool for debugging or development. Combined with a scope, it allows you to look at any location in the circuitry, set breakpoints, trigger and view one-shot events, and many other activities usually possible only with expensive logic analyzers. No wonder it's fast becoming the tool of choice for repair technicians and custom hardware designers.

Intersystems Series II is the most complete line of fully IEEE 696 compatible S-100 boards...easily upgradeable to our MPU 8000™ or other 16 bit S-100 CPU's as they become available...so you're never locked out of rapid expansion, or locked into obsolescence, by dependency on a proprietary product line.

So if you've left those garden-variety applications behind, come to Intersystems and get a system that will grow as big as your next idea. Get it from the people who know small computers...your Computerland store...or other fine full service computer dealers.

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Micros for bigger ideas.

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eliminated the "Background" and "Foreground" designations because we have encountered many good articles that don't fit either category. We invite your comments, pro or con.■

The November Cover

Much mail has come in requesting further information on our November cover. It's actually a "still," one of many extraordinary images from "The Works," a 90-minute fully computer-generated feature film. This science-fiction film is currently in production at the Computer Graphics Laboratory of the New York Institute of Technology in Old Westbury, Long Island, New York. The laboratory staff consists of a large number of exceptionally talented artists and engineers with extensive backgrounds in film-making, computer science, mathematics, and digital audio.

The digital-animation systems are state-of-the-art, using many Digital Equipment Corporation computers that have been interfaced to frame buffers. The contents of the frame buffers are recorded onto 35 mm movie film with high precision. The film will be in production for the next two years. Judging from what I have seen, it should be sensational. We thank the New York Institute of Technology for allowing us to see their work in progress. We hope to report on their graphics activities sometime soon in BYTE.

BYTE's Bits

You Can Bank On It

Electronic home banking is a reality in Knoxville, Tennessee. The Express Information bank-at-home service is a joint venture of United American Service Corporation, Radio Shack, and CompuServe.The United American Bank in Knoxville was selected as the first bank to use and market the service to its customers. For a $15 to $25 per month fee, United American Bank customers can use a TRS-80 Color Computer to access news and financial advisory services, pay bills, receive checking-account information, use a bookkeeping service, and to apply for loans. The CompuServe network provides the bank-at-home customers with a shopping list of national, international, and financial news, plus the latest stock quotations and commodities information. The United American Bank plans to add its own bank news and daily information on savings and deposit rates. Customers of the bank are issued a security pack and certificates that can be redeemed at Radio Shack outlets. In addition to the financial services, customers can use the TRS-80 Color Computer for home entertainment, education, security, message services, electronic filing, and as an electronic mail service. For details, contact Tom Sudman, c/o the United American Bank, in Knoxville, Tenesee, (615) 971-2121; David Beckerman, c/o the Tandy Corporation, Ft Worth, Texas, (817) 390-3273; or Richard Baker, c/o CompuServe, Columbus, Ohio, (614) 457-8600.■

Why not kill two birds with one stone?

If you have an Apple* and you want to interface it with parallel and serial devices, we have a board for you that will do both. It's the AIO.™

Serial Interface.

The RS-232 standard assures maximum compatibility with a variety of serial devices. For example, with the AIO you can connect your Apple* to a video terminal to get 80 characters per line instead of 40, a modem to use time-sharing services, or a printer for hard copy. The serial interface is software programmable, features three handshaking lines, and includes a rotary switch to select from 7 standard baud rates. On-board firmware provides a powerful driver routine so you won't need to write any software to utilize the interface.

Parallel Interface.

This interface can be used to connect your Apple* to a variety of parallel printers. The programmable I/O ports have enough lines to handle two printers simultaneously with handshaking control. The users manual includes a software listing for controlling parallel printers or, if you prefer, a parallel driver routine is available in firmware as an option. And printing is only one application for this general purpose parallel interface.

Two boards in one.

The AIO is the only board on the market that can interface the Apple to both serial and parallel devices. It can even do both at the same time. That's the kind of innovative design and solid value that's been going into SSM products since the beginning of personal computing.

The AIO comes complete with serial PROM's, serial and parallel cables, and complete documentation including software listings.

See the AIO at your local computer store or contact us for more information.

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*Apple is a TM of Apple Computers, Inc.

Maybe we ca
save you a ca

Many people have called with the same questions about the AIO. We'll answer those and a few more here.

Q: Does the AIO have hardware handshaking?
A: Yes. The serial port accommodates 3 types—RTS, CTS, and DCD. The parallel port handles ACK, $\overline{ACK}$, BSY, STB, and $\overline{STB}$.

Q: What equipment can be used with the AIO?
A: A partial list of devices that have actually been tested with the AIO includes: IDS 440 Paper Tiger, Centronics 779, Qume Sprint 5, NEC Spinwriter, Comprint, Heathkit H14, IDS 125, IDS 225, Hazeltine 1500, Lear Siegler ADM-3, DTC 300, AJ 841.

Q: Does the AIO work with Pascal?
A: Yes. The current AIO serial firmware works great with Pascal. If you want to run the parallel port, or both the serial and parallel ports with Pascal, order our "Pascal Patcher Disk."

Q: What kind of firmware option is available for the parallel interface?
A: Two PROM's that the user installs on the AIO card in place of the Serial Firmware PROM's provide: Variable margins, Variable page length, Variable indentations, and Auto-line-feed on carriage return.

Q: How do I interface my new printer to my Apple using my AIO card?
A: Interconnection diagrams for many popular printers and other devices are contained in the AIO Manual. If your printer is not mentioned, please contact SSM's Technical Support Dept. and they will help you with the proper connections.

Q: I want to use my Apple as a dumb terminal with a modem on a timesharing service like The Source. Can I do that with the AIO?
A: Yes. A "Dumb Terminal Routine" is listed in the AIO Manual. It provides for full and half duplex, and also checks for presence of a carrier.

Q: What length cables are provided?
A: For the serial port, a 12 inch ribbon cable with a DB-25 socket on the user end is supplied. For the parallel port, a 72 inch ribbon cable with an unterminated user end is provided. Other cables are available on special volume orders.

The AIO is just one of several boards for the Apple that SSM will be introducing over the next year. We are also receptive to developing products to meet special OEM requirements. So please contact us if you have a need and there is nothing available to meet it.

SSM Microcomputer Products
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San Jose, California 95131
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Send + More = Code

I certainly enjoyed Peter Frey's article "Machine Problem Solving, Part 2" (see the October 1980 BYTE, page 266), which concerned directed search using cryptarithmetic. Unfortunately the program does not do quite all that it is advertised to do, probably due to omissions in the press copy.

For example, on page 268 Mr Frey stated, "It is also necessary to prepare the machine with the knowledge that blank spaces which precede letters in the first two rows should be treated as zeros." Program lines 270 and 280, however, can never be executed because of the branch instruction in line 210, which bypasses lines 270 and 280 completely. As a result, problems such as "SPEND+MORE=MONEY" cannot be solved, and an error message is generated. Changing the branch instructions at line 210 to cause a jump to line 270, instead of line 300, eliminates this problem, as long as the short word is not more than one letter less than the other word.

A second malfunction occurs in problems of the "SEND+MORE=MONEY" type: when the sum word contains one more letter than the addends *and also* is a unique letter (such as in "SEND +MORE=*H*ONEY"). The program recognizes the patterns and alters the array correctly, but the value for that letter is not displayed on the screen. A short statement immediately after a successful pattern search, such as:

```
415 PRINT @ 762+6*NL, 1
```

seems to correct this error.

K W Butcher
Canton ME 04221

*Mr Butcher's comments are correct. We appreciate the feedback....*CM

Software for the Altos

I read with great interest Mark Dahmke's article in the November 1980 BYTE concerning the Altos machine. (See "The Altos ACS 8000 Single-Board Computer," page 158.) I agree with Mr Dahmke's assessment of the Altos as a well-designed and reliable machine. I was especially interested, however, in his comments on the available software for the Altos.

I represent Avtek Inc, the software house that wrote APULIB and the bisynchronous and asynchronous communications packages for the Altos machine mentioned in the article. The software picture for the Altos is not really as grim as the article makes it appear. Avtek has written many other software packages for the Altos. Among them:

- *OPRA*—A enhancement to the CP/M operating system. It increases disk-storage capacity by 40%, disk-I/O (input/output) speed by a factor of 2, it supports a type-ahead buffer, and it provides for easy mixed-mode operation.
- *Communications Packages*—In addition to the full IBM 2780/3780 bisynchronous and asynchronous packages I already mentioned, there is a synchronous communications package for Altos-to-Altos use. Incidentally, the price of the bisync package has been lowered to $495.
- *GRAFLIB*—A two- and three-dimensional graphics-subroutine library for use with the Altos and a modified Lear-Siegler ADM-3A terminal (512 by 256 resolution), a Diablo 1650 printer, and a multicolor plotter.
- *Graphics and Scientific System*—A complete system for the Altos and the modified ADM-3A that contains Avtek's own screen-oriented editor, a scientific-paper typesetting package, and many stand-alone and subroutine packages for graphics and for the solution of specialized scientific and mathematical problems. This system also supports the Diablo 1650 printer, for graphics and manuscripts, etc, and multicolor plotters.

In addition to those packages, Avtek has plans for several others, including a financial modeling package. I think that the software that Avtek supplies makes the Altos a very versatile and useful machine. In fact, it turns the Altos into a system.

John C Theys
President
Advanced Computational Technology Inc
30 Side Cut Rd
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Edison had over 1,800 patents in his name, but you can be just as inventive with an Apple.

Apple is the company with the brightest ideas in hardware and software *and* the best support — so you can be as creative with a personal computer system as Edison was with the incandescent bulb.

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Letters

68000 At Last?

In looking over a recent issue of BYTE, I came across a section titled "BYTELINES" that contained references to the MC68000. (See "68000, Where Art Thou?" September 1980 BYTE, page 164.) The message that I got from reading the commentary was that the MC68000 is still in the experimental stage. This is untrue! All unreserved op codes have been defined, and the instruction set has been frozen since January 1980. The second point is that we have been shipping the 68000 in large quantities for some time now. We have no problem committing to delivery on large-production quantities.

Since those comments were based on customer inputs, I can understand some confusion. I hope that this letter will help to resolve it.

Steve Sparks
Manager
Marketing and Applications
Motorola Inc
3501 Ed Bluestein Blvd
Austin TX 78721

Sol Libes Replies:

The column in question was written some time ago. At that time, two OEMs (original equipment manufacturers) that wanted to use the 68000 reported to me that they were still not able to go into production on planned products because Motorola still had not completed the 68000's design and would not fill production orders. In other words, the facts as I reported them were true at the time. I understand that Motorola is now shipping production quantities.

A System Note

One problem with OSI (Ohio Scientific) systems (most notably the C-2) has been the inability to utilize the 6502 IRQ and NMI commands from a BASIC program, via USR routines. The problem originates from the fact that the reset vectors for these commands, contained in the system's ROM (read-only memory), point to an area of memory that is heavily used by BASIC (ie: hexadecimal addresses 01XX). Thus, it is impossible to field either of these interrupts because BASIC rapidly destroys any service routine.

My colleagues and I have proposed to OSI that new firmware be produced, identical to the old one in all respects but for the IRQ and NMI reset vectors. These would be changed to point to a part of memory that is "stable" (eg: hexadecimal addresses D0XX or E0XX). However, for such a new device to be produced, it must be financially feasible to do so (the cost to be in the $0.25 to $0.50 range). So, we would like to ask all interested OSI users to drop a quick note to Ohio Scientific expressing interest:

Ohio Scientific Computers
Attn: Customer Relations
1333 S Chillicothe Rd
Aurora OH 44202

If enough replies are received, all of us may well see a new monitor device. Thanks so much!

Shaun D Black
University of Michigan
Department of Biological Chemistry
5440 Medical Sciences I
Ann Arbor MI 48109

Intercepting Raster

I very much enjoyed John Beetem's article entitled "Vector Graphics for Raster Displays." (See the October 1980 BYTE, page 286.) To say the least, I found it a unique method. However, I must take exception to one statement that was made regarding techniques for plotting vectors.

In referring to the slope-intercept and trigonometric methods of calculation, Mr Beetem states, "None of these is very good for a small computer, because many slow multiplications and divisions are needed." This is simply not true, at least not in the case of the slope-intercept method. (Note: In the following discussion, for simplicity, it will be assumed that the *X* length is greater than the *Y* length. If this is not the case, the *X* and *Y* values should be swapped; the program under discussion handles the data in approximately this way.)

The formula used in the common implementation of the slope-intercept method is $Y = MX + B$, where $M = (Y2 - Y1)/(X2 - X1)$ and $B = Y2 - (X2 \times M)$. In other words, the value that represents the slope of the line is multiplied by the given *X* value, then added to the origin (offset) to determine the *Y* position. To plot a vector, one would normally step through the *X* values and calculate matching *Y* coordinates from one end of the vector to the other.

In examining the formula, it should be obvious that if *X* is stepped by a constant amount, then *Y* will also increase by some constant value. To reduce the algorithm to its simplest form, it is best to increment *X* by 1 (because, by definition, we cannot plot any fractional points). One can, therefore, find the *Y* increment value simply by dividing the *Y* length by the *X* length.

How complicated is the actual algorithm? Not very. Unitek Ltd is currently developing a high-level graphics package

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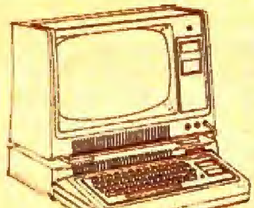

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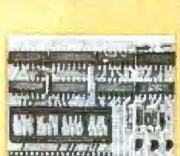

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Circle 11 on inquiry card.

Letters

for a commercial graphics product, and the vector routine uses this method. The division itself encompasses only fifteen instructions (30 bytes), and need be done only once, which is before the actual write loop is entered. The loop proper contains only an *X* increment instruction, a double-precision add (two instructions) for the *Y* increment, the actual write-routine call, and a simple test for end-of-vector. Since Mr Beetem is using an 8080 and Unitek's system is 6800-based, a speed comparison would be worthless. Suffice to say that the routine actually calculates the vector faster than the hardware can plot the points.

To show the simplicity of the algorithm, here is a minimal representation:

1. Find the lengths of the *X* and *Y* components of the vector.
2. Divide the *Y* length by the *X* length.
3. Set location to *X,Y* origin.
4. Set the *X* increment to 1.
5. Set the *Y* increment to the result of the division.
6. Set the *Y* fraction register to hexadecimal 80 (½ for round-up).
7. Plot the location.
8. If location is end-of-vector, stop.
9. Increment *X*.
10. Add the *Y* increment to the *Y* fraction register.
11. If an overflow occurs, increment *Y*.
12. Go to 7.

As can be seen, the algorithm is rather simple, and uses no complex mathematics in the loop.

It turns out that this method solves a particularly knotty problem that crops up in other variations (especially in a parametric line representation). When vectors approach angles that are multiples of 45° (ie: the *X* length nears the *Y* length), varying overflow rates in the two variables cause undesired excursions away from the actual vector. This creates a rough section about the points where steps would normally occur. Incrementing one of the variables by 1 eliminates any possibility of variable overflow and results in a very smooth vector.

I found Mr Beetem's logic interesting and informative; had I considered this method of drawing vectors when we at Unitek were designing our graphics package, I probably would have discarded it without careful examination, believing it too slow and complex. Mr Beetem has proven this not to be so. Perhaps the same thing happened when Mr Beetem was writing his routine. He too may have considered the slope-intercept method briefly, but discarded it, without closer examination, as being too clumsy. (Alas, it always seems that the algorithm one discards later turns out to be the variation with the greatest potential....) In this case, it happened for the best; otherwise, we would not have Mr Beetem's method to consider. I do not in any way intend to detract from his approach; merely to indicate that the slope-intercept is also a viable method for microcomputers.

Richard H Rae, CET
Unitek Ltd
POB 671
Emporia VA 23847

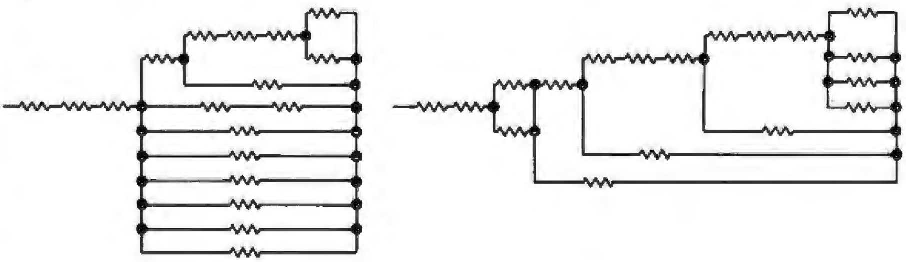
Fewer Resistors = Same Resistance

In the August 1980 BYTE, W Lloyd Milligan shows a network of twenty-six 1-ohm resistors (see "Letters," page 20) that he believes is the smallest network whose value is very close to π (pi). However, by using the same continued-fraction principle with only six parallel-connected resistors, a solution with a total of only eighteen resistors is shown in figure 1. Alas, I have been unable to find any network that starts with three in series with fewer resistors; starting with two in series, there is another solution with eighteen. All of these differ from π by about one part in four million. They all have the value 355/113.

Can anyone find a solution with seventeen or fewer?

John Fitzallen Moore
714 E Birch Rd
Lake Bluff IL 60044

Figure 1



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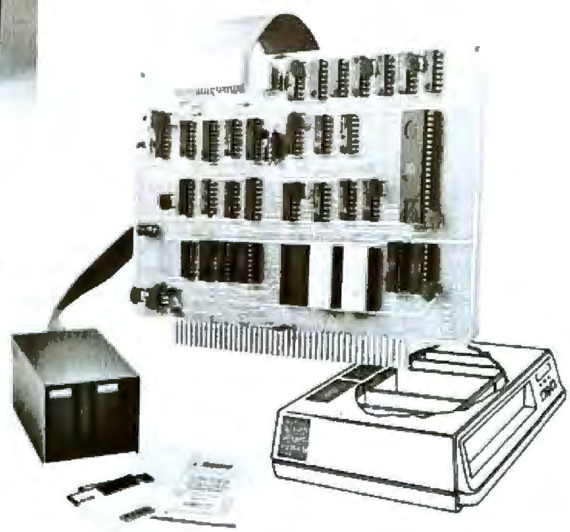

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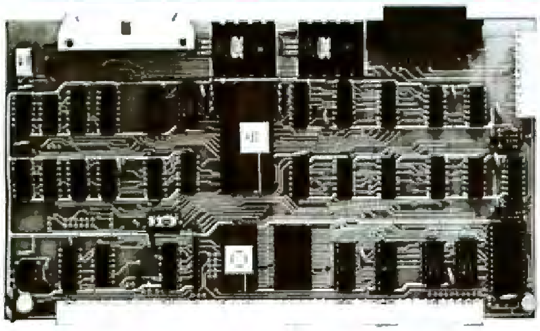

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An Introduction to Atari Graphics

Chris Crawford and Lane Winner
Atari Inc
1272 Borregas Ave
Sunnyvale CA 94086

The Atari 400 and 800 are second-generation personal computers. In addition to the normal memory and processor integrated circuits, they contain three special-purpose LSI (large-scale integrated) circuits which make them capable of many feats of computing legerdemain. Most of this power, however, lies brooding beneath many layers of "human engineering." The beginning programmer working in BASIC is paternalistically protected from the complexities and power of the beast within. The more experienced programmer seeking cybernetic high adventure must first defeat the friendliness engineered into the machine to unleash its throbbing brute power. Without help, this can be most difficult. We will act as native guides for one region of this complex machine: the *display list*. We will show you how to generate flashy displays by creating you own display list and redefining the character set.

Display-List Fundamentals

Most personal computers use a straightforward memory-mapped display in which the screen format is fixed and each screen pixel's (picture element's) contents are provided by a specific location in memory. This is a simple scheme demanding little of either the programmer or the computer. The Atari 400/800 uses a more complex scheme involving a display list and display data. A *display list* is a sequence of commands that defines the vertical format of the video display; the *display data* is the information to be displayed.

The Atari 400/800 display list is actually a small program; it is processed by a special LSI circuit called ANTIC. ANTIC is a dedicated microprocessor whose sole function is to control the video display. ANTIC uses a process called DMA (direct memory access) to gain access to the display list and display data. The display list and display data are stored by the high-speed (1.8 MHz) 6502 microprocessor. When the BASIC programmer types GRAPHICS *n*, the operating system writes a complete display list into memory and clears the display data. The information flow for this process is diagrammed in figure 1. Clearly, the adventurous programmer who bypasses BASIC and writes his or her own display list will have more direct control over the screen.

Associated with the display list are the concepts of a graphics mode and a graphics-mode line. The Atari 400/800 supports fourteen fundamental graphics modes, only nine of which are directly accessible from BASIC. The first six modes (three of which are accessible from BASIC) are character modes which display characters in different combinations of size and color. The remaining eight graphics modes display squares of color in different resolution and color combinations. A *graphics-mode line* is a group of horizontal-scan lines which are treated as a unit for display purposes. (A horizontal-scan line is a single sweep of the electron beam across the television screen. There are 192 horizontal-scan lines in the visible area of the screen.) A graphics-mode line will contain between one and sixteen horizontal-scan lines, depending on the graphics mode involved. A graphics-mode line stretches horizontally all the way across the screen (you

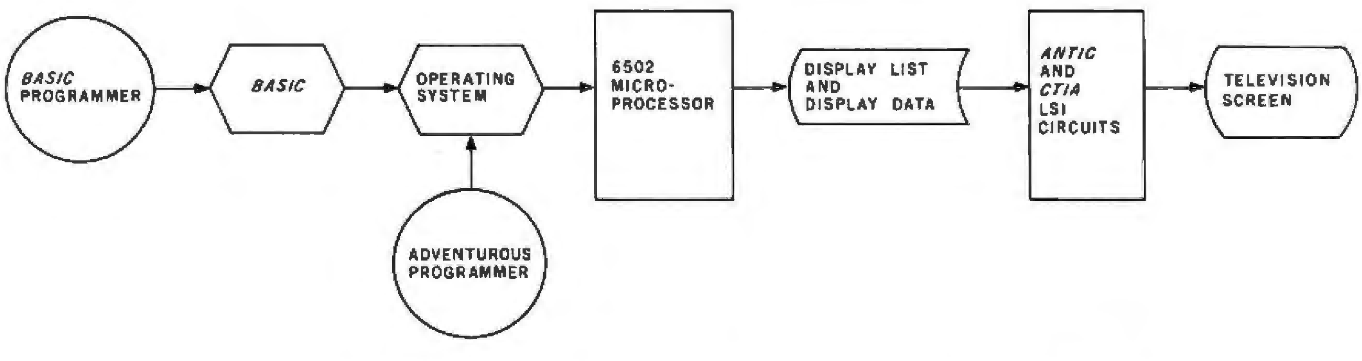

Figure 1: *Information flow for Atari 400/800 display. The adventurous programmer who bypasses BASIC gains more control over the display list and display data, and thus is able to customize the displayed image to a greater extent.*

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cannot change graphics modes halfway across the screen). The video display is thus organized as a vertical sequence of mode lines of varying height and contents. There are many thousands of possible sequences of mode lines on the screen; BASIC restricts the programmer to seventeen such sequences. Each such sequence is referred to in the BASIC manual as a graphics mode.

Display-List Details

The display list and the display data normally reside at the top of available memory-address space. Since the amount of available memory is not fixed, the operating system must keep track of the address of the display list. The address of the beginning of the list is stored in decimal addresses 560 and 561. The first 3 bytes in the display list skip twenty-four blank scan lines, which is necessary to defeat the vertical overscan of many television sets. The next byte is called the LMS (load memory scan) byte. It defines the first mode line of the display and also instructs ANTIC that the following 2 bytes give the address at which display data can be found. Since we rarely need to tamper with these first 4 bytes, we will start with the fifth byte, whose address we will assign to a BASIC variable called START. The value of START can be calculated by:

START=PEEK(560)+256*PEEK(561)+4

The bytes at this location and the succeeding location give the starting address of the display data. Beginning at location START+2 is a sequence of mode bytes which specify the mode lines for the display. The codes for these mode bytes are found in table 1. The programmer has the freedom to create any sequence of mode bytes for the display list. The programmer also has the responsibility to insure that the chosen sequence includes exactly 192 horizontal-scan lines. At the end of the mode-byte sequence, the programmer must place an ANTIC JUMP byte (decimal 65) followed by the low- and high-order address bytes of the beginning of the display list—four bytes lower in memory than the location we refer to as START.

The starting address of the display data, which we will assign to a BASIC variable called MEMST, can be calculated from:

MEMST=PEEK(START)+256*PEEK(START+1)

The display data is simply strung together in sequence; this can cause a headache when mixing modes. Since different mode lines require different numbers of display-data bytes, the programmer wishing to change a display-data byte must calculate its position in display-data memory by adding up the space requirements of each previous mode line. The BASIC POSITION and PLOT commands work reliably only with the homogeneous display lists used by BASIC, so the programmer who mixes modes must expend greater effort to use such a specialized display.

A Real Display List

We shall now illustrate these principles with a sample program and its resultant display, display list, and display data. The program is a straightforward affair which plots the BYTE logo in graphics mode 7+16. The pro-

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Mode	Remark	Left 4 Bits	Right 4 Bits	Color Dots Per Pixel	Scan Lines Per Mode Line	Number of Colors	BASIC Mode	Bytes Per Line
character	1	0	2	½	8	1½	0	40
character	1	0	3	½	10	1½	–	40
character	1	0	4	1	8	4	–	40
character	1	0	5	1	16	4	–	40
character	1	0	6	1	8	5	1	20
character	1	0	7	1	16	5	2	20
character	1	0	8	4	8	4	3	10
character	1	0	9	2	4	2	4	10
graphic	1	0	A	2	4	4	5	20
graphic	1	0	B	1	2	2	6	20
graphic	1	0	C	1	1	2	–	20
graphic	1	0	D	1	2	4	7	40
graphic	1	0	E	1	1	4	–	40
graphic	1	0	F	½	1	1½	8	40
special	2	0-7	0	Blank	–	–	–	–
special	3	4	1	JUMP	–	–	–	–

Table 1: *Interpretation of the graphics-mode-byte codes. Remarks are as follows:*
1. The left nybble of the very first mode byte of the display list must be changed from 0 to 4.
2. The blank mode is used to output a selected number of blank background lines.
3. The JUMP instruction causes the ANTIC graphics processor to recognize the end of the display list and return to the beginning of the list, waiting for vertical blanking to occur so it can proceed with another frame.
Where 1½ colors are indicated, the hue of the foreground color cannot be controlled.

Photo 1: *The BYTE logo as displayed by the Atari 400/800 running the program of listing 1. See table 2 for details.*

gram is presented in listing 1 (page 24), and the display it produces is shown in photo 1. Figure 2a and table 2a show the display list for this display. Since this is a standard BASIC graphics-mode display list, it is neat and tidy.

Tampering With the Display List

With the formal goal of improving the display and the heuristic goal of demonstrating display-list manipulations from BASIC, we shall now tamper with this display list. The first step in this process is to prepare our proposed display list on paper. The desired screen format is shown in figure 2b.

We must consult table 3 to determine which of the display modes will require the greatest amount of memory space. In our case, we are using modes 0, 1, 2, and 7; mode 7 is clearly the most memory-intensive mode. We shall therefore start with mode 7 and modify the mode-7 display list. It is always easier to pare down an oversized display list than to build up an undersized one.

Next, we must verify that our proposed display list does indeed produce 192 horizontal-scan lines. Consult table 1 to find the number of scan lines per mode line. Our calculation produces the following results:

Mode	Number of Mode Lines	Scan Lines Per Mode Line	Total Scan Lines
0	1	8	8
1	4	8	32
2	4	16	64
7	44	2	88
			192 Total

We now determine the mode bytes for each of the mode lines by looking them up in table 1. It is handy to convert these to decimal for later use. Our results are:

Mode	Hexadecimal Mode Byte	Decimal Mode Byte
0	02	2
1	06	6
2	07	7
7	0D	13

Listing 1: *Atari 400/800 program to plot the BYTE logo, shown in photo 1. See table 2 on page 26 for details.*

```
100 GRAPHICS 7:COLOR 1:POKE 765,1:POKE 710,128:POKE 712,128
110 A=0:READ B,C:IF B>-1 THEN GOSUB 800:GOTO 110
120 READ A,B,C:IF A>-1 THEN GOSUB 800:GOTO 120
130 END
800 ON A+1 GOTO 810,820,830
810 PLOT B,C:RETURN
820 DRAWTO B,C:RETURN
830 POSITION B,C:XIO 18,#6,0,0,"S:":RETURN
900 DATA 111,30,111,31,110,31,109,31,108,32,107,33,107,34
905 DATA 106,35,106,36,107,37,107,38,108,39,109,40,110,40,111,40
910 DATA 111,41,110,41,109,41,108,42,107,43,107,44,106,45
915 DATA 106,46,107,47,107,48,108,49,109,50,110,50,111,50,111,51
920 DATA -1,-1,1,97,51,2,96,50,1,96,50,2,96,31
925 DATA 2,97,30,0,93,31,1,92,31,1,91,31,1,90,32,1,89,33,1,89,34
930 DATA 1,88,35,1,88,50,1,87,51,1,80,51,2,79,50,0,79,50
935 DATA 2,79,35,0,79,35,2,78,34,0,78,34,2,78,33,0,78,33,2,77,32
940 DATA 0,77,32,2,76,31,1,74,31,1,74,30,1,93,30,0,71,30
945 DATA 1,71,46,1,70,30,1,70,46,1,69,43,1,69,46,1,68,44,1,68,46
950 DATA 1,67,44,1,67,50,1,66,51,1,59,51,2,58,50,0,58,50
955 DATA 2,58,46,1,54,46,2,54,44,1,64,43,1,63,42,1,63,31,1,62,30
960 DATA 1,55,30,2,54,31,0,54,31,2,54,43,0,51,31
965 DATA 1,51,39,0,51,42,1,51,50,1,50,51,1,50,42,0,50,39,1,50,30
970 DATA 1,49,30,1,49,32,0,49,38,1,49,43,0,49,49
975 DATA 1,49,51,1,48,51,1,48,50,0,48,42,1,48,39,0,48,31,1,48,30
980 DATA 1,46,32,0,46,38,0,46,43,0,46,49,1,45,48,1,45,43
985 DATA 0,45,38,1,45,33,0,47,51,1,36,51,2,35,50,0,35,50,2,35,31
990 DATA 1,36,30,1,49,30,-1,0,0
```

Figure 2: *Horizontal-scan line arrangement for normal- and modified-display screens. The video screen in figure 2a is composed completely of mode-7 horizontal lines. In figure 2b, the video screen is constructed from multiple-mode sections that allow a mix of images to be displayed. Refer to table 2 for details.*

The results of this paperwork are presented in table 2b.

Now, at last, we are ready to write some code. Please *refer to* listing 2 on pages 28 and 30 in conjunction with this narrative. We begin by checking to see that there is enough memory available to reposition the display list (line 0). If there isn't enough, the program aborts. We then move the top of available memory down by 4 K bytes and execute a GRAPHICS call (line 20) to write a new display list and display data in memory. This procedure reserves 4 K bytes of memory for our own use later on. We then define our display strings (lines 30 and 40) and execute another GRAPHICS call to initialize our display list—which we shall subsequently modify. The series of POKEs in lines 50 and 55 define the colors we will be using and turn off the character display while we redefine our characters.

GRAPHIC TERMINAL

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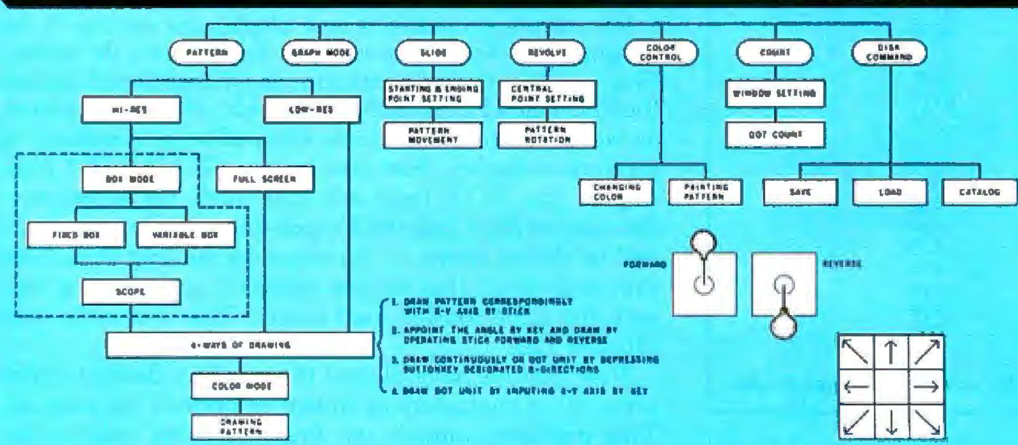

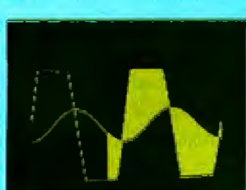

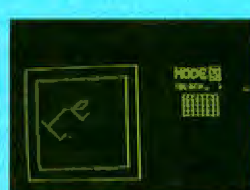

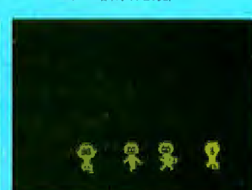

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■ HARDWARE

FANTA STICK-I consists of stick, SW1-3 switch, tenkey, I/O expansion connector, pilot lamp, and change-over switch on the reverse side. Stick and CH1-3 switch are used for making patterns and playing games. Tenkey is used for inputing dot to the screen, graphic mode command, box-position command, and save and load patterns. I/O expansion connector is useful with I/O connector inside APPLE by only changing switch for using expansion connector without removing FANTA STICK-1.

If you need higher performance, you just add another FANTA STICK-I to I/O connector.

■ SOFTWARE

A feature of this software is the division of the screen into twenty individual boxes, for drawing patterns, and memory. Then the boxes are reassembled to make a whole screen.

It does not only draw patterns by putting together the boxes and patterns made with slide and revolve command, but composes new screens by putting together the managed pattern.

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DEALER INQUIRIES INVITED

	Mode Line Number	Mode-7 Display List Hexadecimal/Decimal			Scan Line Number
LMS Byte	1	(4D)		77	2
Start	–		lo		–
	–		hi		–
	2	(0D)		13	4
	3	(0D)		13	6
	4	(0D)		13	8
Mode 7 96 lines	↓	↓		↓	↓
	94	(0D)		13	188
	95	(0D)		13	190
	96	(0D)		13	192
	JUMP	(41)		65	
			lo		
			hi		

(a)

	Mode Line Number	Modified Mode-7 Display List Hexadecimal/Decimal			Scan Line Number
LMS Byte	1	(4D)		77	2
Start	–		lo		–
	–		hi		–
Mode 7 9 lines	2	(0D)		13	4
	3	(0D)		13	6
	4	(0D)		13	8
	5	(0D)		13	10
	6	(0D)		13	12
	7	(0D)		13	14
	8	(0D)		13	16
	9	(0D)		13	18
Mode 0 1 line	10	(02)		2	26
Mode 7 35 lines	11	(0D)		13	28
	12	(0D)		13	30
	↓	↓		↓	↓
	44	(0D)		13	94
	45	(0D)		13	96
Mode 1 4 lines	46	(06)		6	104
	47	(06)		6	112
	48	(06)		6	120
	49	(06)		6	128
Mode 2 4 lines	50	(07)		7	144
	51	(07)		7	160
	52	(07)		7	176
	53	(07)		7	192
	JUMP	(41)		65	
			lo		
			hi		

(b)

Table 2: *Normal- and modified-display lists correspond to the lines displayed in figure 2. The program corresponding to table 2a is given in listing 1, and the actual display is pictured in photo 1. Listing 2 corresponds to table 2b.*

Mode	8 + 16	8138	Bytes
	8	8112	
	7 + 16	4200	
	7	4190	
	6 + 16	2184	
	6	2174	
	5 + 16	1176	
	5	1174	
	4 + 16	696	
	4	694	
	3 + 16	432	
	3	434	
	2 + 16	420	
	2	424	
	1 + 16	672	
	1	674	
	0	992	

Table 3: *Memory requirements for various graphics modes.*

We then calculate the variable START in line 60. In lines 70 thru 90, we POKE the new and different mode bytes into the display list to create our new display list. The offsets from START (the numbers added to START) are simply the mode-line numbers for the new mode lines. Thus, the offset in line 70 is 10 because the mode byte we are POKEing is for the tenth mode line from the top of the screen. (Remember, a mode line is not the same as a scan line.) In line 95, we POKE the ANTIC JUMP byte and the jump-address bytes at the end of our new display list. The value of the jump-address bytes points to the beginning of the display list and can be found in locations 560 and 561.

We have just created a new display list on top of the original one. Now we must put a display onto the screen. This will be a tricky operation; as we mentioned earlier, the PLOT and POSITION commands will not quite work as we expect them to. Some extra effort is necessary to produce a display. Fortunately, our GRAPHICS 7 plotting of the BYTE logo will still work the same way. Because we have inserted a mode-0 line above it, the logo will be shifted down on the screen by six scan lines. This shift is so small that we can neglect it and plot the logo with the same routine used earlier. This is done in lines 110 and 120.

Now that we have plotted the logo, we desire to print some other characters as shown in photo 2 on page 32. Two problems impede us: first, we must redefine the character set to mix uppercase and lowercase characters; second, we must calculate where these characters go.

The first problem arises from the natural limitations of an 8-bit processor. If four colors are supported (as in GRAPHICS 1 and 2), only 64 distinct characters can be displayed in each color. This is because 2 bits are required to specify the color, leaving only 6 bits to specify the character. This restricts our available set; the Atari character set in ROM (read-only memory) supplies uppercase and punctuation or lowercase and graphics symbols, but

Text continued on page 32

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Listing 2: *Atari 400/800 program to plot the BYTE logo and the other characters as displayed in photo 2.*

```
0 IF FRE(0)<5825 THEN PRINT "NOT ENOUGH MEMORY!":END
20 RAMTOP=PEEK(106):POKE 106,RAMTOP-16:GRAPHICS 0
30 DIM SML$(32):SML$(1,32)="  the small systems      journal   "
40 DIM MGH$(41):MGH$(1,41)="@@@A@McGRAW@HILL@@@@@@@PUBLICATION"
50 GRAPHICS 7+16:COLOR 2:POKE 765,2
55 POKE 708,128:POKE 709,40:POKE 710,128:POKE 712,128
60 START=PEEK(560)+PEEK(561)*256+4
70 POKE START+10,2
80 FOR X=0 TO 3:POKE START+46+X,6:NEXT X
90 FOR X=0 TO 3:POKE START+50+X,7:NEXT X
95 POKE START+54,65:POKE START+55,PEEK(560):POKE START+56,PEEK(561)
110 A=0:READ B,C:IF B>-1 THEN GOSUB 800:GOTO 110
120 READ A,B,C:IF A>-1 THEN GOSUB 800:GOTO 120
200 CHBAS=RAMTOP-4:ADDR=CHBAS*256
210 FOR X=0 TO 1023:POKE ADDR+X,PEEK(57344+X):NEXT X
220 POKE 756,CHBAS+2
230 FOR X=0 TO 255:POKE ADDR+512+X,PEEK(ADDR+256+X):NEXT X
240 FOR X=0 TO 7:POKE ADDR+512+X,0:NEXT X
250 FOR X=0 TO 7:READ A:POKE ADDR+99*8+X,A:NEXT X
290 POKE 755,0:POKE 87,0
300 POSITION 4,9:? #6;"AUGUST 1980  Volume 5, Number 8";
310 MEMST=PEEK(START)+PEEK(START+1)*256:CHRPOS=MEMST+46*40
320 FOR X=1 TO LEN(SML$):POKE CHRPOS+X-1,ASC(SML$(X,X))+128:NEXT X
330 CHRPOS=CHRPOS+60
340 FOR X=1 TO LEN(MGH$):POKE CHRPOS+X-1,ASC(MGH$(X,X))-64:NEXT X
```

Listing 2 continued on page 30

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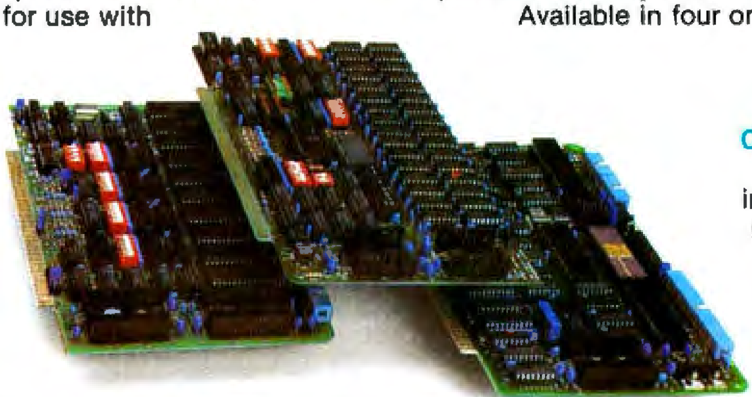

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Listing 2 continued:

```
350 POKE 708,200
360 GOTO 360
800 ON A+1 GOTO 810,820,830
810 PLOT B,C:RETURN
820 DRAWTO B,C:RETURN
830 POSITION B,C:XIO 18,#6,0,0,"S:":RETURN
900 DATA 111,20,111,21,110,21,109,21,108,22,107,23,107,24
905 DATA 106,25,106,26,107,27,107,28,108,29,109,30,110,30,111,30
910 DATA 111,31,110,31,109,31,108,32,107,33,107,34,106,35
915 DATA 106,36,107,37,107,38,108,39,109,40,110,40,111,40,111,41
920 DATA -1,-1,1,97,41,2,96,40,1,96,40,2,96,21
925 DATA 2,97,20,0,93,21,1,92,21,1,91,21,1,90,22,1,89,23,1,89,24
930 DATA 1,88,25,1,88,40,1,87,41,1,80,41,2,79,40,0,79,40
935 DATA 2,79,25,0,79,25,2,78,24,0,78,24,2,78,23,0,78,23,2,77,22
940 DATA 0,77,22,2,76,21,1,74,21,1,74,20,1,93,20,0,71,20
945 DATA 1,71,36,1,70,20,1,70,36,1,69,33,1,69,36,1,68,34,1,68,36
950 DATA 1,67,34,1,67,40,1,66,41,1,59,41,2,58,40,0,58,40
955 DATA 2,58,36,1,54,36,2,54,34,1,64,33,1,63,32,1,63,21,1,62,20
960 DATA 1,55,20,2,54,21,0,54,21,2,54,33,0,51,21
965 DATA 1,51,29,0,51,32,1,51,40,1,50,41,1,50,32,0,50,29,1,50,20
970 DATA 1,49,20,1,49,22,0,49,28,1,49,33,0,49,39
975 DATA 1,49,41,1,48,41,1,48,40,0,48,32,1,48,29,0,48,21,1,48,20
980 DATA 1,46,22,0,46,28,0,46,33,0,46,39,1,45,36,1,45,33
985 DATA 0,45,28,1,45,23,0,47,41,1,36,41,2,35,40,0,35,40,2,35,21
990 DATA 1,36,20,1,49,20,-1,0,0
999 DATA 0,60,96,96,96,60,0,0
```

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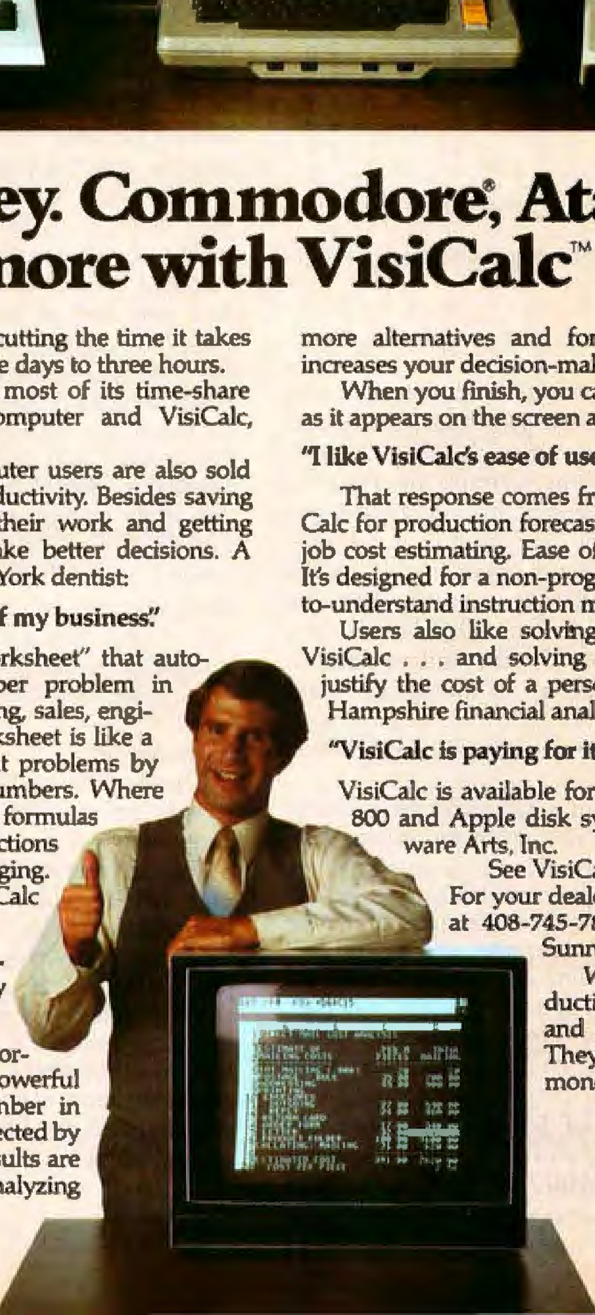

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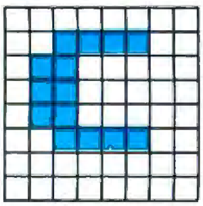
Photo 2: *The BYTE logo as displayed by the Atari 400/800 running the program in listing 2.*



BINARY	HEXADECIMAL	DECIMAL
0 0 0 0 0 0 0 0	0 0	0
0 0 1 1 1 1 0 0	3 C	6 0
0 1 1 0 0 0 0 0	6 0	9 6
0 1 1 0 0 0 0 0	6 0	9 6
0 1 1 0 0 0 0 0	6 0	9 6
0 0 1 1 1 1 0 0	3 C	6 0
0 0 0 0 0 0 0 0	0 0	0
0 0 0 0 0 0 0 0	0 0	0

Figure 3: *The assignment of values to create an elevated lowercase "c" character.*

Text continued from page 26:

not uppercase and lowercase together—at least not in GRAPHICS 1 or 2. Since we want uppercase and lowercase together, we will have to redefine the character set.

To do this, we must have some memory reserved for the new character set. Line 20 did this by fooling the operating system into believing that the top of memory (called RAMTOP) lies sixteen pages lower than it actually does. This has reserved 4 K bytes for our use. The character set needs only 1 K bytes, but the display data cannot cross a 4 K boundary (without entailing difficulty), hence we must move the display list and display data down by an entire 4 K. The address of the beginning of our new character set is calculated in line 200 and is called ADDR.

In line 210, we move the original character set (starting at address 57344 in ROM) into user memory. In line 220, we tell the operating system where the new character set is. In line 230, we move the uppercase characters into the positions previously occupied by punctuation. Our new 64-member character set has uppercase and lowercase, but very little punctuation. In line 240, we define a new space character, as the original space character was part of the old punctuation group. We shall use the place previously occupied by the @ character for our space character.

We next take this technique of defining our own characters one step further. We had earlier decided to elevate the lowercase "c" in "McGraw-Hill." To do this, we must redefine what a lowercase "c" looks like. This is done in line 250, with data coming from line 999. Obviously, this procedure can be greatly extended. The diligent programmer can define any character set that can be expressed in an 8- by 8-pixel grid and POKE it into user memory directly (see figure 3). Greek, Cyrillic, or special technical character sets can be created in this way.

The Atari 400/800 display list is actually a small program.

We now have our display list and character set in order. We need only display our text. This is done starting at line 290. The first POKE suppresses the cursor for a neater display; the second POKE fools the operating system into believing that it is working in mode 0. This prepares the way for a straightforward POSITION and PRINT of the first text line. The only trick is that the line is positioned vertically according to the number of mode lines from the top of the screen.

The next two text lines pose a particularly knotty problem. We desire to print GRAPHICS 1 and 2 characters on mode lines 46 thru 52. Neither graphics mode allows so many lines; when we try to position the cursor onto line 46 the computer will generate a "cursor out of range" error. Our only recourse is to POKE the character bytes directly into the display memory. We do this starting at line 310. First, we calculate the starting address of the display memory (MEMST). Then we calculate the address where our characters are to be stored (CHRPOS). Our calculation relies on the fact that the characters are on the 46th line and all previous lines used 40 bytes each. In more complicated situations, we would have to add up the byte requirements of all previous lines. This can get messy when a display mixes mode-1 or mode-2 lines at 20 bytes per line with other modes that use 40 bytes per line. Fortunately, our case is simple. Once CHRPOS has been calculated, we POKE the character values into the display data using a simple loop (line 320). Adding 60 to CHRPOS (line 330) skips three of our 20-byte mode-1 or mode-2 lines. We then POKE the character values for our third text line using the same technique we used in line 320, except that a different character-value offset (−64 instead of +128) gives us green characters instead of red ones. Line 350 turns the characters back on.

Conclusion

The two major tricks we have demonstrated in this article (modifying the display list and redefining the character set) will greatly extend the graphics and display power of your BASIC programs. The Atari 400/800 running BASIC alone has stunning graphics capabilities. With these tricks, the machine brings previously unheard-of capabilities into the hands of the personal computer owner. Yet, we are still just trundling down the runway. There are even grander functions built into this machine—movable graphics objects for animation, vertical and horizontal fine scrolling, and display-list interrupts, to name a few. With these tricks in hand, we can soar beyond the limits of yesterday's color display and animation.■

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Arthur C Clarke talked about them in his futuristic novel *Imperial Earth.* Jerry Pournelle and Larry Niven talked about them in *The Mote in God's Eye.* The subject is hand-held computers that can run programs, remind you of upcoming appointments, and serve as portable intermediaries between you and large, immobile, mainframe computers. Are they still science fiction? No, the hand-held computer is here—and for less than the price of some color televisions.

The HHC (hand-held computer) is a device about the size of a standard paperback book with two inches added to its longest dimension (see photo 1). Its weight is under a pound, yet it has the capabilities (when extended with portable peripherals) to do anything that existing personal computers do. The device, developed jointly by the Japanese corporation Matsushita (pronounced mat-SOOSH-ta) and Friends Amis of San Francisco, is being marketed in America by Panasonic and Quasar. Photographs in this article show both the Quasar and the Panasonic versions.

It is impossible to lose the work you are doing by pressing the OFF key.

Description of the HHC System

The Quasar/Panasonic HHC is an integrated package of hardware and software that has the ability to do anything that other personal computers do. The HHC unit has the following characteristics:

- Dimensions: 22.7 by 3.0 by 9.5 cm ($8\frac{15}{16}$ by $1\frac{3}{16}$ by $3\frac{3}{4}$ inches);
- Weight: 397 grams (14 oz.);
- 6502 microprocessor running at 1 MHz;
- Sixty-five-key keyboard with two-key rollover;
- 159 by 8 dot low-persistence LCD (liquid-crystal display);
- Uninterrupted storage of all user programs and other data through use of a unique "power-down" circuit;
- Redefinition of all keys during execution of an application program;
- Redefinition of all characters displayed on the LCD display and printer during execution of an application program;
- 2 K bytes of programmable memory, expandable to 4 K bytes internally or any practical limit (up to a theoretical limit of 4 megabytes) externally, by adding programmable memory peripherals;
- 16 K bytes of internal ROM (read-only memory) with sockets for four program capsules containing up to 64 K bytes of application programs or data (additional ROM, up to a theoretical limit of 4 megabytes, can be added externally through ROM peripherals);
- An internal real-time clock with a resolution of $\frac{1}{256}$ second;
- A built-in nickel-cadmium battery

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Photo 2: *The HHC and its peripherals. The HHC computer is in the center of the photograph. The peripherals are (clockwise, from upper left): a programmable-memory extender, the color television interface, the I/O driver (a distributor of bus signals from the HHC to other peripherals), an acoustic-coupler modem, a portable printer, a cassette interface, and a ROM expander.*

All functions are selected via a set of nested menus.

enough current to retain the contents of the HHC's display image and CMOS (complementary metal-oxide semiconductor) memory and to preserve the real-time clock and keyboard functions. A side benefit of this feature is that it is impossible to lose the work you are doing by pressing the OFF key; when you press the ON key, the computer resumes whatever it was doing before it was turned off.

A specially designed 44-pin bus connector allows you to connect and disconnect the HHC and its peripherals while all the components are powered up. Because of this feature, the HHC and its peripherals can join their respective data, address, and control buses without destroying data in either unit. As an additional safety feature, the piezoelectric beeper inside the HHC sounds if the HHC finds any loose connectors.

The ability to connect and disconnect modules while the power is on is very important because it allows the unit to be used in a variety of combinations without worrying that data will be destroyed by doing so. The HHC and its peripherals can be considered as interconnecting modules, and you can effectively forget that they contain volatile data. For example, when future program-development capsules become available, you will be able to write a program while traveling, then debug it more easily by hooking the HHC into the color TV adapter and printer. Data can also be entered into an HHC memory peripheral that may then be detached from the HHC and given to another HHC owner. He or she can plug it into another HHC and access the data that was stored.

Friends Amis has invented a particularly elegant solution to the packaging of programs in ROM (read-only memory). This solution also allows denser storage of information than was previously possible. The HHC uses 24-pin ROMs that are packaged in a plastic carrier around which the pins of the ROM are bent (see photo 3). This combination is called an Amis Memory System Capsule (patent pending). (When a capsule is inserted into the back of the HHC, the flat base of each pin makes contact with the socket. This insures a good electrical contact without the usual fragility of integrated circuit pins.) Since a minimal amount of hardware is used to package the ROMs, more can fit inside the small body of the HHC.

These capsules have already been used in the Craig, Panasonic, and Quasar language translators (also developed by Friends Amis), and in the Friends Amis point of information display computer. Capsules can contain data to be manipulated (eg: words in a French language capsule), application software (eg: a capsule of game programs), programming languages (eg: a BASIC capsule), or any other data that the computer can act upon. Capsules can hold 2 K, 4 K, 8 K, or 16 K bytes of information. The 16 K-byte ROM allows an unprecedented amount of data to be stored in a small space. The large amount of information that can be stored in the HHC is increased by its internal use of a threaded language and by the application of a set of data compression techniques.

Human-Engineered Features

As a direct result of the manufacturers' desire to design a computer specifically for the mass market, the Quasar/Panasonic HHC was developed with a heavy emphasis on human engineering. This design philosophy is reflected in the operation and features of the HHC.

The keyboard has always been a crucial interface between the user and the computer, and the popularity of several existing microcomputers has been largely influenced by the usability of their keyboard. This fact, coupled with the small size of the HHC, makes it necessary for the HHC keyboard to be as usable as possible. We feel that the designers have achieved this objective.

[*Despite my initial disbelief that a keyboard this small could be of any practical use, I was soon convinced that the HHC keyboard is easy to use and that, given some familiarity with it, I could use the keyboard without being distracted from the task at hand*...**GW**]

Photo 1 indicates that the keys on

pack that supplies all power to the unit;

- Internal shielding against RF (radio-frequency) interference in compliance with the new regulations from the Federal Communications Commission;
- An internal set of application programs that includes a four-function calculator, a free-form file system and editor, as well as several other functions.

In addition, the capabilities of the HHC are greatly extended by an integrated system of intelligent peripherals that include:

- A bus expander through which other modules are connected to the HHC;
- A portable thermal printer that prints 16 characters per line;
- A ROM extender that allows you to attach an additional four program or data capsules;
- A programmable-memory extender that allows you to add additional memory to the HHC;
- A 110/300 bps modem and telecomputing program through which the HHC can act as a remote terminal to other computers and to large information utilities and data bases;
- A cassette interface module that transfers data to a microcassette recorder at 1200 bps;
- A color television interface that allows a display of 16 lines of 32 characters each or up to 48 by 64 pixel (picture element) graphics in eight colors and black.

When connected to the HHC, all of the above peripherals can fit in a custom case the size of an average attaché case, or they can be interconnected to make a flat, rigid, easily portable combination. With the exception of the color television interface, the HHC and the peripherals can operate without connections to any outside power source, thus making the system truly portable and hand-held. Photo 2 shows the HHC and several of its peripherals.

Photo 1: *The Panasonic and Quasar HHCs (hand-held computers). Both units shown are prototype models and will have the same keyboard layout in the finished versions.*

Innovations in the HHC

The Panasonic/Quasar HHC embodies several technical breakthroughs. Without these developments, a computer as small and as powerful as the HHC could not have been built.

One of the most important innovations in the HHC is the proprietary "power-down" circuit that allows the HHC to use the popular 6502 microprocessor in a hand-held device. In the past, manufacturers have designed hand-held products around microprocessors like the 1802. Such devices use a very small amount of current and can be powered by batteries, but they force the designer to use a slow microprocessor with a weak instruction set.

Designers have been prevented from using the more popular microprocessors because of their high current drain: a conventional 6502-based circuit (using the same batteries as the HHC) would discharge them in about two hours. But, with this power-down circuit and additional hardware innovations, the amount of current needed to power the HHC in both its fully functioning and "off" (powered-down) modes is drastically reduced.

A related feature of the HHC is that when the OFF button has been pressed, the computer is still on. It is in a dormant state that uses only the HHC are arranged in the standard typewriter format. In addition, a key can be pressed without pressing any adjacent keys, so it is possible to touch-type on the HHC, regardless of individual finger width. This fact allows the HHC to be used in text applications—an area not practically accessible by any other device of its size.

Another powerful feature of the HHC is its ability within an application program to redefine any key position to any function. With the addition of a keyboard overlay, this can provide a keyboard that is completely suited to a given application. It was the intention of the HHC designers that no application, regardless of complexity, would require memorization of command language or special key sequence (like control-P for print) to perform a function available to the computer but not allotted a key. With redefinable keys and keyboard overlays, this will never happen.

Three special keys, labeled f1, f2, and f3, can be assigned to be any sequence of keystrokes, including most function keys. When one of these keys is typed, its current definition is input as if the sequence of keys had been typed by the user. The definitions are processed as interrupts and are independent of the program in use. Thus, they can be used with any present or future programs, even those written in BASIC or SNAP (the two computer languages currently planned for the HHC). For example, one key can be assigned to a sequence of calculations and/or constant values for use with the built-in calculator. Another key can be used to enter repetitive text in the memory bank text editor or to create special functions such as search-and-replace. Another definition can be used to make a commonly used sequence of menu selections to reach a frequently used program.

A unique feature of the HHC is the HELP key. When this key is pressed, you are prompted by the LCD display to press any key to find its definition. When a key is pressed, the function is given in a complete sentence of up to 80 characters. For example, pressing the HELP key followed by the STP/SPD key causes the message "STOP / ENTER 1-9 FOR SPEED" to be displayed.

Four HHC keys are used to indicate LEFT, RIGHT, UP, and DOWN. In most programs, these keys are used for cursor control and horizontal and vertical scrolling. Since the HHC's built-in display shows only one short (26-character) line at a time, it is important to be able to "steer" the display through a larger page or list of material. The display is often used as a window into a larger virtual space (as is done in the popular VisiCalc program), and the four direction keys, which are auto-repeat keys, move the window in any direction. Another key, STP/SPD (stop/speed), allows you to freeze and continue any program, like a run/stop switch, and to adjust the rate of information display.

The HHC also has INSERT and DELETE keys that allow text material to be changed. The HHC normally displays a solid rectangular cursor, but when you enter the insertion mode, the cursor changes to a blinking checkerboard cursor. Similarly,

WORD	FIRST NUMBER*	LETTERS BORROWED FROM LAST WORD	FIRST LETTER NOT COPIED	SECOND NUMBER* (COUNT FORWARD)	NEXT LETTER OF NEW WORD	REMAINING LETTERS OF NEW WORD*
SLOW	--	--	--	--	--	--
SLUMP	2	SL	O +	6 =	U	MP
SLY	2	SL	U +	4 =	Y	--
SMALL	1	S	L +	1 =	M	ALL
SMART	3	SMA	L +	6 =	R	T

Figure 1: *Compression of an alphabetized list. The tables of alphabetized lists within the HHC are kept as small as possible by using numbers to keep track of the number of letters shared from the previous word and the number of letters between the first different letter in the new word and its counterpart in the previous word. Note that the shaded letters on a line make up the word being encoded, but only the two numbers and the letters in the last column (all marked with an asterisk in their table headers) are actually stored in the encoded table. The dashes indicate an empty entry (as in the line for the word SLY). The first line is all dashes because it does not have a previous line to refer to; in practice,* all *the letters of the first entry must be normally encoded.*

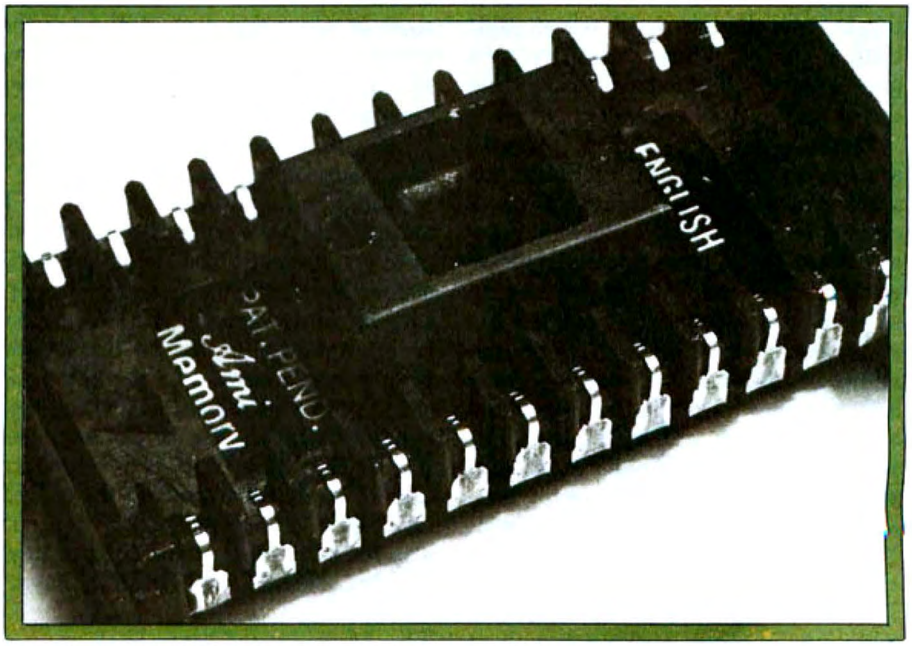

Photo 3: *Close-up of an HHC program capsule. The program capsule is actually a standard 24-pin integrated circuit with its pins curled around a plastic harness. Its length is 3.65 cm ($1\frac{7}{16}$ inches).*

Photo 4: *The Quasar HHC connected directly to its acoustic coupler. The combination, which is also available in the Panasonic HHC system, is a self-contained portable computer terminal.*

The computer executes a FORTH-like language called SNAP.

when you enter the deletion mode, the cursor changes to a rectangular outline cursor. These useful features give you visual feedback regarding the mode that the computer is in.

Other keyboard-related features are the search and locate commands available within the memory bank *electronic file* system. These features are available in two modes—*context* and *initial search*. A context search searches for a match to the given character string anywhere in the file, while an initial search searches for a match beginning with the first character of each record in the file. The former method allows maximum searching power, but the latter provides a faster search when the position of the string to be matched is at the beginning of each record (eg: when the file contains last names and telephone numbers and you are given the last name).

Other strong keyboard features of the HHC are the size and placement of certain keys. The SPACE and ENTER keys are in their traditional positions, and both are wider than the other keys for ease of use. Also notice from photo 1 that the CLEAR, ON, and OFF keys are located five rows to the right of the rightmost letter key, and at least two rows to the right of any other key. Although the consequences of hitting these keys by accident are less critical than on other personal computers (more on that later), the keys were placed there to minimize the danger.

Finally, the behavior of the SHIFT and LOCK keys should be mentioned. In applications where the program differentiates between uppercase and lowercase letters, an uppercase letter is obtained by hitting the SHIFT key, followed by the key to be shifted. The HHC is locked into uppercase by hitting the LOCK key after the SHIFT key. You can return to lowercase by hitting either the SHIFT or LOCK keys. The LOCK key can also lock the four cursor-control keys and the INSERT and DELETE keys.

The Menu and Other Features

To allow for use of the Panasonic/Quasar HHC with minimal prior knowledge of the machine, all functions are selected via a set of nested menus. The first menu that appears when the computer is turned on is called the *primary menu*. It displays the available internal and capsule program choices (eg: clock/secretary, program capsule, etc) with a 1-digit number assigned to each. A choice is selected by pressing the corresponding digit key. If the selected application allows choices of its own, its menu is displayed in the same way. This process is repeated until an executable program is reached. Pressing the CLEAR key causes the HHC to display the second menu (the one immediately after the primary menu). Pressing the CLEAR key twice causes the HHC to return to the primary menu.

The HHC computer contains a piezoelectric beeper that can produce either a click (to provide audible feedback to an event, usually a keypress) or a tone within a four-octave range.

Squeezing More into Less

There has been recent publicity on threaded languages—most visibly FORTH. (See the special language issue on FORTH, August 1980 BYTE.) Threaded languages offer program compactness and speed of execution halfway between those of machine language and a high-level language like BASIC, while offering the programming ease and language transportability of high-level languages.

The Quasar/Panasonic HHC is actually a hardware machine that executes a FORTH-like language called SNAP, in addition to 6502 machine code. The HHC uses SNAP for every function that it performs, from the display of characters on the LCD readout to the handling of interrupts from the peripherals. When timing is critical in a specific routine, such as interrupt handling for high-speed peripherals, SNAP allows any portion of itself to be coded in assembly language for maximal speed.

SNAP, like other threaded languages, is defined in terms of a given set of operators (which are analogous to the operation codes of a given microprocessor). SNAP programs are simply lists of these operators, so these programs (including applications programs embedded in program capsule ROMs) may be used without change on any machine that executes the SNAP language, provided no machine code is used. This protects the sizable programming effort put into the HHC against hardware innovations in future versions of the HHC, while maintaining a body of programs that execute quickly and use little memory.

Another way in which the execution time of programs is decreased is through the use of interrupts for the HHC keyboard and all peripherals. In contrast to other computers which use *polling* (ie: they periodically check the device to see if it needs computer time), the HHC peripherals and keyboard generate *interrupts* when they require attention from the 6502 microprocessor. In this way several peripherals can be serviced at once. The HHC slows down only when it is interrupted to do specific work and is therefore faster than computers that waste time polling inactive devices. The HHC peripherals that require serial data all use separate UART (universal asynchronous receiver-transmitter) integrated circuits for this purpose.

Given the 64 K-byte maximum addressing ability of the 6502 microprocessor, the HHC must somehow pack more memory into less space. It does so, using the familiar technique of *bank-switching*. Three banks of memory, hexadecimal 2000 to 3FFF, 4000 to 7FFF, and 8000 to BFFF, are bank-switched. This means that several blocks of up to 16 K bytes of memory could be assigned to one of the above address areas, with electronic circuitry enabling only one such block to be active at a time.

The program capsules that insert into the back of the HHC all map into the same 16 K-byte address area: hexadecimal 4000 to 7FFF. Only one capsule is active at a time and is selected from the HHC primary menu. This area is also used for user data and programs.

The 16 K-byte area from hexadecimal locations 8000 to BFFF is used for external programmable memory banks. Since this bank is in a different address area from ROM banks, many ROM-based programs can reference data in programmable memory without bank-switching.

The 8 K-byte address area (from hexadecimal locations 2000 to 3FFF) is used by the specialized firmware that is contained in each HHC peripheral. When a given peripheral is being used, the firmware that controls its communication with the HHC is selected and used. This area also contains the memory-mapped contents of the video display when the HHC is connected to the color TV interface.

(a)

Letter	Huffman Code
E	000
T	001
I	010
O	0110
N	0111
S	1000
•	•
•	•
•	•

(b)

Code	Bit(s) to Be Matched	Comments
0 100111	0	--no match
0100111	01	--no match
010 0111	010	--matches I
(I)0 111	0	--no match
(I)0111	01	--no match
(I)0111	011	--no match
(I)0111	0111	--matches N
(I) (N)	done	--message is IN

Table 1: *An example of Huffman coding. Table 1a shows an example Huffman code for several letters. Table 1b shows how the code 0100111 is decoded into the letters I and N. Bits are taken from the left side of the remaining binary string until the sequence of bits matches one of the table entries. Notice in table 1a that the code for no letter is a beginning substring of the code for another letter. (This, for example, accounts for the fact that no letter is given to the bit string 011—it would conflict with 0110, the code for the letter O.) Every Huffman code (of which there are an infinite number) is constructed so that no two letters can be confused with each other. If the letters are assigned codes in the order of their decreasing frequency for the text to be decoded, a Huffman code permits the maximum data compression possible.*

Table Rank (N)	Number of Elements In Table ($=2^N$)	Number of Bits In New Permutation Algorithm ($F(N)=2^N+2F(N-1)$)	Number of Bits In Ordinary Look-up Table ($=N2^N$)
1	2	1	2
2	4	6 = 4 + 2(1)	8
3	8	20 = 8 + 2(6)	24
4	16	56 = 16 + 2(20)	64
5	32	144 = 32 + 2(56)	160
6	64	352 = 64 + 2(144)	384

Table 2: *Efficiency of the permutation algorithm given in figures 2 through 4 and the text box. As can be seen from the last two columns, this algorithm uses fewer bits to define a given permutation. The ordinary look up table uses a table 2^N entries long by N bits long to look up the value (from 0 to 2^N-1) that a given element (in the same range) is permuted to.*

In both 16 K-byte bank-switched areas it is possible to reference a program or a program/data combination that is more than 16 K bytes long. The program (or program and data) is divided into 16 K-byte blocks, all of which map into the same area. Under program control the software can then jump between 16 K-byte blocks by writing the appropriate value to a location in the HHC that determines which block is currently selected.

Text Compression in the HHC

The increase in data storage caused

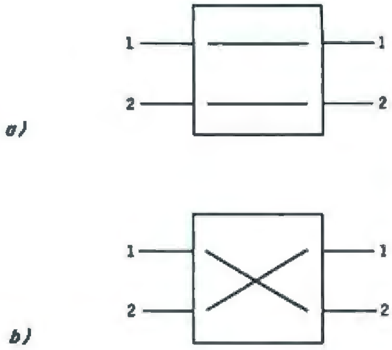

Figure 2: *Two possible outcomes for the permutations of a two-element list. See the Mapping Algorithm text box for further details.*

by the use of SNAP and 16 K-byte program capsules is significant. But the increase caused by the use of data compression techniques is even more significant, almost doubling the amount of information that can be stored in an HHC data capsule. A variable word-length code and increased data compaction through context are the two techniques used.

In traditional data storage, one character of information is stored in a byte (or 8 *bits* or binary digits) of computer memory. Letters, numbers, and punctuation are stored in the ASCII (American Standard Code for Information Interchange) format, which uses 7 bits per character. Using a method developed by Friends Amis that modifies what is called a *Huffman code*, variable bit-length codes can be devised for the characters to be encoded such that frequently used characters will be given shorter codes (called *codons*), thus decreasing the average number of bits used per character. Table 1 shows an example of a standard Huffman code (there are an infinite number of such codes).

Because of this variable-length coding, the computer's memory is seen as a long string of bits. Bits are read from left to right (figuratively speaking) until the bits read match the codon for any character in the set. (Codons are generated by rules that guarantee that a beginning string of bits can match the codon of only one letter in the set.) Codons are also devised so that the most frequently used letters have the shorter representations and are also near the top of the look-up stack. Because the number of look-up entries read before a match occurs is kept to a minimum (on the average, slightly more than eight entries), the decoding process does not slow the machine down.

A further measure of compression is made by modifying the look-up procedure to be sensitive to the context of the previous letter. For example, even though the most frequently used letters in normal English text are (in decreasing frequency) E, T, I, O, N, and so on, if the previous letter looked up was Q, then the letter U is most probably the next letter and so should be close to the beginning of the look-up table. Within the HHC, the letter-decoding routine uses the previously decoded letter to index one of *several* look-up tables. In this way, encoded characters can be represented in even fewer bits than would otherwise be possible using straight frequency-determined codons.

Two more techniques are used within the HHC to decrease the number of bits used to represent character information to a final density of just over 4 bits per character. Although these techniques were developed to deal with alphabetized lists of words (for the Friends Amis language translator), it is possible to use them to compress nonalphabetized text in some situations.

The first technique replaces the beginning of each word (except the first word in a list) with two numbers. The first number tells how many letters to borrow from the previous word. The second number tells how many letters away the first nonmatching letter is from its counterpart in the previous word. For example, if the words are SMALL and SMART, the following is stored for the word SMART: 3 (telling the computer to borrow SMA from the word SMALL); 6 (telling the computer to count forward six letters from the L in SMALL to arrive at the R in SMART); the encoded letter T (ending the encoding of the word SMART). (See figure 1 for other examples.) Because the two numbers (contained in 3 and 4 bits, respectively) take up fewer bits than the letters

The Mapping Algorithm

It is sometimes profitable to maintain a list of words in alphabetic order but to be able to retrieve them in some other prespecified order. The problem then becomes one of finding the most compact way of specifying a permutation of N elements from (1, 2, 3, ., N) to some other ordering.

The algorithm used within the Panasonic/Quasar HHC requires that the list be a power of 2 (ie: have 2, 4, 8, 16, 32, 64,... elements). The algorithm can be considered as a recursive set of pair switchings. The permutations of a list of two elements can be represented by 1 bit of information—say, a 0 to represent that the elements are not switched, eg: (1, 2) becomes (1, 2); and a 1 to represent that the elements are switched, eg: (1, 2) becomes (2, 1). This is represented pictorially in figure 2, where a box represents 1 bit of information.

The diagram in figure 3a is used with a list of four elements. The upper-lefthand box is always filled in with an equal sign (=). The input arrangement, usually (1, 2, 3, 4), is substituted for IN1 thru IN4, and the desired permutation is substituted for OUT1 thru OUT4. The boxes in the first and third columns are filled in with either equal signs (=) or cross signs (×), leaving the boxes in the second column for last.

Consider the example of permuting the list (1, 2, 3, 4) to become (4, 1, 3, 2). Given the interconnections between boxes and the constraints given above, the only path that can be taken from 1 to 1 goes through the top middle box (in a manner not yet specified) and to the righthand side through a cross in the upper-right box, as shown in figure 3b. In figure 3c, the element 4 is traced from box A to box B. Similarly, element 3 is traced from box B to box C, and element 2 is traced from box B to box S, where we started.

Given the conditions shown in figure 3c, it is a simple task to fill in the middle columns, thus completing the diagram. The finished diagram is shown in figure 3d. Through use of this diagram, the list (1, 2, 3, 4) can be permuted to the list (4, 1, 3, 2) using 6 bits of information (1 bit for each of the six boxes).

Study of an eight-element list example illustrates the recursive they replace, this method can represent the same text in fewer bits.

The last technique saves space in that it allows alphabetized lists to be used in a different order. (For example, in language lists a given set of words is mapped from the sequential order in its alphabetized list to a semantic order in a list of words of equivalent meaning available in each language list; this is done so that the computer can translate a given word to its equivalent in another language.) With this technique, a list of 2^N elements can be permuted into any other arrangement of the same elements by a relatively small number of bits of information (see table 2). Refer to the Mapping Algorithm text box for the details of this algorithm.

The Real-Time Clock

One of the most important internal features of the Panasonic/Quasar HHC is its real-time clock and event sequencer. The real-time clock exists in memory as a 40-bit number stored

method that is used to generate the final structure for longer lists. Figure 4 shows a mapping of the list (1, 2, 3, 4, 5, 6, 7, 8) to (6, 3, 8, 1, 7, 5, 4, 2). As before, box S is marked with an equal sign. Boxes in the first and last columns are then filled in; this can even be done with no knowledge of the contents of boxes X and Y. The boxes A through G are filled in alphabetically. Note that when these boxes are filled, the boxes X and Y become "black boxes" that map four-element lists into another ordering. These boxes are then solved as shown in figure 3, and the permutation of eight elements is now solved. The final solution has twenty boxes: eight as shown in figure 4, plus six boxes each for boxes X and Y.

Larger lists are solved in an analogous way, with a list of 2^N elements first filling the 2^N boxes in the first and last columns, followed by the solution of the two middle boxes, each of which permutes a list of 2^{N-1} elements. Table 2 shows the number of boxes (or bits) necessary to solve larger permutations.

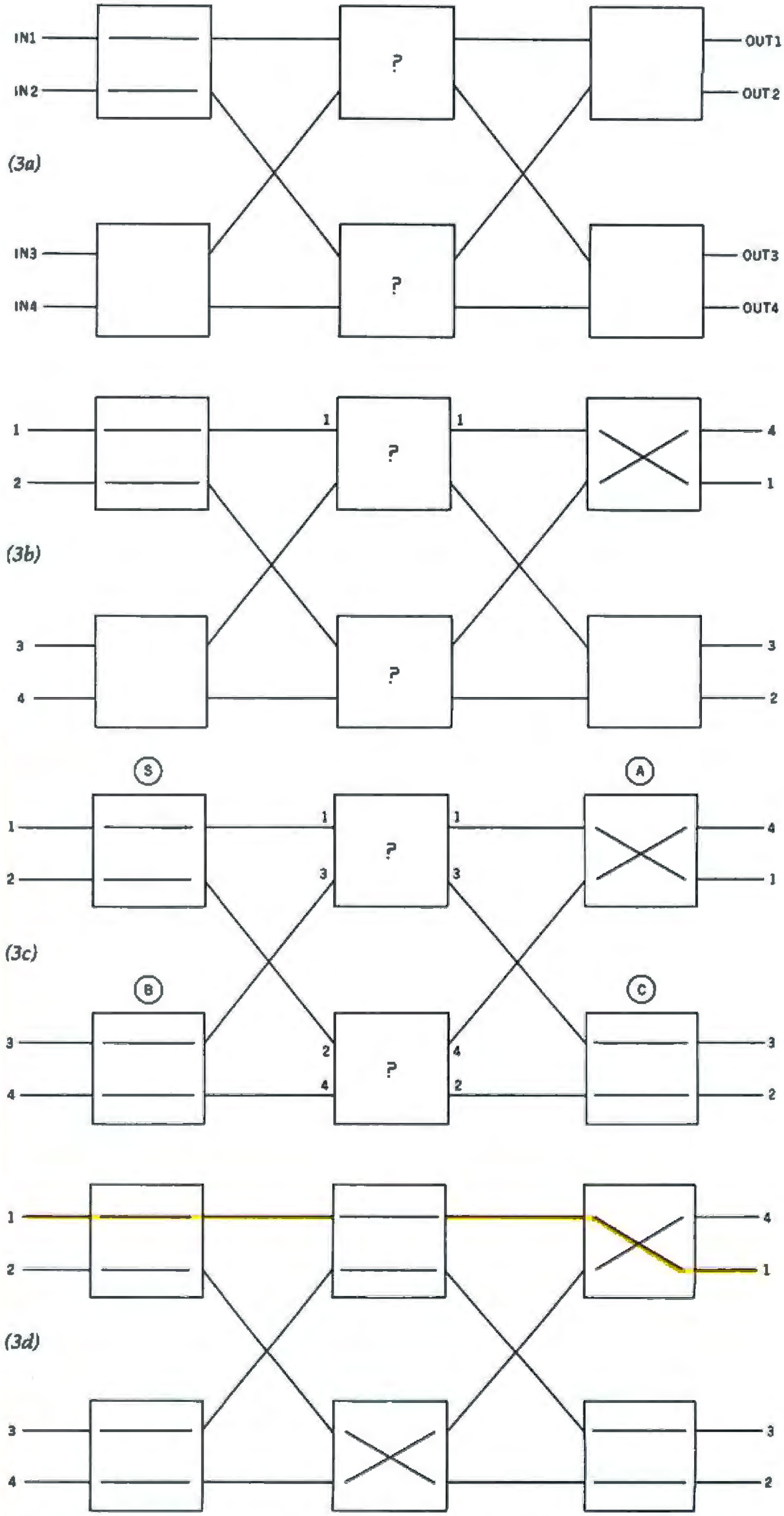

Figure 3: *Solving a four-element permutation problem as a network of binary decisions. Figure 3a shows the initial configuration used in the solution of any four-element permutation. Figures 3b, 3c, and 3d show steps in the solution of this problem. See the Mapping Algorithm text box for further details.*

in 5 contiguous bytes of programmable memory, supported by a hardware counter that can be preset. An increment of one unit in this number represents a time change of 1/256 second (about 4 milliseconds), so that the 40-bit number represents the number of 1/256 second intervals that have elapsed since the computer was permanently turned on. (Given the above figures, a 40-bit number will represent a time period of approximately 139 years.)

In keeping with the design philosophy of burdening the 6502 microprocessor with as few tasks as possible, the real-time clock was designed to require the generating of as few interrupts as possible. Another area of memory contains a signed 23-bit counter circuit that automatically counts down to 0 at a rate of one count every 1/256 second. Normally, when this timer reaches 0 (once every $2^{23}/256$ seconds, or about 9 hours), it generates an interrupt that adds the same amount (about 9 hours) to the 40-bit clock number. However, if any program needs to access the real-time clock, the appropriate count based on the value in the 23-bit counter can be added to the 40-bit clock number and the 23-bit counter can be cleared, thus updating the clock to its correct value.

Associated with the real-time clock is an event queue in which future events are stored as 40-bit numbers along with instructions to be carried out when the 40-bit clock number reaches that value. Internally, the operating system software can use this event queue to manage a set of asynchronous events with a minimum of processing. Application programs can use the event queue, as can users programming on the HHC.

Design for Component Interaction

The Quasar/Panasonic HHC was designed to be compatible with both existing and future hardware and software. Because of this, the memory usage of the computer had to be planned to provide maximum flexibility.

In most microcomputer systems, there are fixed memory locations or I/O (input/output) ports assigned for specific hardware peripherals. The limitation of this approach is that the entire memory mapping must be foreseen; otherwise the ability to include future peripherals is questionable. The HHC does not make any fixed assignments. Instead, 4 bytes for each peripheral are dynamically assigned as I/O and status locations for all currently connected peripherals each time the clear key is pressed, so any number of different peripheral types can be accommodated without running into memory map conflicts.

Data compression techniques in the computer almost double the amount of information that can be stored in a given number of bits.

This flexible system of directing input and output allows the HHC to offer a more commonsense approach to dealing with devices like printers, modems, LCD displays, and other devices. In most computers, special commands must be given to direct input and output to specific devices, and even then you may not be able to distribute it to several devices. For example, a special command, LPRINT, must be used to get either the Radio Shack TRS-80 or the Atari 400 or 800 to print information on their associated printers, and it is impossible to get a program to print on both the video display and the printer without using both PRINT and LPRINT statements. With some limitations this can be done with the Apple computer, but only with the correct interface board and the correct PR#N command.

The attitude taken by Friends Amis is that you *shouldn't have to remember* extra information (which is often complicated by being conditional on what the computer is currently doing). With the HHC computer, the use of I/O devices can be changed by pressing the I/O key and enabling or disabling the appropriate devices from a menu displayed by the HHC. You can even, for example, interrupt a running program to enable the printer, and resume the program without error; from that point on, both the current display device (the LCD display, color TV, or other device) and the printer display whatever the program tells them to. This method allows HHC programs to be independent of the I/O devices, and it allows the use of future peripherals with current software.

Application Software

The Panasonic/Quasar HHC includes several application programs that are contained in the same built-in read-only memory devices as the operating system. These programs implement a calculator, a clock/ secretary, and an electronic file system and editor. Each of these programs is called from the primary menu of the HHC.

The calculator program, when selected, transforms the HHC into a standard four-function calculator that adds, subtracts, multiplies, and divides. The calculator can store one number and has keys to add to, subtract from, clear, and recall memory. It also has a percent key.

The clock/secretary uses the real-time clock that knows the time of day, the day of the week, and the date (day, month, and year). A clock option within the clock/secretary allows the time and date to be displayed and continuously updated on the LCD display window. Otherwise, the clock/secretary can be used to keep track of future events. You can specify a time for the clock/secretary to activate itself, and include an optional reminder message. When that time arrives, the HHC sounds a musical tune regardless of its current task; you can then perform an "acknowledge" operation and see the message associated with the event. The number of events and messages that the clock/secretary can hold is limited by the amount of programmable memory in the HHC.

The "memory bank" is the nickname of an electronic file system and editor within the HHC. You can enter lines (or *records*) of up to 80 characters of ASCII information, group them to make *files*, and modify and list these files. Any file can be edited with a powerful cursor-controlled editor that allows insertion and deletion of characters or lines at the current cursor position. With the SEARCH key, you can also retrieve records from a file based on a character string to be matched.

Memory bank files can have any number of records, with each record holding up to 80 characters. The size and number of files that can be stored depends on the amount of programmable memory in the HHC. The current model of the HHC has somewhat less than 1500 bytes of memory for this purpose, but the amount of memory in the HHC can be expanded with a battery-powered 4 K-byte memory extender peripheral. Future models will accept more programmable memory in the form of capsules that fit into the same sockets as the read-only memory capsules.

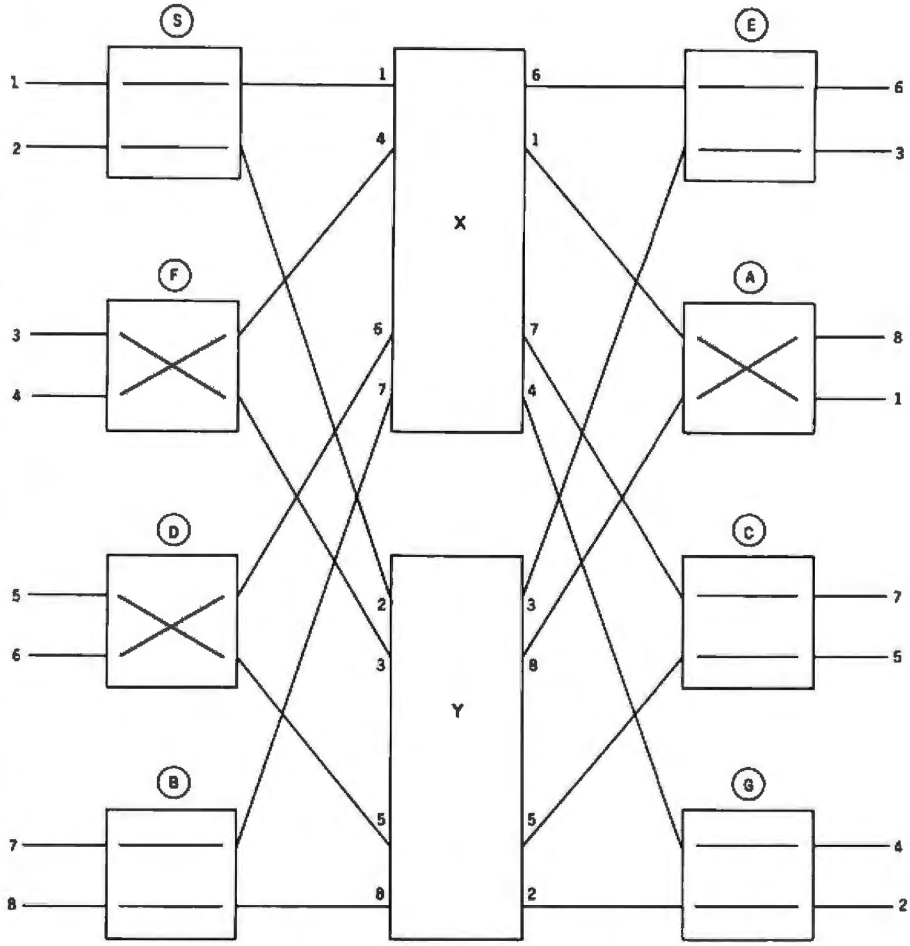

Figure 4: *Partial solution of an eight-element permutation problem. Each of the boxes in the first and last columns is filled in first. The solution of this problem is then finished by the solution of two four-element permutations as given by the numbers on both sides of the boxes marked X and Y.*

The Extended HHC

The Quasar/Panasonic HHC, when combined with its line of peripherals, has the ability to perform any function that existing personal computers do, while retaining the characteristics and advantages of a hand-held unit. The following sections describe two of the most interesting peripherals—the color television interface and the modem.

The color television interface is the only peripheral that requires connection to an AC power line. But since the interface is also connected to a color TV, this is hardly a limitation. Once the interface is connected, output can be routed to the TV through the use of the I/O key.

Through the color TV, the HHC will display 16 lines of 32 characters each. Characters can be displayed in several combinations (orange or green characters on black, or black characters on either an orange or a green background). Several kinds of characters can be displayed: uppercase and lowercase ASCII letters; numbers and punctuation; graphics patterns; and katakana characters (a set of phonetic characters used by the Japanese). All characters are created in a 7 by 9 dot matrix.

The color TV interface offers two modes of color graphics: 32 by 64 pixels, or 48 by 64 pixels. The interface allows for black and eight colors (red, blue, green, yellow, orange, magenta, cyan, and buff).

The color TV interface contains a built-in RF (radio-frequency) modulator, as well as 1.5 K bytes of dynamic memory organized as two software-selectable screen images. The connection from the interface to the HHC is an interrupt-driven parallel connection.

The modem, which connects to the HHC through an interrupt-driven parallel interface, is acoustically coupled to a standard telephone handset (see photo 4). Its options—110 or 300 bps (bits per second) data transfer rate, full- or half-duplex transmission, answer or originate mode, number of start and stop bits, and parity—are all selected by software. In a daring departure from conventional modems, the HHC modem has no visible switches to set any of its options. This forces the software to control all the options and leaves nothing for you to worry with (or set incorrectly).

The HHC modem, like other HHC peripherals, is responsible for supplying standard input and output routines. (By using a uniform software interface for all peripherals, the HHC can be expected to work with peripherals that have not yet been designed.) Since the modem can be used in several ways, it is supplied with a socket in which to place a program capsule for a given application. The first capsule to be produced for the HHC modem is called "Telecomputing" and it will allow the HHC to be used as an intelligent remote terminal that is connected, through the modem, to a timesharing computer or data base. The program can be used with the small battery-operated modem directly connected to the HHC, in a hand-held configuration, or the printer and TV can be used.

The telecomputing software can use an automatic X-ON/X-OFF handshaking with a host computer so that you can regulate the rate of display to your reading speed. This protocol is supported by most popular networks such as Micronet, The Source, and Tymnet. When a printer is not connected, you can review many lines of previous interaction as they appear in the LCD display, creating, in effect, a virtual printout. Incoming *lines* longer than the 26-character LCD display are divided only at blanks. This "word-wrap" feature, combined with the review mode, assures readability with the 1-line display.

Background of the HHC

The HHC was developed as a result of a unique union of Japanese and American technology. Friends Amis, with headquarters in San Francisco, contributed the best of Silicon Valley—a software-based systems architecture, circuit design, a unique operating system and SNAP language. The company's founders, who came from Atari Inc, were responsible for introducing the now widely accepted consumer video games. Friends Amis' first product was the highly successful language translator sold by Craig, Quasar, and Panasonic; this product was quickly followed by its point of information display computer and the HHC (hand-held computer).

Matsushita, the parent company of Panasonic and Quasar, in Osaka, Japan, brought its unparalleled techniques of miniaturization, industrial design, quality assurance, and the ultimate in highly automated, high-volume, low-cost manufacturing—areas in which Japan has clearly outstripped the US in recent years. Putting the best of both worlds together has resulted in a special product that could not have been produced alone: the first hand-held computer with bus architecture, a powerful operating system, and a fast 8-bit microprocessor.

The HHC, through the color television interface, can display 16 lines of 32 characters each.

Conclusions

- The Quasar and Panasonic HHCs are certainly impressive first entries into the new market of hand-held, consumer-oriented computers. Great emphasis has been placed on human engineering. This is important for any device marketed to the general public, even more so when so many functions are being placed into such a small package.
- The HHC was designed as a basic unit augmented by an extensive complement of peripherals. This "debundled" approach allows you to buy only those peripherals you want, giving you a customized computer at minimal cost.
- Several innovations in the HHC computer allow it to have the power of conventional personal computers while retaining the portability of a hand-held unit. The use of data compression techniques and program capsules enables very large amounts of data to be contained within the hand-held unit.
- The HHC is supplied with internal application programs that include a clock, an electronic secretary that reminds you of future appointments, and a file system for user data contained completely within the programmable memory of the computer. These are nice touches that add to the utility of the computer.

A Fictional Hand-Held Computer

Duncan's Minisec had been a parting gift from Colin, and he was not completely familiar with its controls. There had been nothing really wrong with his old unit, and he had left it behind with some regret; but the casing had become stained and battle-scarred, and he had to agree that it was not elegant enough for Earth.

The 'Sec was the standard size of all such units, determined by what could fit comfortably in the normal human hand. At a quick glance, it did not differ greatly from one of the small electronic calculators that had started coming into general use in the late twentieth century. It was, however, infinitely more versatile, and Duncan could not imagine how life would be possible without it.

Because of the finite size of clumsy human fingers, it had no more controls than its ancestors of three centuries earlier. There were fifty neat little studs; each, however, had a virtually unlimited number of functions, according to the mode of operation—for the character visible on each stud changed according to the mode. Thus on ALPHANUMERIC, twenty-six of the studs bore the letters of the alphabet, while ten showed the digits zero to nine. On MATH, the letters disappeared from the alphabetical studs and were replaced by ×, +, ÷, −, =, and all the standard mathematical functions.

Another mode was DICTIONARY. The 'Sec stored over a hundred thousand words, whose three-line definitions could be displayed on the bright little screen, steadily rolling over page by page if desired. CLOCK and CALENDAR also used the screen for display, but for dealing with vast amounts of information it was desirable to link the 'Sec to the much larger screen of a standard Comsole. This could be done through the unit's optical interface—a tiny Transmit-Receive bull's-eye operating in the near ultraviolet. As long as this lens was in visual range of the corresponding sensor on a Comsole, the two units could happily exchange information at the rate of megabits per second. Thus when the 'Sec's own internal memory was saturated, its contents could be dumped into a larger store for permanent keeping; or conversely, it could be loaded up through the optical link with any special data required for a particular job.

From Imperial Earth, *copyright 1976 by Arthur C Clarke. Reprinted by permission of Harcourt Brace Jovanovich Inc.*

[Editor's Note: The 'Duncan' referred to in the first paragraph is Duncan Makenzie, the main character in Clarke's Imperial Earth. *Duncan's boyhood friend is Karl Helmer, a character whose name is a variant spelling on that of our Founding Editor, Carl Helmers. For a humorous (and somewhat eerie) commentary on the name similarity and the anticipated possibility of a hand-held computer, see Carl Helmers' editorial in the April 1977 BYTE (page 6), "How I Was Born 300 Years Ahead of My Time."]*

•The HHC retains the contents of memory even when it is turned off. In addition, you do not lose what you are working on if you accidentally hit the OFF button. These are important features that indicate the amount and depth of human engineering that has been applied to the design of the HHC.

•The HHC will be marketed aggressively by both Quasar and Panasonic. The public reaction to this device, which is the first of its kind to be marketed on such a large scale, will be carefully observed by manufacturers and may determine the extent and direction of future consumer products in this area. We feel that the Panasonic/Quasar HHC is highly qualified to receive this scrutiny and that the public response will be favorable. ■

Acknowledgment
The cover photograph and all interior photographs are by Ed Crabtree. Photo 2 is courtesy Quasar Electronics Company.

Another Pocket Computer

The internal architecture of the TRS-80 Pocket Computer is radically different from the other pocket computers now reaching the market. Instead of a single 8-bit microprocessor (such as that used in the Quasar/Panasonic HHC and the Sinclair ZX-80), the designers of the TRS-80 Pocket Computer (Sharp Electronics of Japan) decided to use two 4-bit microprocessors in a unique serial configuration.

Both microprocessors are custom CMOS (complementary metal-oxide semiconductor) integrated circuits with built-in ROM (read-only memory). The purpose of microprocessor 1 is to arrange data and make decisions. It reads the data that is keyed in or fetched from programmable memory. It is also responsible for parsing arithmetic operations and interpreting the syntax of BASIC statements. It then arranges the data and provides instruction codes to microprocessor 2 through a transfer buffer. The actual execution of an instruction is performed by microprocessor 2, which also updates the display and notifies microprocessor 1 that it has finished its function. The respective duties of the microprocessors are listed at right.

Microprocessor 1	Microprocessor 2
Key input routine	*Display processing routine* *Input buffer* *Computational result* *Error*
Acknowledgment of the remaining program	*Arithmetic routine*
One instruction to one program step incorporation	*Character generator*
Interpreter: *Program execute statement* *Cassette control statement* *Command statement* *Printer control (reserved)*	*Cassette routine* *Print routine* *Buzzer*
Execution of manual operation	*Recognition of printer (reserved)*
Power shut-off control	*Power off*
Clock stop control	*Clock stop*

Memory Organization

The programmable memory of the TRS-80 Pocket Computer is contained in four integrated circuits. There are three memory ICs, each containing 512 bytes of programmable memory. The three ICs which drive the liquid-crystal display each contain 128 bytes of programmable memory. Putting it all together, you end up with 1920 bytes of programmable memory. After you subtract memory space used for the transfer buffer, input buffer, display buffer, fixed memories, and reserved keys, you end up with 1424 bytes of user-addressable memory. Into this space you can easily fit a BASIC program of around 250 lines (average length)...SM■

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Electromagnetic Interference

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You may have noticed that certain household appliances such as a microwave oven or tools such as a power saw affect television reception when they are running. This television interference, or TVI, is caused by the electromagnetic energy which is radiated when these electrical devices are in use. The general term used to describe such noise is EMI (*electromagnetic interference*).

EMI emanates from both natural and artificial sources. Natural terrestrial EMI sources include lightning discharges, precipitation, and storms. Man-made EMI can come from electrical-power systems, rotating electrical machinery, gaseous-discharge systems, and electronic equipment such as radar, computers,

Photo 1a: *To illustrate the effects of radiated and coupled interference, a portable TV set is placed next to an operating TRS-80 Model I computer. The result is a very snowy picture, primarily the result of radiated noise. Also note a slight blurring of the characters on the TRS-80 display screen. A beat frequency caused by magnetic coupling between the two video displays causes the TRS-80 screen image to shake. In a longer exposure, the characters would be illegible.*

and television transmitters. Natural EMI is usually beyond man's control, and attempts to reduce it must be centered on the susceptible equipment. Man-made EMI, on the other hand, can be suppressed at the source—this is the most satisfactory way to eliminate interference.

Various forms of EMI are a major concern today due to the rapid growth of digital electronic processing in business, industrial, and home environments. My mail has been overflowing with questions on computer-related interference. The letters have been almost evenly divided between readers who require help in cutting down the EMI emitted from their computers and those concerned with their computers' own susceptibility to noise.

The problem has received considerable news coverage lately, due to the FCC's (Federal Communications Commission's) stepping in to regulate noise emissions from personal computers and other electronic equipment. In the past, only equipment intended for certain military applications had to meet EMI limitations. The few EMI filters that were installed were primarily intended to protect the equipment in which the filters resided from the effects of EMI generated by external sources, entering through the AC (alternating current) power lines.

The relative effect of capacitive coupling of noise is dependent upon the distance between conductors.

Little if any thought was given to attenuating electrical noise which was generated within the equipment, leaking out through a variety of coupling paths. Because of the large volume of complaints about EMI that have reached the FCC, the Commission has set new regulations on the maximum level of electrical noise that can be emitted from electronic equipment. These regulations took effect on January 1, 1981. (See "FCC Regulation of Personal- and Home-Computing Devices" by Terry G Mahn, September 1980 BYTE, page 180.)

But what about the equipment you own now? What if you have an immediate noise problem? Where do you start to solve the problem? How do you detect where the noise is coming from? How do you break the path between the noise source and the affected receiver? Should you put noise filters on every electrical outlet in the house? How does shielding work?

Answering all these questions could easily fill a book. However, because EMI is such a pressing prob-

Photo 1b: *Demonstration of the effects of shielding. We have added a line filter to eliminate conductive interference to the setup of photo 1a. In addition, two grounded copper sheets, one under the portable TV set and one to the left of it against the side of the TRS-80 video monitor, protect the TV set from radiated noise. The results can be seen as greatly improved picture quality.*

The three forms of noise coupling are conductive, common-impedance, and radiated-field coupling.

lem for many computer owners, I think it needs to be addressed nonetheless.

This article is intended as an introduction. While not endeavoring to cover all sources and solutions, it will outline the common causes and paths of noise and suggest possible methods for controlling interference. For that reason, I am not limiting the discussion merely to computer-generated EMI and related suppression methods. I hope the result will be a better understanding of the entire problem.

First, a few definitions:

- Noise: any electrical signal present in a circuit other than the desired signal.
- Noise Path: the coupling medium that conducts the noise from the source to the receiver.
- Interference: the undesirable effect of noise.
- Susceptibility: the capability of a device or circuit to respond to unwanted electrical noise.
- Receiver: any circuit or device being affected by interference.

If you own a typical computer purchased before the FCC regulations went into effect, then you no doubt have noticed that it emits considerable EMI. Depending upon the manufacturer and configuration of the system, the extent of the noise may range from a little extra fuzziness in television pictures to an actual blackout of TV reception. The effect upon nearby television sets is dependent upon the level of the emitted noise, the susceptibility of the receiver, and the coupling channel which conducts the noise from the source to the receiver.

Noise Coupling

In order for noise to be a problem, there must be a noise source, a receiver that is susceptible to the noise, and a coupling channel that transmits the noise to the receiver. The relationship is shown in figure 1a.

We start to analyze a noise prob-

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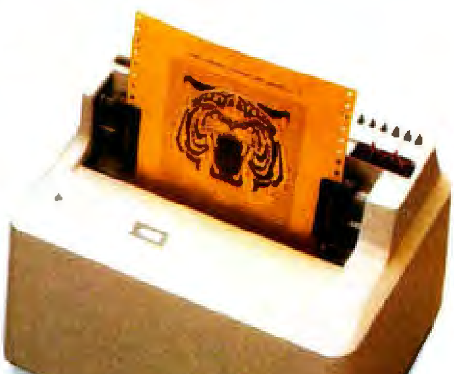

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Circle 26 on inquiry card.

lem by defining what the noise source is, what the receiver is, and how the source and receiver are coupled together. It follows that there are three ways to break the path:

1. The noise can be suppressed at the source.
2. The receiver can be made insensitive to the noise.
3. The amount of energy leaking through the coupling channel can be minimized.

There are three forms of noise coupling: conductive, common-impedance, and radiated-field coupling. Figure 1b demonstrates a typical situation. In this circuit, the commutator noise generated from the motor is both conducted along and radiated from the leads going to the motor-control circuit. Also, the motor control and the television receiving set are plugged into the same long extension cord, so they share a common line impedance. The coupling channel consists of:

- conduction on the motor power-supply leads
- radiation from the leads
- common line impedance

To eliminate the motor's influence on the TV, all three parts of the coupling path must be broken. You can apply EMI controls to any or all of these elements.

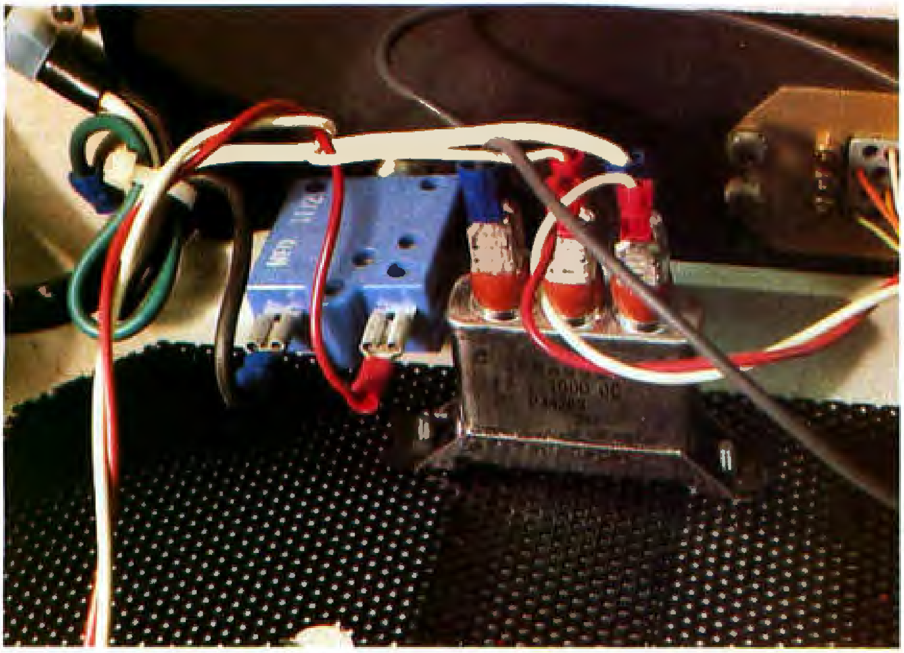
Photo 2: *The simplest method of noise reduction is to use capacitors as simple filters. This photo shows two 0.1 μF, 1000 V capacitors used to filter the AC power line in a video terminal.*

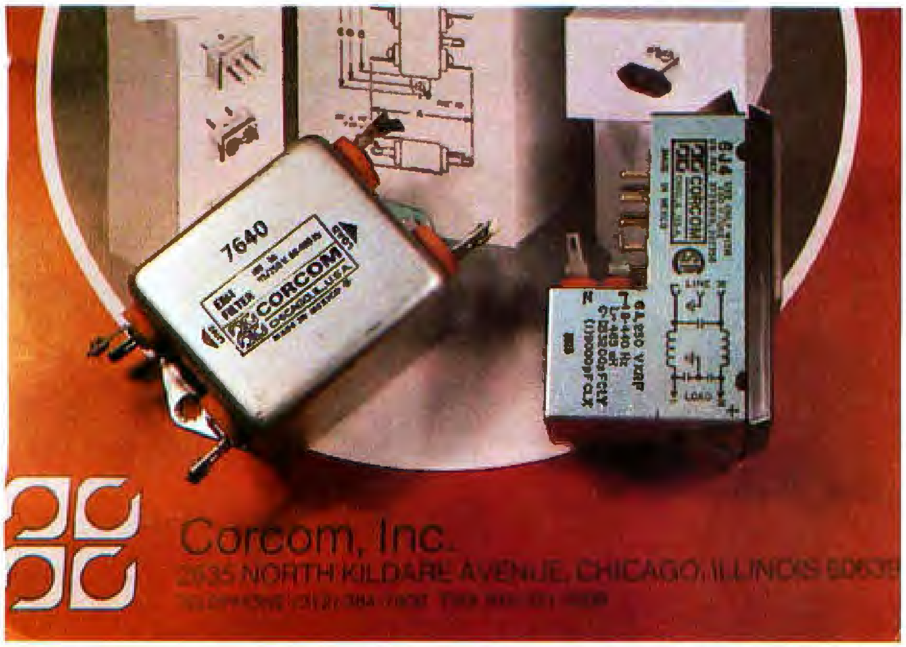

Photo 3: *Commercial power-line filters from Corcom Inc, 2635 North Kildare Ave, Chicago IL 60639. Prices range from $10 to $20.*

Conductive Coupling

Conductively coupled noise is often overlooked. A wire passing through a noisy environment picks up noise either by capacitive or magnetic coupling and conducts it to another circuit. A simple representation of capacitive coupling between two conductors is shown in figure 2. When the resistance from conductor 2 to ground, R, is large, the voltage coupled from conductor 1 to conductor 2 is defined as follows:

$$V_N = \left(\frac{C_{12}}{C_{12} + C_{2G}} \right) V_1$$

where C_{12} is the stray capacitance between conductors 1 and 2, C_{1G} is the capacitance between conductor 1 and ground, C_{2G} is the capacitance between conductor 2 and ground, R is the resistance from conductor 2 to ground, V_1 is the interfering voltage, and V_N is the noise voltage produced on conductor 2.

Even though this may appear small (perhaps a few microvolts), remember that some receivers amplify input signals thousands of times. A few microvolts of noise on the antenna terminals of a television set could easily be greater than the desired video signal.

Figure 3 shows the effect of conductor spacing on capacitive coupling. The coupling factor is said to be 0 dB (decibels) when the two conductors are separated by a distance equal to three times the conductor diameter (for 22-gauge wire, d=0.71 mm or about 0.028 inches); the factor decreases rapidly as the spacing increases. Separating wires reduces the capacitive coupling between them. However, little is gained by spacing

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Figure 1a: *The general case of the transmission of electrical noise.*

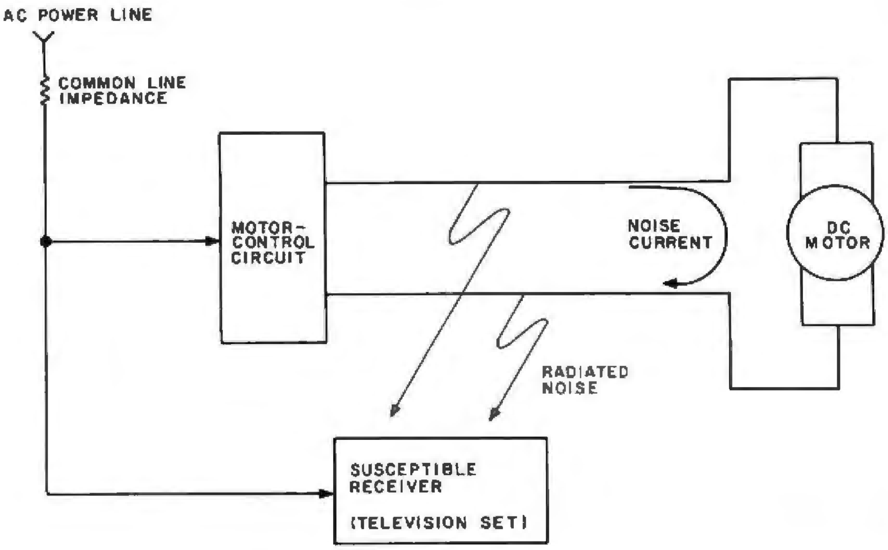

Figure 1b: *A typical noise-coupling situation: commutator noise generated by the motor is conducted along and radiated from the connecting leads. Common line impedance shared by the receiver (a television set) and the motor cause motor noise to be imposed on the receiver's power input.*

C_{12} = *stray capacitance between conductors 1 and 2*
C_{1G} = *capacitance between conductor 1 and ground*
C_{2G} = *capacitance between conductor 2 and ground*
R = *resistance from conductor 2 to ground*
V_1 = *interfering voltage*
V_N = *noise voltage produced on conductor 2.*

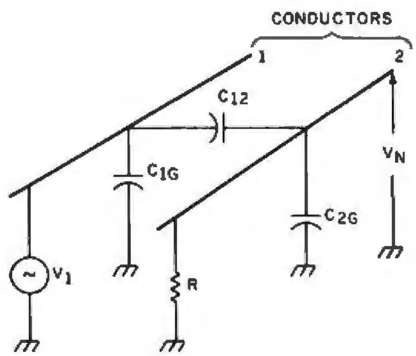

Figure 2: *Representation of capacitive coupling between two conductors. The definitions of the symbols are listed above.*

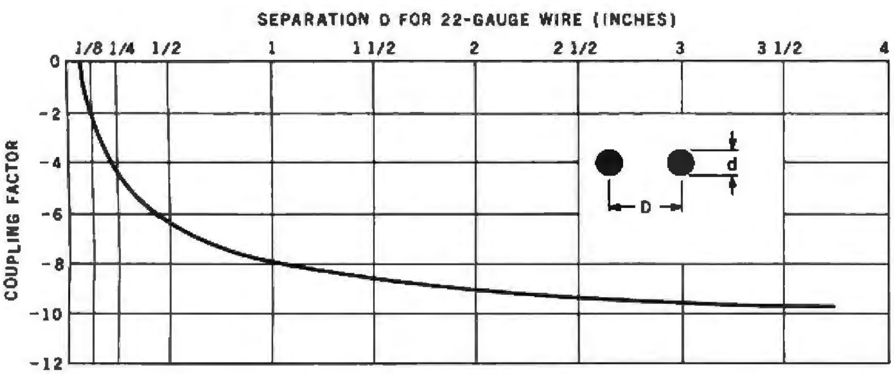

Figure 3: *The relative effect of capacitive coupling of noise is dependent upon the distance between conductors. In the chart shown, for 22-gauge wire, coupling is significant only when the conductors are closer together than 25 mm (1 inch).*

the conductors more than 40 diameters apart (about 25 mm or 1 inch).

Magnetic Coupling

Magnetic coupling is also a problem. When a current flows in a closed circuit, it produces a magnetic flux which is proportional to the current. If two wires are parallel, the flux produced in one wire will induce a voltage in the second wire. This induced voltage constitutes noise. When you are running wires between sensitive electronic components, avoid laying signal wires parallel to noisy, high-current AC power lines. If a signal line *must* cross a power line, have it do so at a right angle.

Common-Impedance Coupling

Common-impedance coupling occurs when currents from two different circuits flow through a common impedance. Two examples of this type of coupling are shown in figures 4 and 5. In figure 4, the ground currents of both circuits flow through a common ground impedance. The ground potential of circuit 1 is modulated by circuit 2, and vice versa. Any fluctuations in the ground current of circuit 2 will be coupled through the ground impedance, X_G, to circuit 1.

Another example is the power-distribution schematic diagram shown in figure 5. Any change in the current required by circuit 2 will affect the voltage at the terminals of circuit 1. This effect is due to the common impedance of the power-supply lines and internal source impedance, R_S, of the power supply. Shorter leads will help reduce the line impedance, but the source impedance always remains. The typical computer system plagued with common-impedance noise is one where the builder has attempted to use the processor power supply to run everything, including peripherals. The apparent economy is outweighed by periodic system crashes and unpredictable errors.

Radiated-Field Coupling

Radiated electric and magnetic fields provide the last form of coupling. This form of coupling can be most easily thought of as free-air radio transmission. The interfering circuit broadcasts noise just like a radio station, and every conductive surface in the receiver acts as an antenna. At close distances, the noise can in fact be much stronger than a real radio station. [*Many readers*


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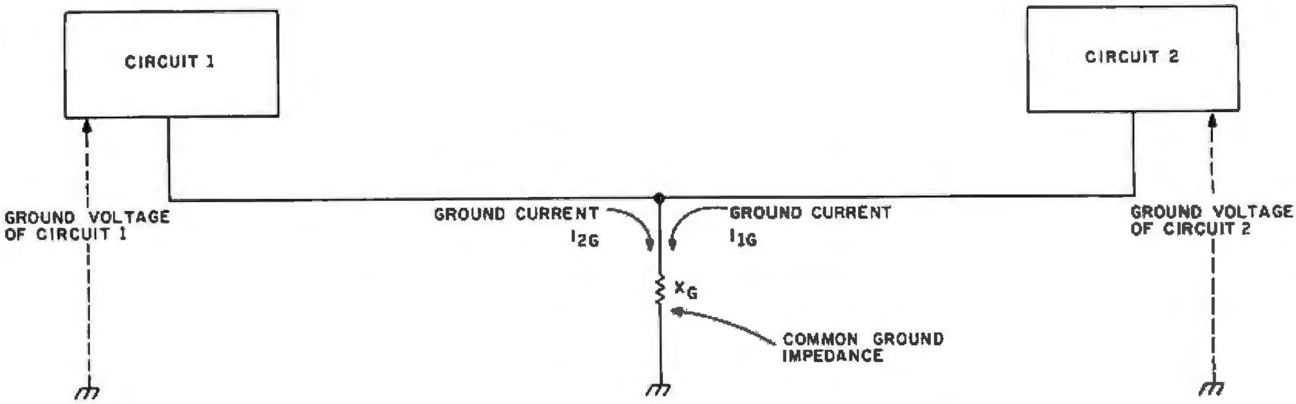


Figure 4: *Common-ground-impedance coupling is caused by two pieces of equipment using the same electrical lead to ground. The ground current of one influences the ground-reference voltage of the other, and vice versa. One solution to this is a single-point grounding system.*

*probably know of methods for generating computer music by using an AM radio to pick up computer-emitted noise while the appropriate program runs...*RSS]

The characteristics of a field are determined by the source of the field and the distance between the source and the point of observation. When the receiver is *near-field*, closer than 1/6 wavelength, the electric and magnetic fields are considered separately. Any source/receiver distance greater than 1/6 wavelength is *far-field*, and the electric and magnetic fields are considered together and are called simply the electromagnetic field.

At frequencies below 1 MHz, most coupling is near-field, because the near-field boundary at the corresponding wavelengths extends out to approximately 45 meters (150 feet) or more. At 100 MHz, most coupling is far-field. For purposes of this discussion, however, radiated-field-interference problems within any given piece of equipment should be considered to be caused by near-field radiation unless the interference is clearly from far-field radiation.

Finding and Fixing a Noise Problem

The key to solving a noise problem is finding the source of the noise. In fact, your computer might not be the culprit. More than one computer owner has suffered complaints about his "computerized noise generator" only to later find that the real source of the interference was the solid-state light dimmer on the overhead light.

Continuous sources of noise are easier to identify than intermittent ones. The interference from appliances and computers is usually broadband, affecting the entire radio-frequency spectrum. Digital waveforms are especially rich in harmonic frequencies, as shown in figure 6. Therefore, the continuous, harmonic-rich emissions of computers are relatively easy to find.

A standard battery-operated AM radio makes a good EMI detector. With it tuned to a frequency at which the noise is the loudest, just roam around the house looking for the place where the interference is the strongest.

If you suspect the computer, then move the radio around it and along the connecting cables. You will be surprised how much the cables contribute to radiated noise. Disconnect cables and peripheral devices selectively to further isolate interference sources. Often, the long leads between the computer and printer emit electromagnetic radiation as well as any transmitting antenna you could have possibly designed.

Finally, move the radio along the power cord you have supplying the computer system. If you are using a 15-meter (50-foot) extension cord without the ground lead connected, shortening the cord will reduce radiation considerably.

If the computer system is indeed found to be the source of the interference, there are a variety of possible coupling paths. The coupling efficiency of digital interference is proportional to frequency; the higher the frequency, the greater the interference. Depending upon the design, these interfering signals can radiate from the source, couple from line to line, or be conducted directly through connecting wires to the external environment. Each noise path must be suppressed.

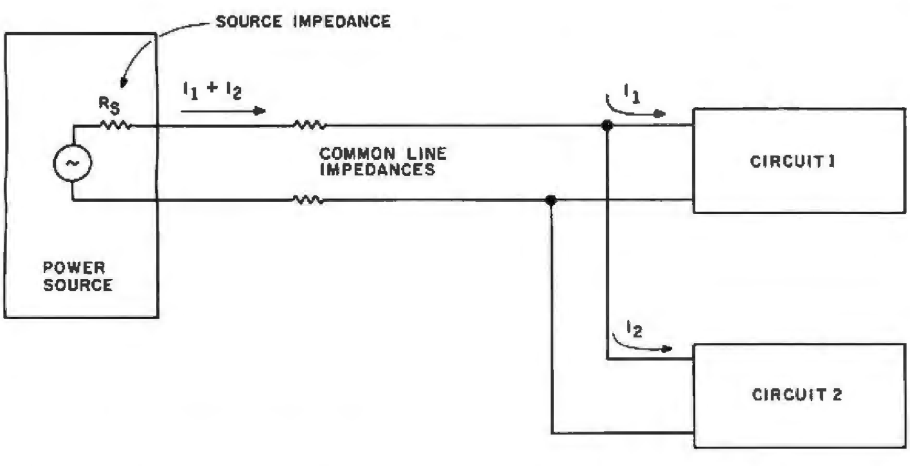
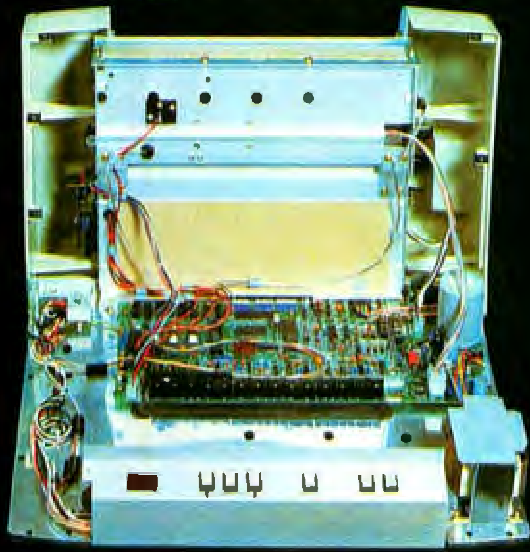


Figure 5: *Common-power-source coupling occurs within a computer that uses a single power supply for multiple peripheral devices. Due to the impedances on the connecting lines, the current drawn by one circuit changes the voltage "seen" by another circuit.*

Grounding

Grounding is the primary way to

Say Ahh...



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minimize unwanted noise and pickup. It is often the optimal solution to most problems. There are two basic objectives in designing proper grounding systems. The first is to minimize the noise voltage generated by currents from two or more circuits flowing through a common ground impedance; the second is to avoid creating ground loops which are susceptible to magnetic fields and differences in ground potential. This ground is the reference point for all voltages in the system.

Signal grounds are generally classified as either single-point or

Photo 4: *Switching-type power supplies, which use high-frequency pulse-width-modulated waveforms, are a potential source of noise. Most often they are contained in shielded enclosures, as in the Apple II, to eliminate possibly interfering radiation.*

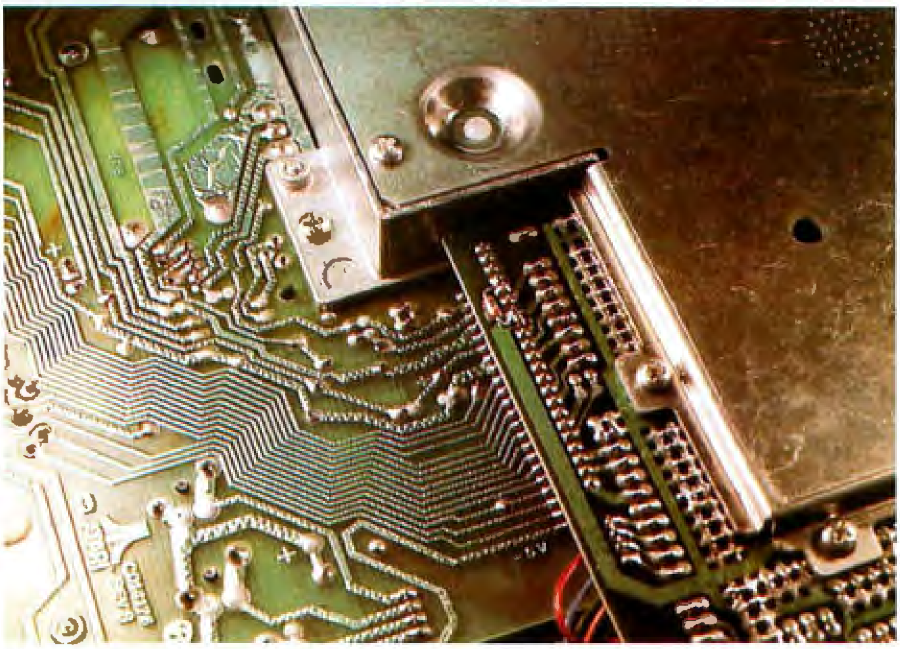

Photo 5: *The Atari 400 and Atari 800 personal computers are designed to eliminate any forms of EMI coupling and to meet the new FCC standards. This requires considerable shielding. The high-frequency processor and memory sections of the printed-circuit board are segregated from the power supply and I/O (input/output) areas. A heavy-gauge aluminum enclosure encircles the high-frequency sections, as shown in this Atari 800.*

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multipoint grounds. From a noise-reduction point of view, the single-point ground is more desirable. Normally, with equipment operating at frequencies below 1 MHz, a single-point system is used. Above 10 MHz, a multipoint ground is best, to minimize ground impedance. Between these bounds, the type of grounding depends on the system configuration and layout. For personal computers, single-point grounding is advised.

The AC power ground is of little practical value as a signal ground. It is usually connected to signal ground as a safety measure only.

Shielding

When properly used, shielding is an effective means of reducing the coupling of noise between conductors. Shields consist of a variety of conductive materials (usually steel, copper, or aluminum), all of which serve in some way to reflect, absorb, or otherwise channel noise currents away from the protected conductor. Shields may be placed around components, circuits, complete assemblies, cables, or transmission lines.

A parallel-tuned trap cannot be used for broadband computer-generated noise.

The best way to minimize radiated noise and susceptibility on connecting wires is to use coaxial cable (coax) or shielded twisted-pair cabling between peripheral devices and the processor. If the coaxial-cable shield is grounded at one end, it will protect the central conductor from electric-field radiation. Grounding the shield at both ends creates a *return current* in the shield, which generates a field that cancels the conductor's electric field and any magnetic interference as well.

In twisted-pair shielded wire, grounding the shield at one end takes care of electric fields, while twisting the conductor with the return line serves to reduce magnetic susceptibility. (Twisted-pair shielded wire is especially useful on low-level signals.) The number of twists per foot determines the insensitivity to magnetic fields.

When comparing coaxial cable and shielded twisted-pair cable, it is important to recognize their differences in signal propagation, irrespective of their shielding characteristics. Shielded twisted-pair cable is very useful at frequencies below 100 kHz. Above 1 MHz the signal losses are considerable.

Coaxial cable, grounded at one end, provides a good degree of protection from capacitive pickup and can be used at all frequencies from DC (direct current) to UHF (ultra-high frequencies). However, due to the potential for noise currents to flow *through* the shield (which is also part of the signal path), coaxial cable is better used at higher frequencies where such errors are minimized. Shielded twisted-pair cable, on the other hand, does not exhibit this problem and should be used for conducting low-frequency signals.

An unshielded twisted pair, unless it is balanced, provides very little protection from capacitive pickup, but can still be good for magnetic-field protection. Plain untwisted-pair cable, such as the zip cord you might purchase from a hardware store, provides no electromagnetic-field protection and should be avoided if you have a noise problem.

Multiple-conductor cables, including ribbon cables, are also available in twisted-pair configurations. A common cable used in data acquisition is a twelve-conductor shielded cable that consists of six twisted pairs surrounded by a single foil or braided shield. This cable is very expensive, however, and it is best acquired on the surplus market.

Shielding the connecting cables may eliminate only part of the problem, especially if you determine that the major source of radiation is the computer. Most computers are encased in metal chassis. If these are not properly grounded, the benefits of the metal as shielding material are lost.

On the other hand, if the computer is encased in plastic, the only solution is to coat the inside (or the outside) of the case with a conductive substance and connect it to signal ground. Aluminum foil, for example, could be used, but I suggest that you try all the other suppression measures before attempting this.

Encasing the entire computer in a conductive enclosure is not unthinkable. In fact, newer small computers such as the Atari 800 and Hewlett-Packard HP-85 are built ex-

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actly that way. It is very effective in both containing the computer's electromagnetic fields and protecting the computer circuitry from external noise. When an EMI field impinges on a shield, some of its energy is reflected at the first surface, some is absorbed by the shield material, some is reflected by the second surface, and some passes through. In general the following is true of enclosure-type shielding:

- Magnetic fields are harder to shield against than electric fields. Magnetic material should be used to shield against low-frequency magnetic fields.
- At high frequencies, a good conductor suitably shields against both elec-

Summary of Noise-Reduction Techniques

Suppressing noise at the source:

1. *Enclose noisy sources in a shielded enclosure.*
2. *Filter all leads leaving a noisy environment.*
3. *Shield and twist noisy leads.*
4. *Ground both ends of coaxial-cable shields to suppress radiated interference.*
5. *Limit pulse-rise times where possible.*

Eliminating noise coupling:

1. *Twist and shield signal leads.*
2. *Ground shielded leads used to protect low-level signals at one end only.*
3. *Avoid ground leads in common between high-level and low-level equipment.*
4. *Keep ground leads as short as possible.*
5. *Separate noisy and quiet leads.*
6. *Use a single-point grounding system.*
7. *Avoid ground loops.*
8. *Keep sensitive-signal leads as short as possible.*

Reducing noise at the receiver:

1. *Use frequency-selective filters where applicable.*
2. *Use shielded enclosures for sensitive circuitry.*
3. *Provide proper power-supply filtering.*
4. *Separate signal and hardware grounds.*
5. *Use shielded cables to protect low-level signals.*

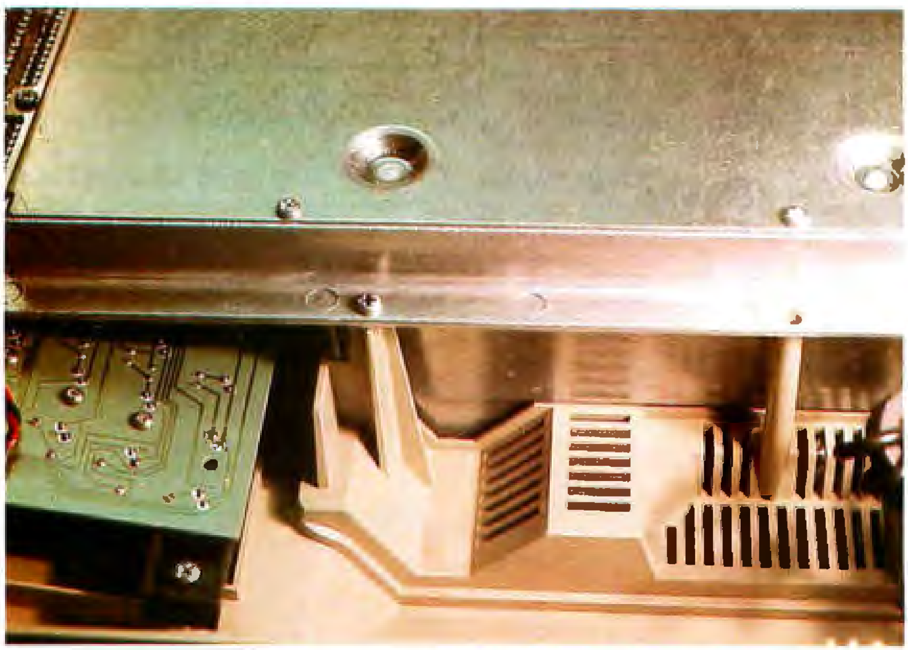

Photo 6: *The underside of an Atari 800. Metal plates enclose the processor and memory. The green printed-circuit board on the lower left contains the keyboard circuit. Since it runs at low frequencies, it does not require a shielded enclosure.*

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tric and magnetic fields.

- Shielding effectiveness is increased with thicker shielding material.
- In practice, actual shielding effectiveness obtained is determined by the leakage through seams and joints, not by the shielding effectiveness of the material.

Filtering

Grounding and shielding were prescribed to eliminate noise at the source. The final measure, filtering, is applicable either at the source or at the receiver. Filtering is generally the easiest form of noise abatement. It is primarily used to reduce noise con-

Photo 7: *The Atari computers allow the user to plug in special game and business program cartridges. These ROM packs (read-only-memory modules), which are connected directly to the processor bus, must also be kept within the shield when the computer is running. This is accomplished using a special molded, ⅜-inch (9.5 mm)-thick socket that is electrically part of the shield. A plate of aluminum with conductive gasket material around the edges is attached to the cover. When the cover is closed, the memory is completely shielded and virtually no electrical noise is emitted.*

Photo 8: *To reduce any high-frequency harmonics that might radiate from the video-monitor cable, a toroidal ferrite core may be wrapped in the line.*

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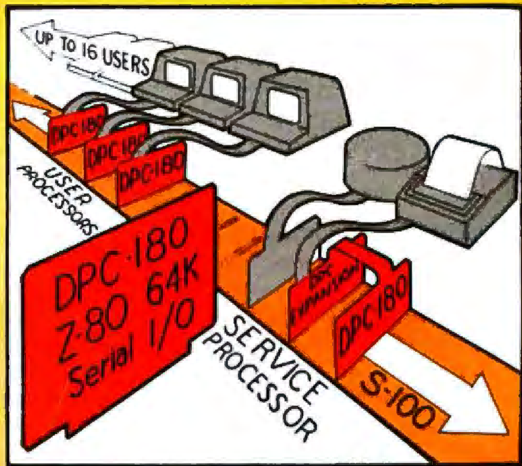

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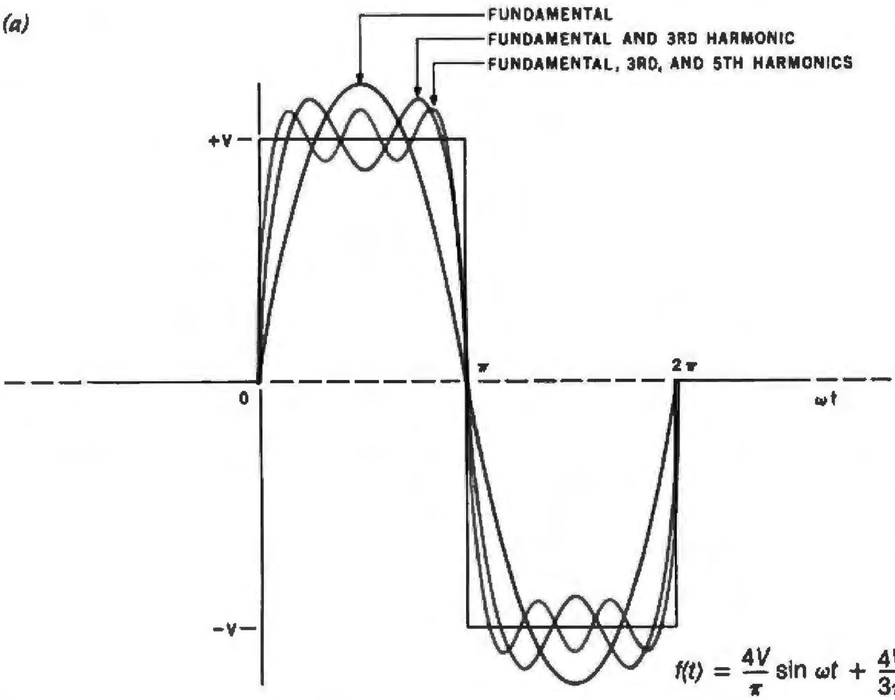

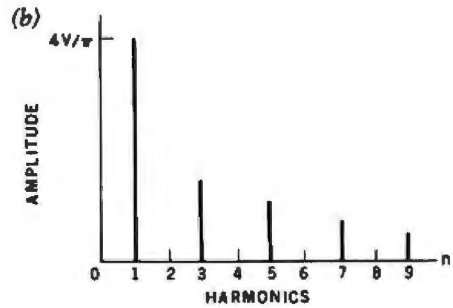

Figure 6: *Within the computer and between peripherals, signals are digital. (6a) Such signals are square waves with very fast rise times, composed of the fundamental frequency, ω, and all the odd harmonics of the fundamental frequency. In a computer with a clock frequency of 8 MHz, there will be radiated noise at 8 MHz, 24 MHz, 40 MHz, etc. (6b) The amplitude becomes less at each higher harmonic.*

$$f(t) = \frac{4V}{\pi}\sin \omega t + \frac{4V}{3\pi}\sin 3\omega t + \frac{4V}{5\pi}\sin 5\omega t + \frac{4V}{7\pi}\sin 7\omega t + \ldots .$$

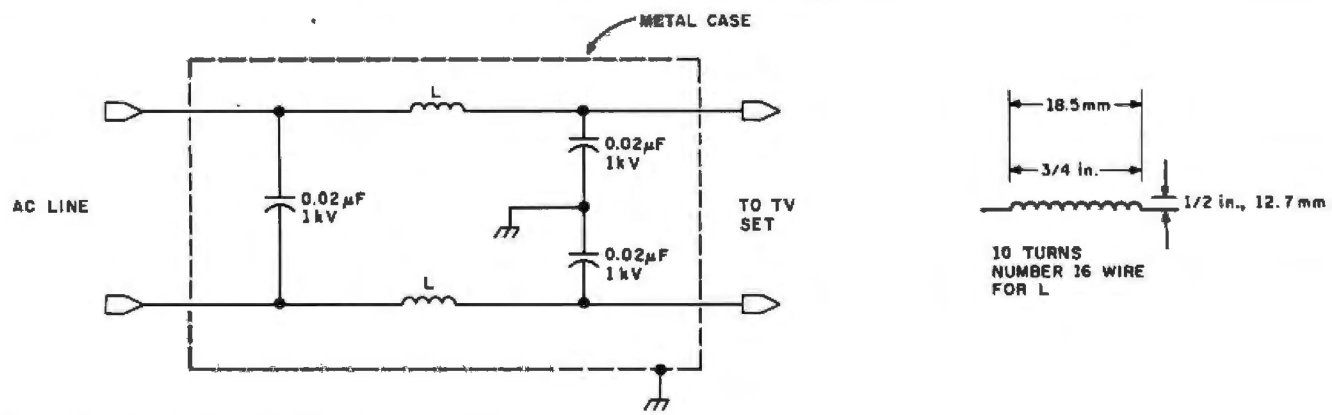

Figure 7: *A simple low-pass line filter with homemade inductors.*

duction into or out of the AC power lines.

A circuit used as a power-line filter is a low-pass filter ideally designed to supress all frequencies above 60 Hz. Such filters are commercially available from many sources but are also easy to construct.

If you prefer to build a simple line filter, figure 7 shows the schematic diagram of a typical circuit. This circuit is applicable for use in instances of minor television interference. It should clear up most line-coupled noise problems.

As a practical matter, simple line filters are less than ideal. Typical commercial single-section line filters use toroidal inductors and provide about 55 dB of attenuation at 3 to 5 MHz. Attenuation can be typically increased to 70 dB by adding a second LC (inductance/capacitance) section. A line filter should be used on the computer and any susceptible receivers.

If your TV reception is still garbled or nonexistent after you install a line filter, then your set is picking up radiated noise through the antenna input. Generally, you will find the VHF (very-high-frequency) channels to be affected much more than the UHF channels. This is because most of the noise energy generated by the computer is at frequencies below 100 MHz (VHF channels 2 thru 6 are between 54 and 88 MHz). At frequencies above 470 MHz, where channel 14 starts, there isn't much energy in the noise spectrum.

The process of eliminating radiated-noise pickup starts with replacing the 300-ohm twin-lead cable from the antenna to the television receiver with 75-ohm coaxial cable. If the problem persists after you do this, then additional filtering is in order. If the noise is determined to be a single frequency, such as that emitted from a Citizens' Band radio transmitter next door, then a parallel-tuned trap that singles out this one frequency should be used. Figure 8 shows such a filter circuit.

Computer-generated noise is broadband rather than narrow-band. A parallel-tuned trap cannot be used, and a different filtering technique must be employed. A high-pass filter on the set's antenna input may be needed. The system clock frequency of most computers is between 1 MHz and 8 MHz. Harmonics will, of course, reach much higher frequencies. The harmonic amplitude


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The decision is...

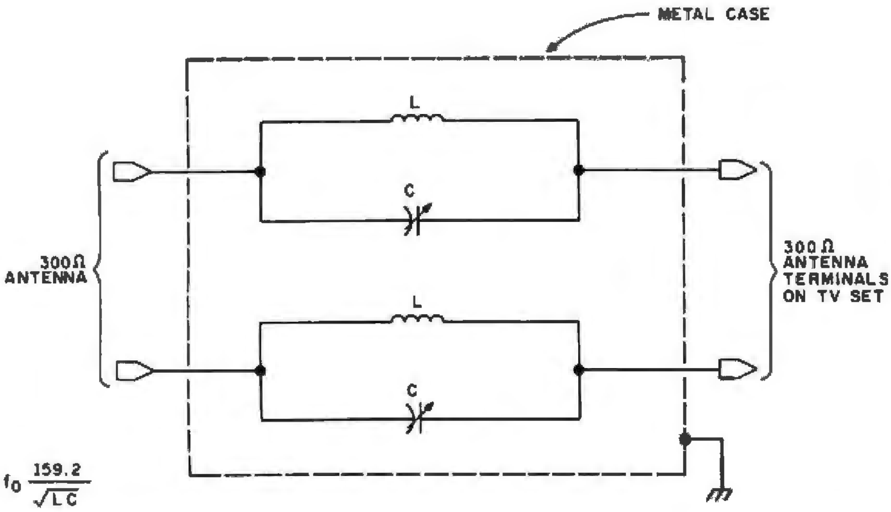

Figure 8: *A parallel-tuned trap filter for use on FM-radio or television sets. Each LC combination is set for resonance at the frequency that is causing the interference. Trap filters are suitable only for eliminating narrow-band interference such as that from Citizens' Band radio transmitters.*

Here, the center frequency trapped by the filter can be calculated from the equation $f_0 = 159.2/\sqrt{LC}$, where f_0 is the resonant frequency in Hertz, L is the inductance in microhenrys, and C is the capacitance in microfarads.

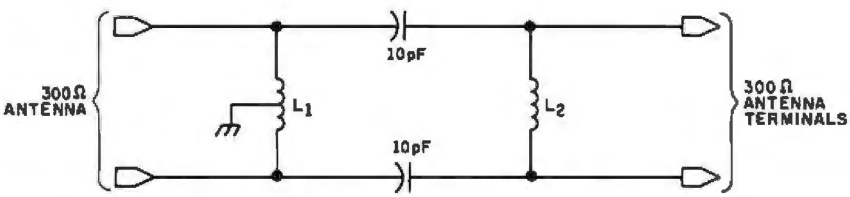

Figure 9a: *A high-pass filter for use with 300-ohm antenna cable. A high-pass filter can be used on television-receiving sets and FM-radio receivers to reduce or eliminate noise at frequencies under 50 MHz, such as that produced by personal computers. These filters pass frequencies above 54 MHz (where the VHF-TV broadcast band lies) and attenuate any lower frequencies where noise may reside.*

In this design, the inductors L_1 and L_2 are made from eight turns of 18-gauge wire in a coil 19 mm (¾ inch) in diameter, 25.4 mm (1 inch) long.

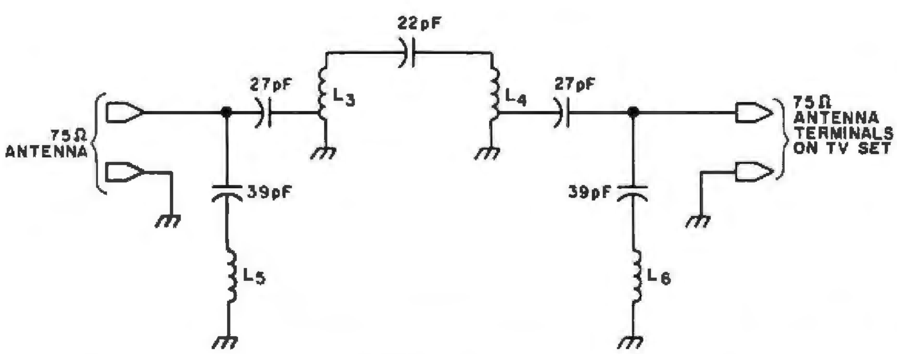

Figure 9b: *A high-pass filter for use with 75-ohm coaxial antenna cable. In this design, inductors L_3 and L_4 are made from four turns of 14-gauge wire in a coil 6.35 mm (¼ inch) in diameter and 12.7 mm (½ inch) long, tapped one-half turn from the end. Inductors L_5 and L_6 are made from ten turns of 22-gauge wire in a coil 6.35 mm (¼ inch) in diameter, with the turns spaced at 3.175 per cm (8 per inch).*

diminishes with each successive frequency multiplication.

If we can presume that practically all of the radiated noise is below 54 MHz where channel 2 starts, then we can construct a filter that passes only the frequencies above 54 MHz. The filter should actually be set for a cutoff frequency of 45 MHz to reduce attenuation at the desired frequencies above 54 MHz. In combination with coaxial cable, the high-pass filter usually remedies 80% of all interference problems. Figure 9 shows the schematic diagram of a typical high-pass filter.

The use of a coaxial cable, a line filter, and an antenna filter should get you out of the digital doghouse.

In Conclusion

EMI is but one of the many problems confronting computer users. I have only touched on a few of the basics in this short article, with my concern obviously centered on the effect the computer has on other equipment. I hope that I have provided you with some solutions.

The effect the environment has on the computer is an entirely different matter. You have probably noticed that I have tactfully avoided discussing things like voltage spikes, line fluctuations, frequency variations, and line interruptions. While often included in the consideration of EMI, problems of power-line performance is an entirely different subject, requiring different solutions.

Noise filtering may improve your relations with your neighbor, and reduce the susceptibility of your equipment to transients, but it will do nothing to save you from the power company. It remains for me to cover this latter problem in a separate discussion.■

Next Month:

Milton-Bradley's Big Trak is a clever toy. Wireless remote control makes it even more clever.

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for the articles he presents each month. These articles are available in reprint books from BYTE Books, 70 Main St, Peterborough NH 03458.* Ciarcia's Circuit Cellar *covers articles appearing in BYTE from September 1977 thru November 1978.* Ciarcia's Circuit Cellar, Volume II *presents articles from December 1978 thru June 1980.*

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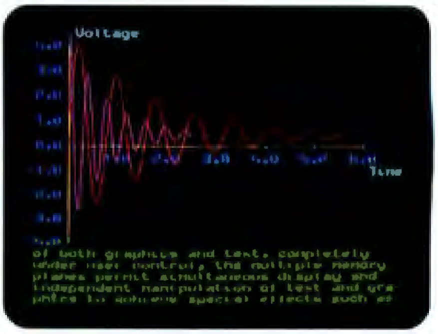
While some of the features of Terak's new 8600 can be found in other computer graphic systems, no other system in the $5K-$20K price class (and even those costing thousands more) provides a comparable combination of features and benefits. Features such as

Low Entry Cost The basic 8600 color system is priced at about $15,000. It can be upgraded to higher resolution and a greater number of colors, but even fully expanded it still comes in at less than $19,000.

Or, you can start with a black and white system for less than $8,500 and upgrade to color at any time by the addition of a color processor and monitor.



Simultaneous Graphic/Text Display

The 8600 offers outstanding control and formatting of both graphics and text. Completely under user control, the multiple memory planes permit simultaneous display and independent manipulation of text and graphics to achieve special effects such as overlays, scrolling and zoning. This capability, in conjunction with Terak's unique flexible character generation, enables the 8600 to present visual displays that are unequalled by any other system of its class.

Broad Spectrum of Color Selection

The number of color maps and the colors in each map is completely under software control. With a 6-plane memory (640 x 480 x 6), up to 64 colors can be displayed on the screen simultaneously. With a 3-plane memory (320 x 240 x 3), up to 8 simultaneous colors can be displayed from any one of eight color maps. The output of the color map produces eight levels each for red, blue and green. The result is the selection of 512 possible levels of intensity, saturation and hue. Switching from map to map is under software control.

Zoning

The 8600 monitor screen can be divided into a maximum of four variable size zones. In a typical application, the upper three zones can display graphics while the lower zone displays text. The text can be scrolled or slow scrolled while the graphics are changing to coincide with the text changes.

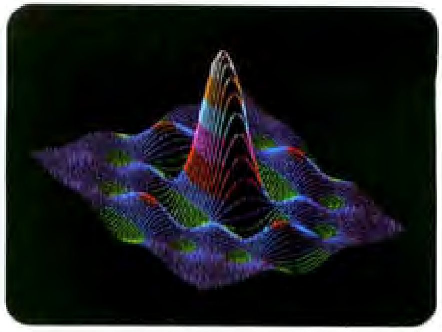
Dual Processors For Speed and Flexibility The two 16-bit processors (each with its own memory) are assigned those tasks which they can accomplish most efficiently and with the fastest throughput. The result is more available user space in memory, faster processing and increased flexibility of operation.

DEC Based Hardware and Software The DEC based hardware and software includes the LSI-11 main processor, RT-11 operating system and Q bus compatibility. As a result, the 8600 will support a variety of software and easily integrates peripheral devices.

USCD Pascal, Too The 8600 also supports the easy to use USCD Pascal operating system for program development, text editing, word processing and interactive applications.

Siggraph Core Standards, 2D1 Level Graphic support is provided for USCD Pascal and RT-11 for Fortran, Basic and Pascal.

The Other Reasons? Add such things as graphics display list processing, a high resolution quadrant, four modes of display blanking, emulation, remote on-line diagnostics, etc. The list goes on and on. But to fully appreciate the system you should see one in action. We'll be happy to set up an appointment. Just contact us.



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DYNAMIC FEATURES

The 8600 also offers several dynamic features that are impossible to illustrate and must be seen to fully appreciate.

Flexible Character Generation

Unlike the rigid cell sizes of many graphic display systems, the 8600 character generation is under software control. Characters can be programmed to any size or shape including the creation and display of foreign languages such as Arabic, Hebrew, Russian, etc., mathematical symbols, primitives, specially configured letters, characters or symbols and a host of others.

Fill Algorithms

Terak's fill algorithms are fast and allows you to fill the inside of simple or complex geometric figures without calculating points. This not only helps define charts, graphs, etc., but greatly enhances the appearance of presentation material.

Smooth or Line Scrolling

The speed of the vertical, bi-directional scrolling is under operator control. It can be slowed down for text editing or speeded up for search. And, unlike most terminals that jump a line at a time, the 8600 moves in increments of one scan line. The result is a smooth moving text that is easy to read.

External Video Synch

The 8600 can be synchronized to receive externally generated RGB signals or transmit 8600 signals to external video monitors. This lets you combine and/or overlay internally and externally generated characters and graphics onto a single screen if mixing hardware is incorporated in the system.

The NEC PC-8001: A New Japanese Personal Computer

Michael Keith
D46 Abbington Dr
Hightstown NJ 08520

C P Kocher
505 South 42nd St
Philadelphia PA 19104

One of the products attracting a lot of attention at the 1980 NCC (National Computer Conference) in Anaheim, California was the PC-8001 personal computer produced by NEC (Nippon Electric Company). Because this well-made little machine has been selling briskly in Japan, NEC was trying to gauge consumer reactions to the PC-8001 that would aid them in deciding whether or not to sell it in the US.

This article is based on our evaluation of a PC-8001 that some colleagues purchased in Japan. When we first received it, we were bewildered because all the instructions and documentation were in Japanese (with only the BASIC commands in English). After several months of poking, playing, and progamming, some syllable-by-syllable transliterations of the katakana (a Japanese syllabary) instruction manual, and a few puzzled visits to Hiro, a Japanese-American co-worker, we believe that we have a good understanding of the PC-8001's most important features, its strong points, and its limitations.

Photo 1 shows the basic components of the computer. It consists of two units: a keyboard (including both the processor and memory) and

The processor is an NEC version of the Z80 running at 4 MHz.

a color monitor, and it features a 24 K-byte version of Microsoft BASIC in ROM (read-only memory). The dollar equivalent prices of the keyboard unit and monitor are $700 and $910, respectively. *[These prices, however, may be only distantly related to the final price of the American version of this microcomputer....GW]*

Keyboard

The eighty-two-key keyboard has a high-quality standard English alphabet keyboard, five user-definable function keys, and a separate numeric keypad. In the normal mode, the user can enter uppercase and lowercase Roman characters; if he presses a locking shift key, he can enter characters in the Japanese katakana syllabary as well. Pressing a letter key and the nonlocking "graph" key causes one of a set of graphic characters to be displayed; this set includes bars, arcs, crosses, hearts, spades, clubs, and diamonds. (Although the katakana character set may appear useless to most American users, the characters are visually interesting and nicely augment the set of graphics characters.) All the characters available are shown in photo 2. There is also a reset button on the back of the console, so it can't be hit accidentally.

Inside the keyboard unit, the most noticeable feature is the switching power supply, which is mounted in a long, thin metal cage (approximately 38 by 6.35 by 3.175 cm [15 by 2½ by 1¼ inches]) extending along the entire rear of the keyboard enclosure. (See photo 3.) The elongated shape allows the entire power supply to be suspended over the printed-circuit board under the only portion of the cabinet that can be vented. During operation, however, the power supply remains cool.

The 22.9 by 38.1 cm (9 by 15 inch) printed-circuit board has three layers, but the center layer does not appear to be nearly as extensive as the other two layers. There are at least sixteen test-point posts staked into the board.

Most of the integrated circuits are mounted directly on the board, but the circuits that are either expensive or might have to be replaced (the memory, central processor, DMA [direct-memory access] controller, USART [universal synchronous/asynchronous receiver-transmitter], video display device, and font memory) are all in sockets. The board is easy to remove because all connections to it—power, keyboard, beeper—are made with plugs and sockets; there are no external connections or even jumpers soldered to the board.

The processor is an NEC version of the Z80 running at 4 MHz. The BASIC ROM occupies the 24 K bytes of memory from hexadecimal 0000 to 5FFF, and hexadecimal locations 6000 to 7FFF are available for an expansion ROM. Standard programmable memory extends from hexadecimal locations C000 to FFFF, with locations 8000 to BFFFF available for expansion. The board has empty sockets available for both expansion ROM and programmable memory. A time-of-day clock is included on the board (see figure 1).

The video controller is a custom NEC integrated circuit. There are two separate video output connectors on the back of the keyboard unit. A 5-pin DIN (Deutsche Industrie Norm) connector provides a baseband video signal for a black and white monitor and a similar 8-pin connector provides red-green-blue signals for a color monitor. With a black and white display, colors appear as different shades of gray.

In addition to a video-out signal and ground, the 5-pin connector provides V_{DD} (+12 V) and horizontal and vertical sync signals. The 8-pin connector provides V_{DD}, ground, color-clock signal, horizontal and vertical sync signals, and red, green, and blue signals. Although the color monitor has an audio amplifier and speaker, the processor does not use them. The only sound made by the PC-8001 is provided by a 2-inch speaker mounted on the power supply. The user can only control the duty cycle of a fixed-frequency beeper.

Another DIN connector and an adapter cable provide an interface to any standard cassette recorder for program loading and storage. The encoding scheme is 600 bps (bits per second) FSK (frequency shift keyed) Kansas City format (which uses 1200 and 2400 Hz frequencies). This encoding scheme is very robust—unlike many computers, almost any volume setting on the tape recorder is okay. A relay inside the console controls the tape recorder motor (or any other motor for that matter—a MOTOR command in BASIC allows a user to toggle this relay).

A 16-pin socket on the printed-circuit board serves as an RS-232C connector, while cutouts at the back of the cabinet give access to a pair of edge connectors on the board. One is for a printer and one is a DMA channel. An expansion unit is available to interface the DMA channel to up to four disk drives, two RS-232C serial

Photo 1: *The NEC PC-8001 personal computer system. Shown here is the basic system: high-resolution color monitor, keyboard unit, and documentation (reference manual, BASIC manual, and BASIC reference card).*

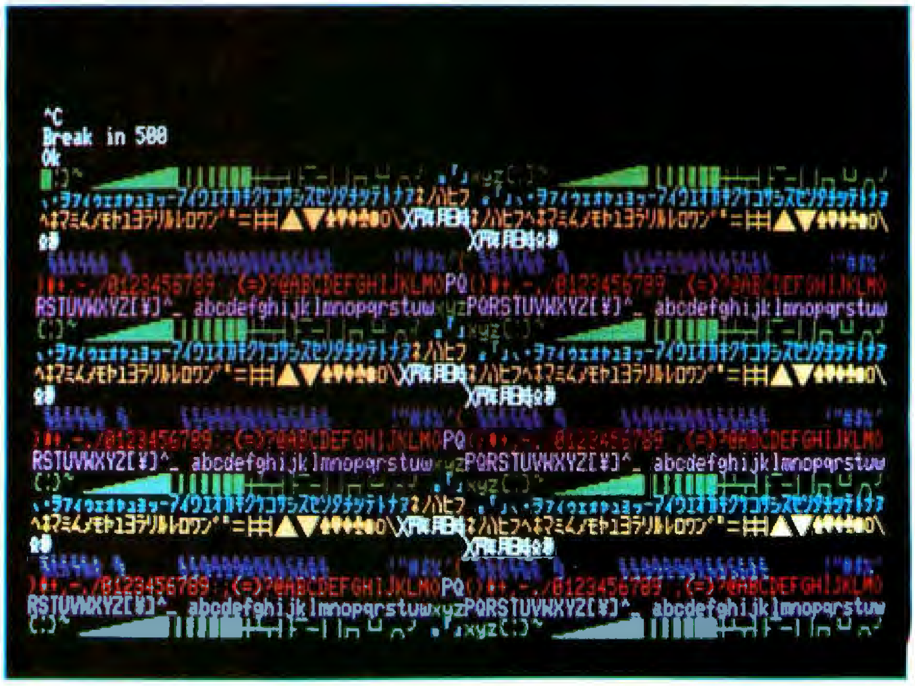

Photo 2: *A display illustrating the colors and the character set on the PC-8001. In addition to complete ASCII, there are various graphics characters, control characters, and katakana characters.*

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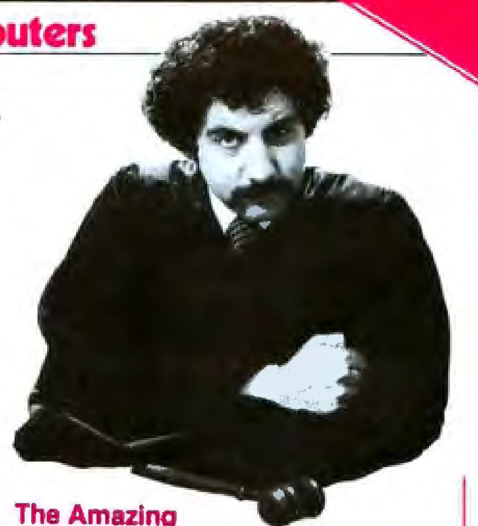

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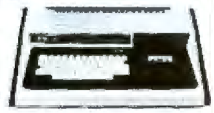

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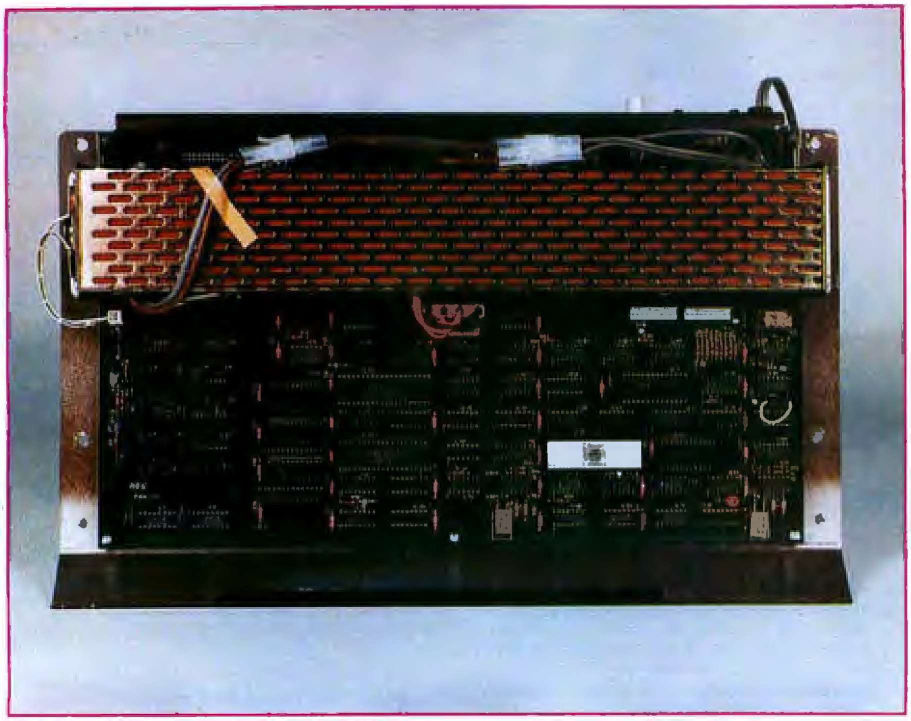

Photo 3: *Inside the keyboard unit. The bottom of this photo corresponds to the front of the keyboard. Along the top edge is the power supply and, below it, the main printed-circuit board. The reset button can be seen at the rear of the keyboard near the power cord.*

N-BASIC, written by Microsoft, is a floating-point BASIC capable of operating in either single or double precision.

ports, a parallel port, and an IEEE (Institute of Electrical and Electronics Engineers)-488 bus (see figure 2).

Monitor

Everyone who has seen the NEC color monitor has commented favorably on its convergence and overall quality of construction. The CRT (cathode-ray tube) is a 30.48 cm (12-inch) diagonal tube and has an in-line gun structure and dot screen face with 12-mil (0.012-inch) dot spacing. The deflection yoke is the precision wound torodial type. Convergence is excellent: during construction, wedges were inserted between the yoke and the neck of the tube to shim the yoke into correct alignment.

The chassis is transformer powered. Almost all the electronics are mounted on one large single-sided printed-circuit board. The horizontal scan frequency is 15,974.4 Hz, and the vertical scan frequency is 60 Hz. The monitor uses an RGB (red-green-blue) signal interface with separate horizontal and vertical sync signals. All signals are at TTL (transistor-transistor logic) levels. Although the monitor has an audio amplifier and speaker, the audio line on the connector is tied to V_{DD} on the Z80 microprocessor. The computer generates a format of up to 80 characters per line and 25 lines, noninterlaced. The image quality is excellent, as can be seen from photo 2.

The monitor power supply apparently has some sort of time delay element, either intentionally or unintentionally, that prevents the user from turning on a set that is still warm. If you turn the monitor off and then try to turn it back on again without waiting a minute or so, the screen remains dark.

Software

As mentioned previously, the BASIC by Microsoft, called N-BASIC, is contained in three 8 K-byte ROMs. Contained within these 24 K

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bytes of ROM is a very complete BASIC, as well as a system monitor program. Advertisements in the Japanese computer magazine *ASCII* indicate that a number of user programs (including a color version of the ever-popular Space Invaders) are readily available on tape.

N-BASIC is a floating-point BASIC capable of operating in either single or double precision. All the features of standard BASIC are present, along with a few interesting extensions, such as:

- SWAP: exchanges value of two variables;

The PC-8001 has one feature that ought to be included in all personal computers: a single BASIC command that changes it from a computer to a terminal.

- BEEP, MOTOR: toggles beeper or motor relay;
- HEX$: decimal to hexadecimal conversion;
- STRING$ (X,Y): string equal to X copies of the character with ASCII (American Standard Code for Information Interchange) code Y.

In addition, there is a whole set of graphics and display commands that will be described further.

There is also a monitor program which gives the user direct access to the Z80 machine code. After entering the monitor by typing MON, the user can test, manipulate, load or store bytes of blocks of memory using the commands in table 1.

Another useful feature of N-BASIC is the use of the ESC (escape) key on the keyboard as a pause function. It

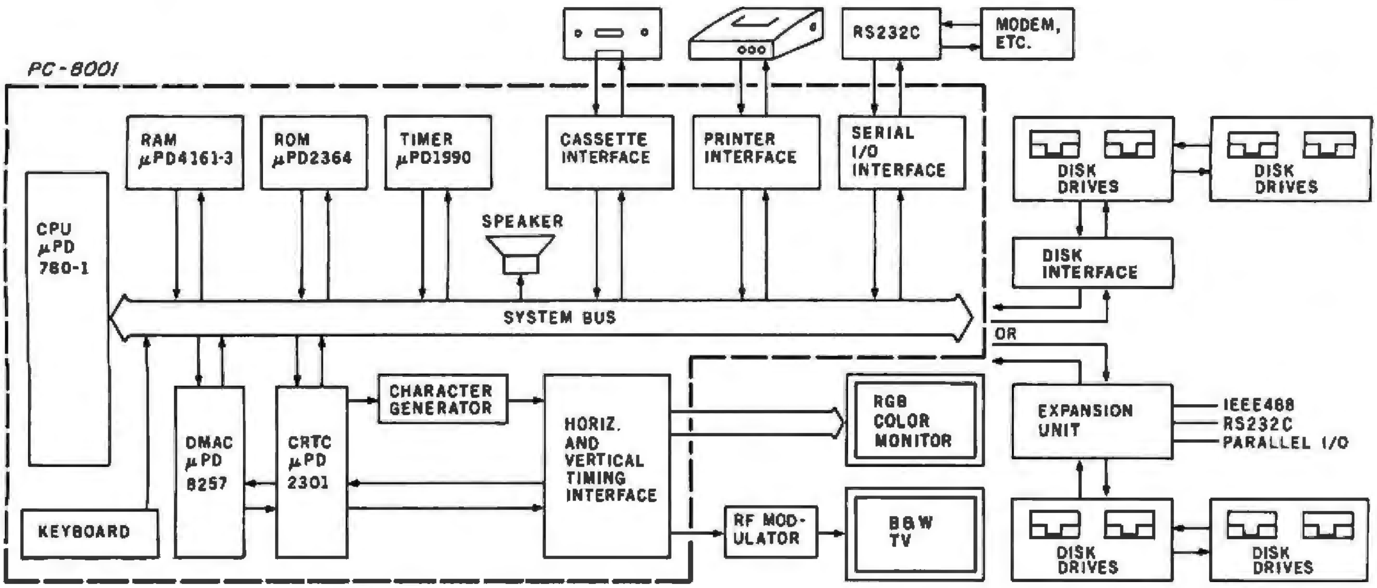

Figure 1: *Block diagram of the NEC PC-8001 system. The modules within the dotted lines are contained in the PC-8001 keyboard unit.*

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can be used to pause in the middle of a program execution, program listing, monitor dump, and just about any other process. Pressing ESC again resumes the program or listing. This is very handy for debugging or for reading parts of a long program listing.

Finally, the PC-8001 has one feature that ought to be included in all personal computers: a single BASIC command that changes it from a computer to a terminal. The TERM command allows the user to select either ASCII or JIS (Japanese Industry Standard) coding, parity, and clocking options. A jumper inside the keyboard unit selects data

Command	Meaning
S xxxx	displays the byte whose address is xxxx and changes it to the value to be entered
D xxxx, yyyy	displays the hexadecimal values stored in locations xxxx to yyyy
G xxxx	goes to byte xxxx and starts executing
W xxxx, yyyy	writes to tape the block from xxxx to yyyy
L	loads a stored block from tape back to memory
LV	loads a stored block from tape and verifies that it has been correctly loaded
TM	tests memory and returns to BASIC
control-B	returns to BASIC

Table 1: *Monitor commands within the NEC PC-8001. These commands are available to the user for work in machine-language programming.*

CONSOLE <T>, <N>, <K>, <M>
Sets the following display parameters:

T = top line of scrolling window
N = number of lines in scrolling window
K = key list flag; if 1, displays identity of programmable function keys
M = color mode: 1 = color, 0 = black and white

COLOR <C>, <B>, <M>
Sets the following parameters:
C = color (or attribute in black and white mode):

In Color Mode:	In Black and White Mode:
0 = black	Bit 0 = visibility (0 = visible)
1 = blue	Bit 1 = flashing (1 = flash)
2 = red	Bit 2 = reverse video (1 = reverse)
3 = magenta	
4 = green	
5 = cyan	For example, color 6 in black and white mode would produce flashing, reverse-video characters.
6 = yellow	
7 = white	

B = background character; fills the background with the character whose ASCII code is B.
M = mode flag, 1 = graphics mode, 0 = text mode

WIDTH <H>, <V>
sets screen format (H by V); (H = 80, 72, 40, or 36; V = 25 or 20)

LOCATE <X>, <Y>
moves cursor to character position (X,Y)

PSET (<X>, <Y>, <C>)
draws a graphics dot at graphics coordinate X,Y in color C

PRESET (<X>, <Y>)
erases a graphics dot at X,Y

LINE (<X1>, <Y1>)–(<X2>, <Y2>), "<char>", <C>, [B [F]]
Draws a line from (X1,Y1) to (X2,Y2). The line is a line of text characters "char". If "char" = PSET or PRESET, the line is a graphics line and X and Y are interpreted as graphics coordinates. <C> is the color of the line. If present, B causes a rectangle (block) to be drawn with (X1,Y1) and (X2,Y2) as opposite corners, and F causes the rectangle to be filled.

GET @ (<X1>, <Y1>)–(<X2>, <Y2>), X
stores characters from the specified rectangular area of the screen into array X

PUT @ (<X1>, <Y17>)–(<X2>, <Y2>), X
puts characters from array X to the display

Table 2: *Commands for color-graphics display from within N-BASIC.*

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transfer rates of either 4800, 2400, 1200, 600 or 300 baud; the function keys on the keyboard determine whether the terminal operates in half- or full-duplex modes. The only apparent deficiency is the lack of a shift lock key for the terminal mode.

Graphic and Display Features

The display features of the PC-8001 include:

- eight-color display (both text and graphics);
- 248-symbol character set (complete ASCII, katakana, and graphics characters—lines, arcs, card symbols);
- variable screen format: (80, 72, 40, or 36 characters by 25 or 20 lines);
- two display modes: text and medium-resolution (160 by 100 pixels) graphics (these two modes can be intermixed on the same display);
- flashing, reverse video, and underlined text.

Table 2 lists the graphics and display-related extensions in the PC-8001 dialect of BASIC. These include commands for cursor positioning, changing various display parameters, and plotting points and drawing lines in graphics mode. Two particularly worthwhile instructions are GET and PUT. GET allows the user to store the image in a specified rectangular area of the screen in an array, which can then be PUT at another location on the screen. This allows the user to define complex shapes that can then be drawn on the screen with a single instruction. Repetitive erasure and redrawing of a shape also provides a simple method of animation.

Photo 4 is a sample of what can be done with the PC-8001 graphics. This display uses most of the commands in table 2 and, in addition, illustrates the use of some of the Japanese characters for graphics purposes (the invader figures and the television speakers are made from these characters).

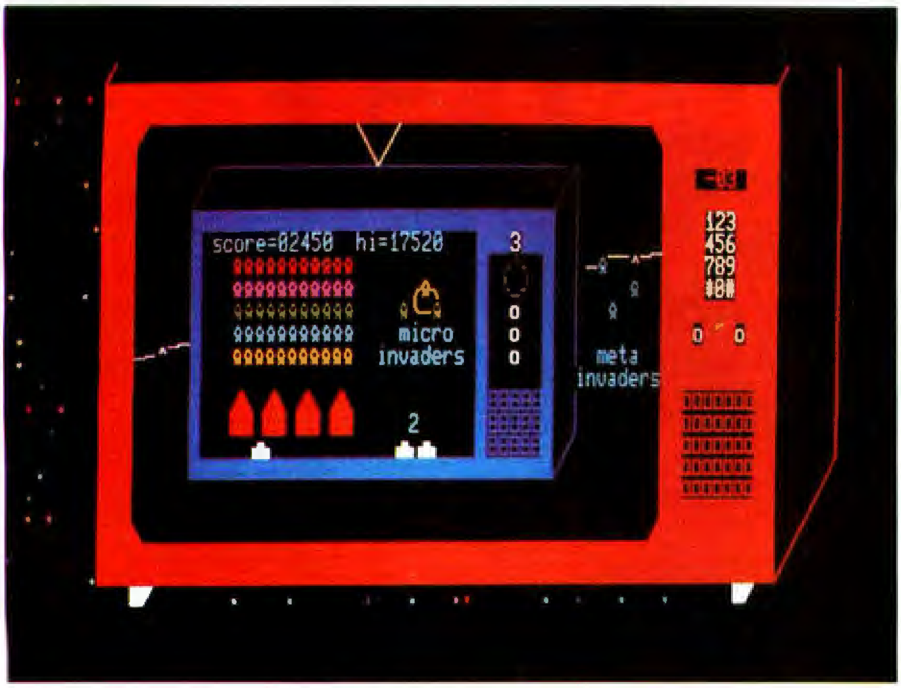

Photo 4: *Sample display created on the PC-8001 by the authors. Note the use of the Japanese characters for graphics—the little invaders are actually the Japanese characters for the word "minute."*

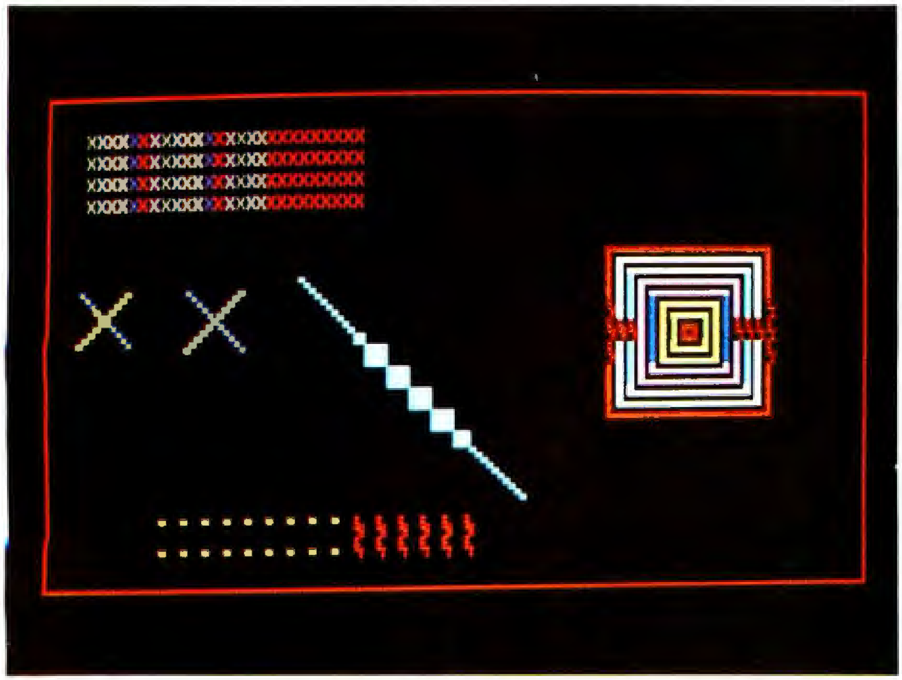

Photo 5: *Illustration of some of the display restrictions of the PC-8001. See text for explanation.*

Problems with Video Displays

Upon further experimentation with the computer, we discovered that certain graphics operations can sometimes produce strange and unexpected results. A sampling of some of the display anomalies which can occur is shown in photo 5. The following unexpected things happen in this display:

1. Each column of Xs in the upper-left corner should be a different color, but after eighteen columns, the display remains in one color.
2. The two pairs of intersecting lines should be the same, but in the one on the left, extra areas are colored in near the intersection.
3. The width of the white diagonal line should stay constant, but it becomes much thicker in the middle.
4. The two rows at the bottom left should be all dots, but some of the dots are printed as text characters.
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display should be a ring of concentric squares, each a different color, but the line thickness varies and some dots are replaced by text characters.

The explanation for all these anomalies lies in the way the text and graphic information is represented in memory. For example, consider the full 80-character by 25-line screen format. To represent a screen of information in memory requires storage space for 2000 characters and their attributes (color, flashing, etc). At 1 byte for the character and 1 byte for its attributes this would require about 4 K bytes of memory. However, only 3 K bytes are allocated for screen storage (addresses F300 to FEB8). The way these 3 K bytes of memory are organized explains all these display anomalies and also provides insight into a useful feature that makes the PC-8001 unique.

As shown in figure 3, each row of characters on the screen is represented by 120 bytes in memory. The first 80 of these 120 bytes contain the ASCII codes for the 80 characters in the row. The remaining 40 bytes are organized into twenty pairs. We have not determined the use of the first pair, but the remaining nineteen pairs are used to encode up to nineteen attribute fields for that row. Each pair P_i points to the beginning of the field, which runs to position $P_{i+1}-1$ (the P_i are always ordered so that $P_1 < P_2 < \ldots$etc) and contains characters with attributes a_i (where a_i is the 1-byte attribute within pair P_i).

Whenever a program, in printing on the screen, uses up the first eighteen attribute fields for a row, all suc-

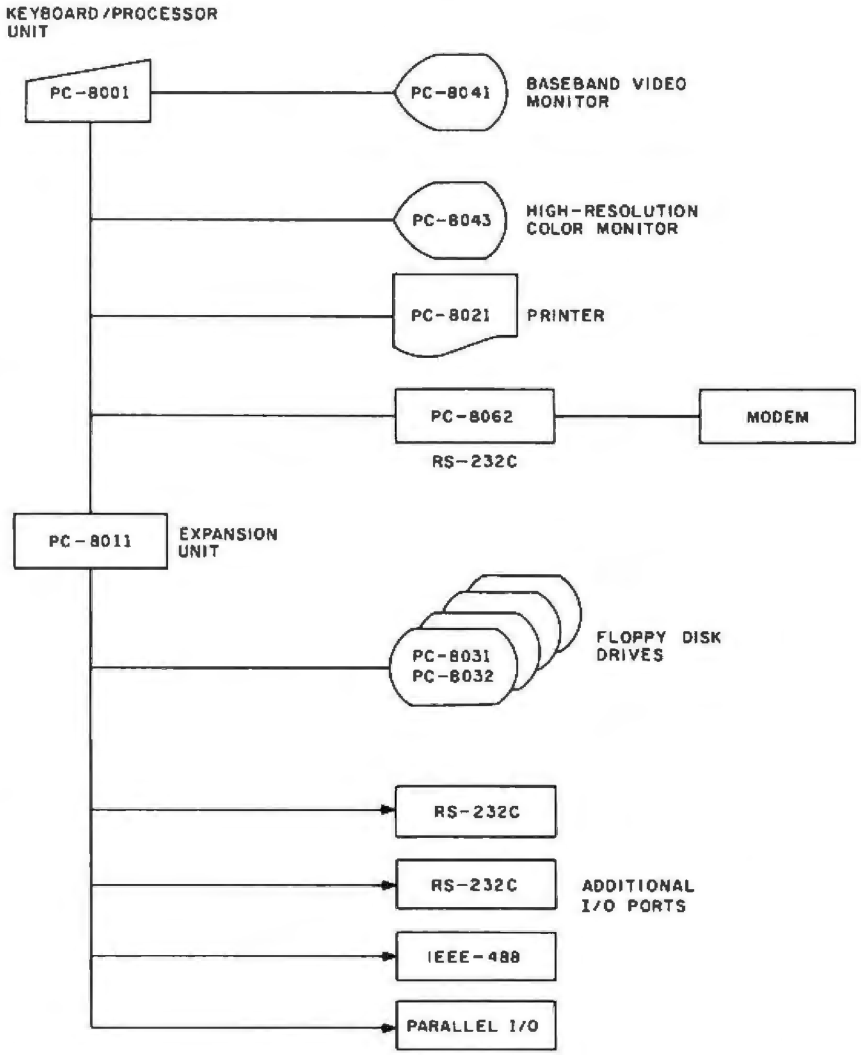

Figure 2: *Interconnection block diagram of the NEC PC-8001 system. While many peripherals can be directly connected to the PC-8001, disk drives and I/O ports must be connected through the PC-8011 expansion unit.*

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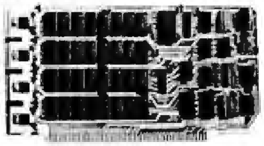

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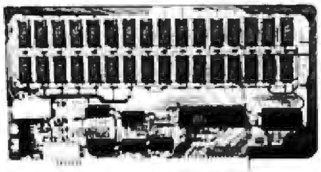

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cessive characters on the same line that occur after these fields are given the attribute a_{19}. This is the default attribute for that row that is set to the current attributes in effect whenever a clear-screen command is received.

This explains the first anomaly in photo 5. After eighteen different-colored columns, the computer "runs out of colors," and the remaining columns default to red. Red is not specified in the program; it just happened to be the color in effect when the program started.

Another problem occurs when plotting color graphics because the PC-8001 has character-oriented (not bit-mapped) graphics. (In this respect, it is closer to the Radio Shack TRS-80 than to the Apple II, for example.) Each character space is divided into a 4 by 2 array of cells, each of which can be "on" or "off." This provides an alternate character set consisting of the 256 possible arrays of on and off cells. When points, lines, or graphics shapes are drawn, the computer automatically converts the points to the required graphics characters and displays these, thus providing an effective graphics resolution of 160 by 100 cells.

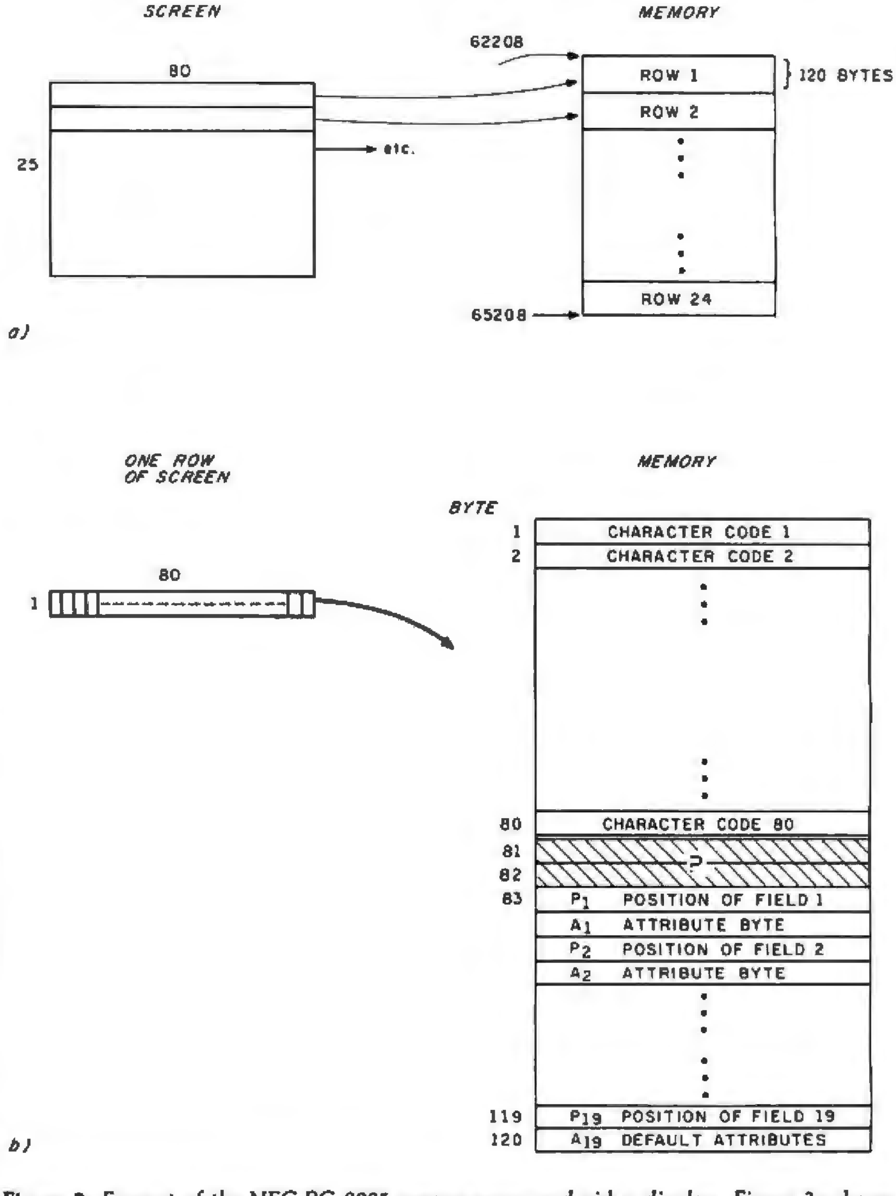

Figure 3: *Format of the NEC PC-8001 memory-mapped video display. Figure 3a shows how each row of the video display translates into a block of programmable memory. Figure 3b shows how each 80-character row is stored in memory. A row can be broken into a maximum of nineteen fields, the position and attributes of which are described in the last 38 bytes of the memory associated with one row. All numbers shown are in decimal. See the text for further details.*

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However, a problem occurs when, for example, two lines of different colors intersect. Because a character cannot be two colors at the same time, the algorithm used by the computer gives the most recently plotted points precedence. Any cells within the same character space that are already "on" are changed to the new color. Thus, an adjacent pair of horizontal lines for which different colors are specified may be displayed in either the same or different colors, depending on whether or not they lie on opposite sides of a character cell boundary. We can show that this is a limitation of the software and not of the hardware video-controller device: the command OUT 63,41 (presumably an output to part of the video-controller device) fills the screen with adjacent horizontal lines of different colors.

This also explains anomalies 2 and 3 in photo 5. The two crosses look different because they intersect in different positions relative to cell boundaries. The white diagonal line changes width because it crosses a black graphics rectangle. Even though the black rectangle is invisible to the casual observer, it changes the appearance of the intersecting diagonal line: every cell in each character space changes to white.

This alternative graphics-character set is selected with one of the bits in the attribute byte. This implies that the user can also "run out of graphics" on a horizontal line. This is what happens in anomalies 4 and 5 (bottom and far right of photo 5). The default attribute byte happens to specify text mode. Hence the remaining characters on the line are displayed as their text equivalents.

It is unclear why the designers chose this display approach, particularly since a full character- and attribute-mapped display would have required only 4 K bytes of memory instead of 3 K bytes. But even though this implementation imposes some restrictions on the types of displays that can be generated, it also provides an interesting capability which, to our knowledge, is not found on any other personal computer.

This capability is a consequence of the fact that the attributes of a character on the screen are specified indirectly. That is, each character is identified with a field number which in turn is associated with an attribute byte. Thus, by a direct POKE into memory (a 1-byte change), the user can change an attribute (specifically, color) of a character or group of characters (up to an entire field) without altering the character or field codes. This allows a sophisticated method of animation called *color table animation* in which the user first prints a number of images in different fields on the screen, then changes the color of the fields to make each image appear in succession. As an example, we have written a BASIC program which animates a large flying saucer flying amidst a field of stars at 20 images per second. This is very fast for an interpretive BASIC animation.

Summary

The PC-8001 appears to be an attractive, well-planned, and well-made personal computer. The graphics, though somewhat rudimentary, are more than adequate for charting, graphing, and business applications, and they can do a creditable job on many games as well. Most people who have seen our PC-8001 feel that, if it were sold in this country, it would provide strong competition for any of the color-based home computers currently being sold. ■

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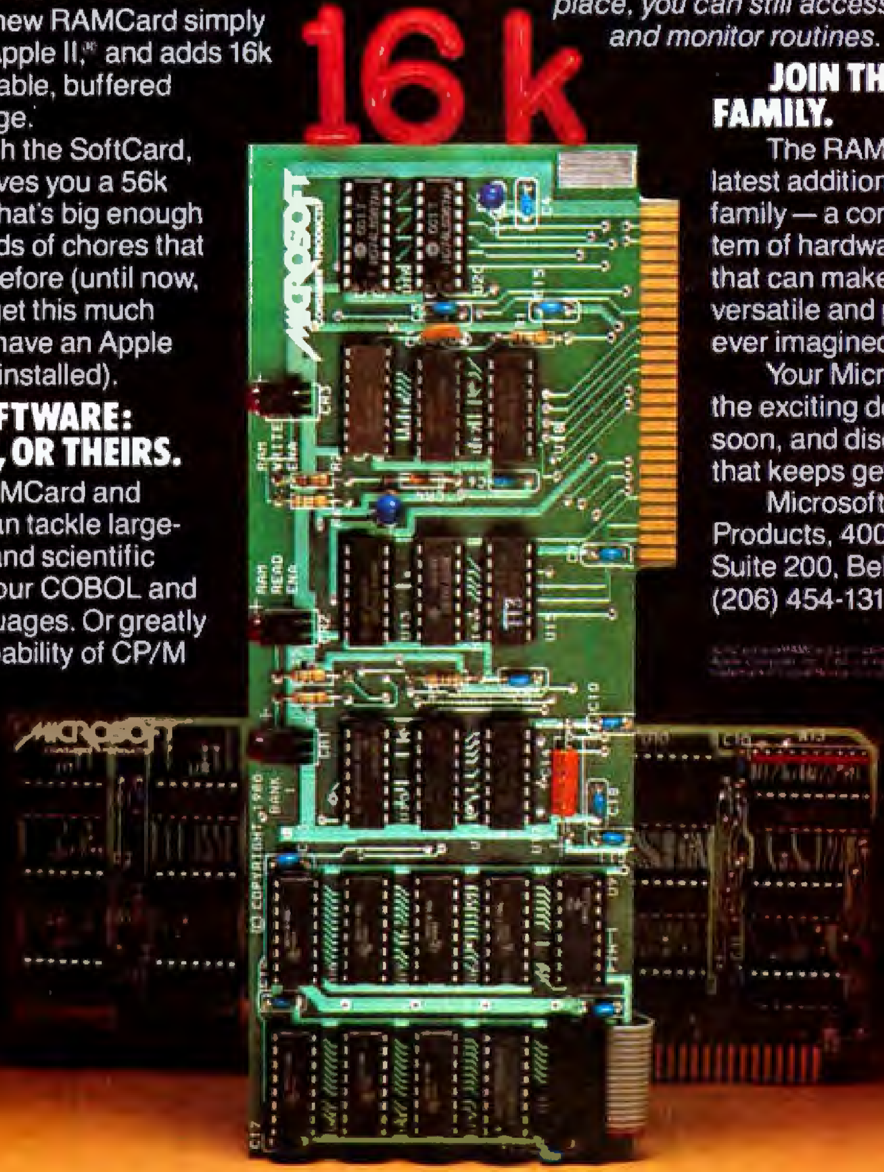

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SC/MP Instruction Set Summary

Professor Walter E Burton Jr
Electrical Engineering Technology Department
Southern Technical Institute
Marietta GA 30060

If you hand-assemble or debug programs for National Semiconductor's SC/MP processor, here is a simplified instruction-set summary to speed you on your way. Table 1 contains the hexadecimal codes, the standard SC/MP mnemonics, and the SC/MP addressing modes.

Hexadecimal codes are separated into the high-order digits, which are in the left-hand column, and the low-order digits, which are in the top row. Mnemonics are located within the table. The abbreviation *PTR* refers to the four SC/MP pointer registers 0 thru 3. The register numbers are associated with the related instructions in the same column in table 1.

Different addressing modes associated with two-byte instructions are located along the bottom of the table. Blanks identify areas of illegal code.

As a reference I used the *SC/MP Technical Description,* Publication Number 4200079B (Santa Clara CA: National Semiconductor Corporation).■

	High Hexadecimal Digit	Low Hexadecimal Digit: 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
One-Byte Instructions	0	HALT	XAE	CCL	SCL	DINT	IEN	CSA	CAS	NOP							
	1										SIO			SR	SRL	RR	RRL
	2																
	3	XPAL	XPAL	XPAL	XPAL	XPAH	XPAH	XPAH	XPAH					XPPC	XPPC	XPPC	XPPC
	4	LDE															
	5	ANE								ORE							
	6	XRE								DAE							
	7	ADE								CAE							
Two-Byte Instructions	8																DLY
	9	JMP	JMP	JMP	JMP	JP	JP	JP	JP	JZ	JZ	JZ	JZ	JNZ	JNZ	JNZ	JNZ
	A									ILD	ILD	ILD	ILD				
	B									DLD	DLD	DLD	DLD				
	C	LD	LD	LD	LD	LDI	LD	LD	LD	ST	ST	ST	ST		ST	ST	ST
	D	AND	AND	AND	AND	ANI	AND	AND	AND	OR	OR	OR	OR	ORI	OR	OR	OR
	E	XOR	XOR	XOR	XOR	XRI	XOR	XOR	XOR	DAD	DAD	DAD	DAD	DAI	DAD	DAD	DAD
	F	ADD	ADD	ADD	ADD	ADI	ADD	ADD	ADD	CAD	CAD	CAD	CAD	CAI	CAD	CAD	CAD
	PTR	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
	Address Mode	PC-Relative	Indexed			Immediate	Auto-Indexed			PC-Relative	Indexed			Immediate	Auto-Indexed		

Table 1: *Instruction set summary for National Semiconductor's SC/MP processor.*

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VERSA WRITER DIGITIZER SYSTEM	215
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VIDEX VIDEOTERM w/graphics ROM	335
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LOBO DRIVE w/cont. & DOS 3.3	499
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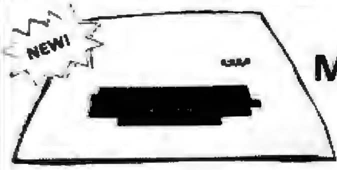

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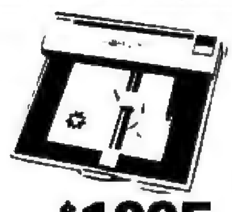

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The Sinclair Research ZX80

John C McCallum, Department of Computer Science
York University, 4700 Keele St
Downsview, Ontario, M3J 1P3 Canada

The new ZX80 microcomputer from Sinclair Research Ltd is a remarkable device. Although first announced to the North American public in February, 1980, the microcomputer did not become available until the fall. During the wait, the price has dropped from the expected $245 to just under $200. Because of this, the ZX80 is being widely advertised as the first personal computer for under $200.

At a Glance

Name
Sinclair ZX80

Manufacturer
Sinclair Research Ltd
475 Main St
POB 3027
Wallingford CT 06492
(617) 367-1988

Price
$199.95

Dimensions
15.9 by 20.8 by 3.7 cm
(6½ by 8½ by 1½ inches)

Processor
Z80A, 8-bit

System clock frequency
3.25 MHz

Memory
1 K-byte static memory, 4 K-byte system ROM (includes BASIC interpreter)

Mass storage
Uses standard cassette recorder (not included)

Other hardware features
Forty-key pressure-sensitive keyboard; built-in RF (radio-frequency) modulator (for channel 2); creates video display of 24 lines of 32 characters each; includes AC adapter, cables to cassette recorder

Software
4 K-byte system ROM, which includes a BASIC interpreter and necessary internal software

Options
8 K-byte BASIC module and 16 K-byte programmable memory module (see "New Sinclair Modules" text box for details)

Comments
Contains introductory BASIC book, *A Course in BASIC Programming,* 128 pages, 20 by 14 cm (8¼ by 5¼ inches)

The ZX80, shown in photo 1, is a new design from Clive Sinclair, a well-known British electronics innovator. Sinclair is best known for his previous products: a miniature television, low-cost calculator and digital watch kits, and miniature stereo components. All of his products have stressed small size, low cost, and high-quality operation—usually at the expense of packaging. The same is true of the ZX80.

Can it be any good if it sells for under $200? This is a reasonable question, but the question that is most important when buying a computer is, "Will it do the job I want it to do?" The only way to tell is to look at its features in some detail. In order to design a very low-cost computer, some features had to be cut. However, the new features that have been added are rather impressive. The good features include low price, small size, high microprocessor speed, ease of program entry, and real-time BASIC syntax checking.

The price of $199.95 includes the assembled computer, an AC (alternating current) power adapter, a cable to connect the ZX80 to a standard television set (channel 2), connectors for a cassette recorder, and a well-written book on programming in BASIC for the ZX80. For those interested in building kits, a kit version is available. However, you will not save money by doing so, and the kit involves some steps that are rather involved for an inexperienced kit builder.

The ZX80 is small. The actual dimensions are 15.9 by 20.8 by 3.5 cm (6½ by 8½ by 1½ inches), or about the size of a hardcover book. It is not the smallest personal computer—the new pocket computers from Sharp, Panasonic, Quasar, and Radio Shack have that honor. Also, because the ZX80 has to be attached to its AC adapter and a television set to work, some of its size advantage is lost.

As part of this evaluation, several benchmark programs were run in BASIC to compare the ZX80 to other personal computers. Although the ZX80 is not as fast as advertisements imply, it does run faster than many other personal computers, including the Radio Shack TRS-80 Model I.

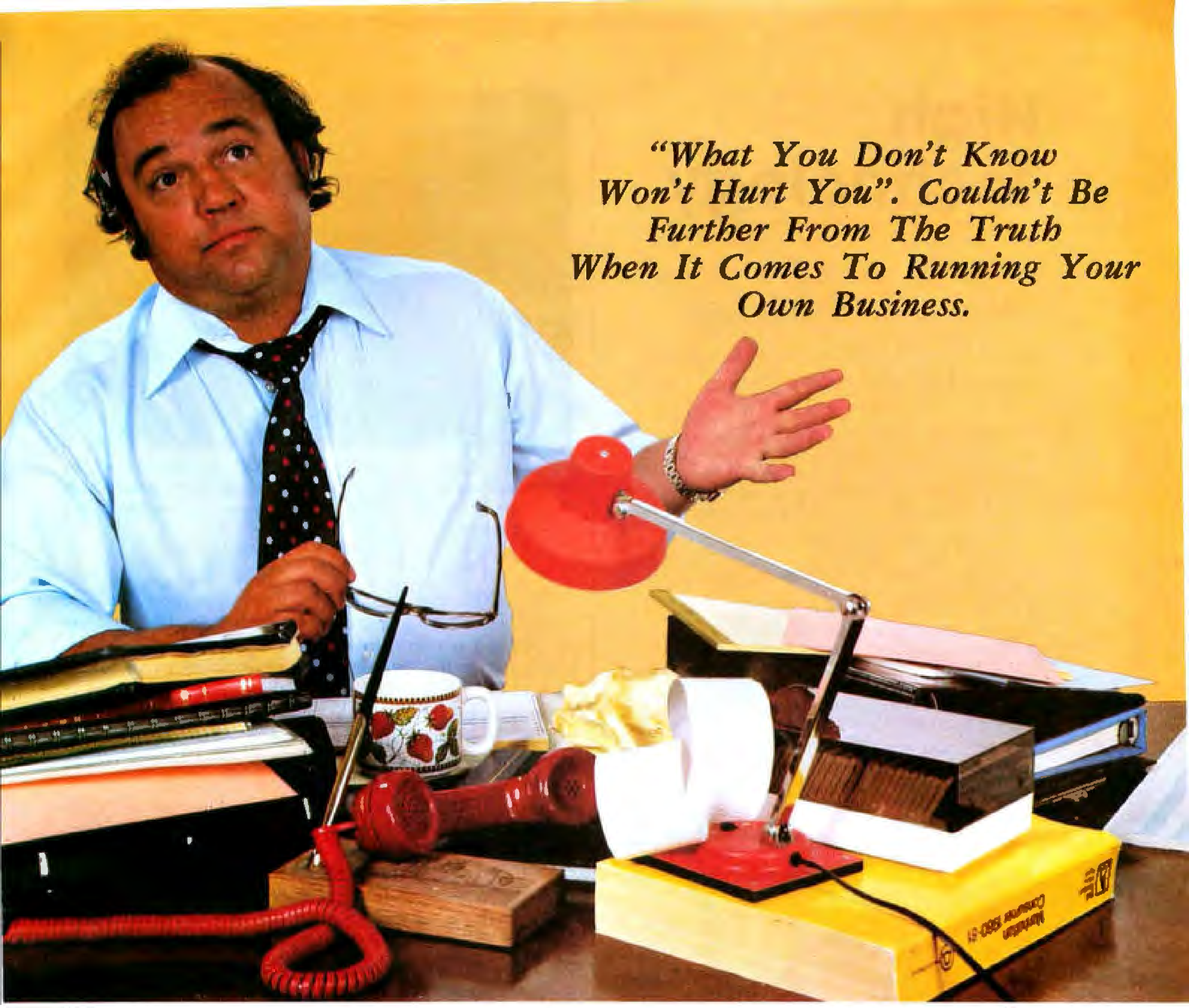

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Photo 1: *A photograph of the ZX80 in operation. The homemade power supply gives an indication of the small size of the computer. At the bottom of the television set, a BASIC line is being edited.*

The ZX80 also has a few software features that are useful. The single-keystroke keywords mean that, instead of typing a whole word, you have to type only a single character on the keyboard. This can cause some confusion at first, and it takes some time to remember not to type the whole word. But it does speed up the typing process when entering a program. Because the keywords are stored in 1 byte each, you save memory space that can be used for extra program storage.

Another BASIC feature that I found impressive is the syntax checking of the program as you type it in. I have always been disappointed that most other versions of BASIC do not do this. The ZX80 actually prompts you with the type of input it is looking for—a keyword, a literal, a string, or a number. If you enter an illegal statement, it indicates where the statement is wrong and will not let you enter that statement into the program. It also does a similar check on input data requested by a running BASIC program. In fact, it allows you to enter simple expressions for numeric input and calculates the value while reading the value into the program; a very nice feature.

At $200, though, everything cannot be optimum. There are objectionable features too. The most annoying or limiting features of the ZX80 are its small memory size, screen blanking during program execution, its limited BASIC, and its keyboard.

The ZX80 comes with 1 K bytes of programmable static memory, although a memory-expansion board allowing 16 K bytes of memory is expected soon (see text box). These 1024 bytes of memory are shared by system variables, your BASIC program, the program variables, working space, the video-display memory and the stack. Although the space is used very efficiently, 1 K bytes of memory do not store a large program, no matter how efficiently it is squeezed.

Perhaps the most limiting characteristic of the ZX80 is the screen-blanking behavior. When the ZX80 is executing a program, the TV screen goes black. This happens because the processor is used to control the display as well as to do the processing, and the design decision was made to have the processor devote its time to only one of these. The effect of this trade-off is to increase pro-

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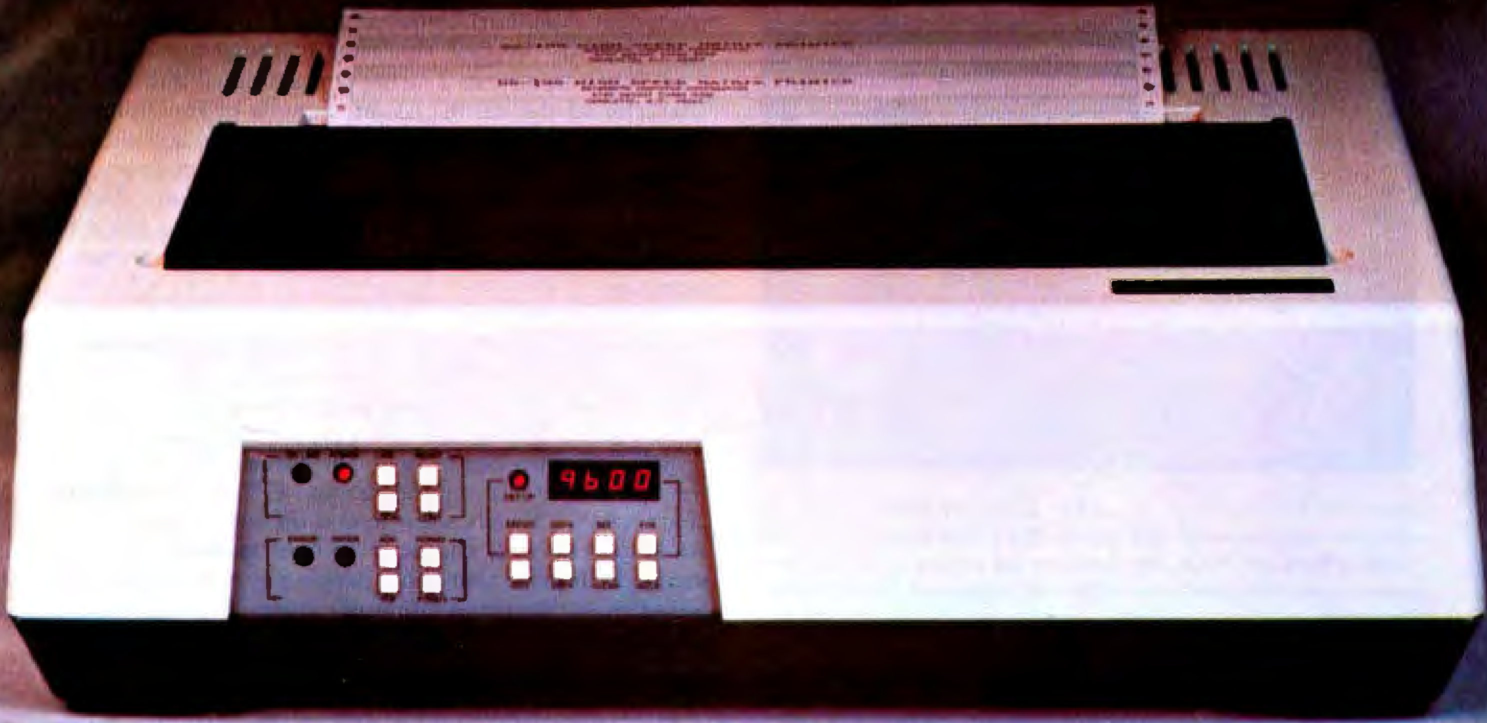

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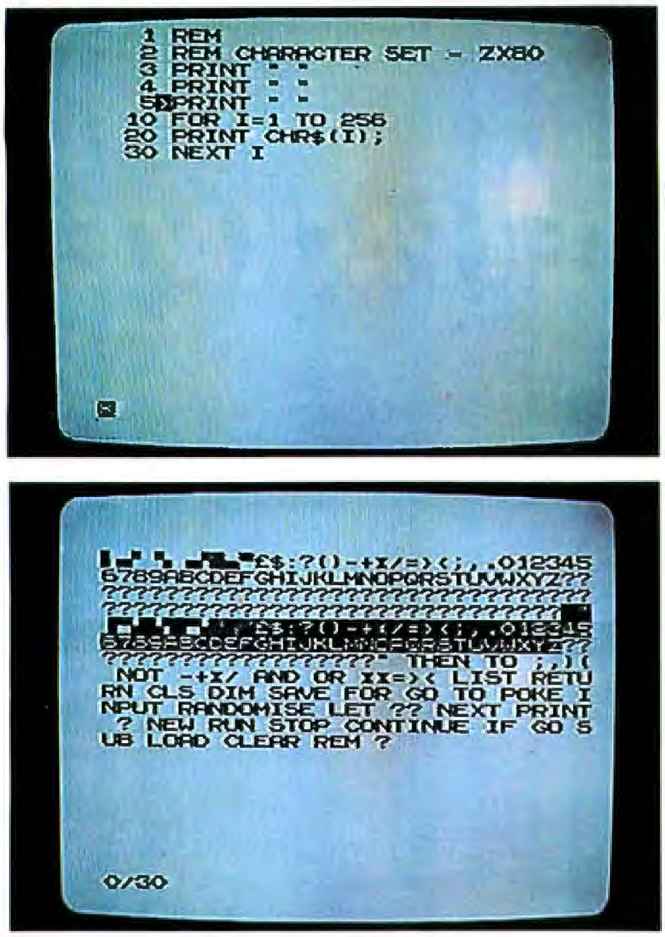

Photo 2: *The character set of the ZX80 computer. Photo 2a shows a program that will list all 256 characters used by the ZX80. Photo 2b shows the character set produced by the program; note that some characters are expanded to multiletter keywords and that undefined codes are represented by a question mark.*

Photo 3: *Editing on the ZX80. The cursor (at line 510 at the top of the screen) can be moved via arrow keys to different lines of the program. When the Edit key is pressed, the line being pointed to is copied at the bottom of the screen, where it can be edited. The cursor on the bottom line can be moved right and left; characters can be deleted or inserted at the current cursor position. When the Newline key is pressed, changes made in this line are added to the existing program.*

cessing speed at the expense of limiting the interactive quality of the ZX80. It is not going to have the same types of games as the Commodore PET or the Apple II computers. However, when performing long calculations on the ZX80, it is easy to tell when the program ends—the room bursts into light!

The limited features of ZX80 BASIC are also frustrating. This is a result of the limited amount (4 K bytes) of ROM (read-only memory) available. This memory contains the software used for the BASIC interpreter, for the character generator for the TV display, for decoding the keyboard, and for cassette reading and writing. This squeeze results in many useful BASIC functions being omitted.

When dealing with strings, for example, you can break up a string using two functions: CODE gives the ASCII (American Standard Code for Information Interchange) equivalent of the first character of the string; the TL$ (tail) function returns a string containing all but the first character of the string. As an example of functions left out, you cannot put two strings together (no concatenate operation or function exists). However, Sinclair intends to bring out an optional 8 K-byte floating-point BASIC on a single ROM. With more than double the space to work with, it should be a very rich and impressive language.

The last feature that I find annoying is the keyboard. It works—but @"#$. It is a touch-sensitive keyboard—smooth, washable, indestructible. But it is difficult to keep your fingers positioned properly on the keys, particularly on the shift key, without inadvertently pressing an extra key or two. The hardest keys to use are the cursor controls and the rubout keys (both are shifted characters). I always seem to end up with zeros where I want to remove a character (rubout is *shift-zero*). Remember, though, that some people pay more for a keyboard than this entire computer costs. This was a very wise place to save money on the design.

Some Technical Details

The ZX80 microcomputer uses a very efficient design with a total of only twenty-two standard integrated circuits, including the voltage regulator. The main processor is a Z80A processor running at a speed of about 3.2 MHz. The programmable memory is a pair of 4 K-bit static memory devices. The ROM is a single 4 K-byte part that includes both the BASIC interpreter and the other functions listed above.

The operation of the ZX80 is—so far as I understand it—quite complicated because it works on a mix of hardware and software. The overall concept is that the refresh counter of the Z80 is used to control the generation of the lines of the video display, producing dots on the TV screen at twice the frequency of the processor clock. The keyboard is scanned under software control as I/O (input/output) port number 1, a port that is also shared by the cassette input circuitry. The cassette output signal is the same as the video synchronization signal; it is also under software control. It is an interesting design, but you will need to study the ZX80 ROM carefully before you can really understand it.

The character set is also a little strange. The keywords that are entered with single strokes are stored as single tokens and are expanded when displayed. Photo 2 shows

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a program for generating all 256 codes.

The high quality of the black-and-white display can be seen in the photograph of the TV screen, which is a standard 12-inch color TV set (see photo 2b). The question marks are undefined codes, and the keywords (which are spelled out) are fairly obvious. The graphics characters allow a limited 46- by 64-pixel graphics resolution. However, since the ZX80 is not primarily designed for interactive graphics applications, the existing resolution on the ZX80 should be sufficient.

Software Features

The ZX80 system is excellent for learning introductory programming concepts. This is in large part due to the immediate feedback about errors. For the student at the introductory level, the limited features of the language are useful in preventing confusion; compare this with the extreme detail taken to describe some complicated versions of BASIC. When you are ready to progress at a later time, the expanded version of BASIC will be available.

ZX80 BASIC not only prevents you from making syntax errors, but it also prompts you with a cursor that tells you what it is expecting—a *keyword* (denoted by a K inside the square cursor) a *literal* (denoted by an L), or a *numeric literal* (denoted by an LS). When a program is expecting string input, it puts the cursor between quotes, then expands the quotes as you enter the text. With the ZX80, you never get the string errors during data entry that are so common with other personal computers.

The method of editing programs is also well planned. A cursor, controlled by the ↑ and ↓ cursor keys, is used to point to the "current" line. When the Edit key is pressed, the current line moves down to the bottom of the screen to the program-entry line. There is always at least one line between the program and the text-entry line, so you will not get the areas confused.

Once the line is in the program-entry area, the line is treated exactly like a program line that you are typing except that the cursor is at the beginning of the statement. The cursor control keys — and — are used to move the cursor within the line. Typing anything just inserts it at that point in the line, and the rubout key is used to delete the previous character. When you are finished editing, just press Newline and the edited line replaces the old line in the program (see photo 3). If you modify the line number during editing, you create a new line in the program. This feature makes it very easy to duplicate lines in a program.

The best way to describe the features of the ZX80 BASIC language is to add to the comparison table used by *Creative Computing* in their "BASICs Comparison Chart" (July 1980 issue, pages 28 and 29). The major features of the Sinclair Research ZX80 4 K-byte BASIC are given in table 1.

Performance of the ZX80

At some time, all users become concerned about the speed of their computers. There is no simple way to compare the speed of various personal computers without running actual programs. Two standard benchmarks have been used to compare a wide range of computers running BASIC. These have been run on the ZX80 to get a valid estimate of its speed.

The system clock frequency of the Z80A processor is 3.2 MHz. This compares to about 1.77 MHz for the Radio Shack TRS-80 Model I or to the 4 MHz of the TRS-80 Model II, both of which also use the Z80 as the main processor. A Z80 running at 2 MHz should be

Integer variables	yes; names must contain letters and numbers only, but can be any length.
Real variables	no
String variables	yes; names must be one letter followed by a dollar sign (eg: A$, B$, ..., Y$, Z$).
Arrays	integer and one-dimensional (eg: C(N)) only; names must be one letter long and are initialized to zero values.
Arithmetic operations	performed on 16-bit signed integer values.
Arithmetic operations	+ , − , * , / , ** (exponentiation)
Relational operations	= ,>, <, on either string or integer argument pairs.
Boolean operations	NOT , AND , OR performed on corresponding bits of integer arguments.
String operations	CHR$(X), TL$(X$), STR$(X$)
BASIC statements	CLEAR, CLS, DIM, FOR, GOSUB, GO TO, HOME, IF, INPUT, LET, NEXT, POKE, PRINT, RANDOMIZE, REM, RETURN, STOP
BASIC expressions	ABS(X), CODE(X$), PEEK(X), RND(X), USR(X)
BASIC commands	CONTINUE, EDIT, LIST, LOAD, NEW, RUN, SAVE
Graphics	20 graphics characters; effective resolution is 46 rows of 64 squares per row, plus some graphics characters for shading.

Table 1: *Summary of the Sinclair Research ZX80 4 K-byte BASIC.*

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Benchmark Number	1	2	3	4	5	6	7
Execution Time (Seconds)	1.6	4.7	9.0	8.5	12.2	25.3	38.5

Table 2: *Execution times of BASIC benchmark programs on the Sinclair ZX80. See text for details*

similar in speed to a 6502 running at 1 MHz (as used in the Commodore PET or the Apple II). These estimations, however, do not consider the efficiency of the BASIC interpreter, which is often the most important speed factor. Thus, the execution-timing test of actual BASIC benchmark programs is the most important way of comparing the speed of various personal computers.

The ZX80 ranked between second and third places in the BASIC benchmarks done for *Kilobaud* magazine (see "BASIC Timing Comparisons" by Tom Rugg and Phil Feldman, October 1977, page 20). It was beaten only by a 6502 microprocessor running at 2 MHz (an Ohio Scientific Challenger II running its 8 K-byte BASIC), and by a Z80 running at 4 MHz (Zapple 8 K-byte BASIC). For those interested in the actual times of the benchmark programs, they are given in table 2.

The prime-number program used for benchmarking BASIC processors by *Interface Age* was also run (see "Assignment: Benchmark," by Tom Fox, June 1980, page 130). [*A similar benchmark program was given in "TRS-80 Performance: Evaluation by Program Timing" by James R Lewis, on page 84 of the March 1980 BYTE....*GW] This benchmark is particularly interesting because it was run on several of the fastest small computers, as well as on a DEC (Digital Equipment Corporation) PDP-10 computer. The program given in the *Interface Age* article had to be modified slightly to allow for integer BASIC. However, the only major effect was to change an INT function to an integer multiply. The execution time for the program running on the ZX80 was 1604 seconds. Although this was not very fast compared with many of the computers in this benchmark, it was not the slowest either (the TRS-80 Model I took 1928 seconds). The execution time was decreased to 1513 seconds by removing the comment statements from the program (a 5% increase in speed). This is a typical way of speeding up BASIC interpreters.

The ZX80 might be summarized as a high-performance, very low-cost, portable personal computer system. It is best used for home or school use in learning the concepts of programming. When the memory-expansion and floating-point-BASIC modules become available (see the "New Sinclair Modules" text box), it will also be good for low-cost mathematical, scientific, and engineering applications. If you are looking for your own home computer, the ZX80 is a good starting point. ■

New Sinclair Modules

As this article goes to press, Sinclair Research Ltd has announced two new modules for the ZX80, an 8 K-byte BASIC in ROM and a 16 K-byte programmable-memory module. According to an American representative of Sinclair Research Ltd, the programmable-memory module and a later version of the BASIC module currently being sold in England will probably be available soon on the American market. The prices are expected to be "under $100" for the 16 K-byte programmable-memory module and "about $40" for the 8 K-byte BASIC module. The BASIC module will be slightly different from the one now being sold in England in that it will add printer support to the ZX80.

References

1. Davenport, Hugo. *A Course in BASIC Programming—ZX80 Operating Manual.* Sinclair Research Ltd, 1980.

2. "Personal computer looks to open up the market with an ultralow price." *Electronics*, Volume 54, Number 4, February 14, 1980, pages 80 thru 82.

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Multi-Micro Learning Environments:
A Preliminary Report on the Solo/NET/works Project

Dr Thomas A Dwyer, Soloworks Laboratory,
University of Pittsburgh, Department of Computer Science,
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Photo 1: *Students from a local high school learn to play N-Trek. The terminals being used were connected to a PDP-11 RSTS time-sharing system, with each terminal controlling a job related to a function of one starship crew member. The jobs interacted through use of shared variables in a common segment of memory.*

Inventive Learning

It's a good idea to "back off" occasionally from the tough problems of education in the real-school world and spend some time thinking about what it would take to develop learning systems that go beyond training in the basics. In particular, it is valuable to contemplate the intricacies of some of the impressive natural-learning phenomena that surround us. For example, when a two-year-old child startles her parents by speaking an adult-sounding sentence (one recently heard was, "No garage sales today—that's ridiculous") it's worth contemplating the significance of such a minor miracle as a key to understanding later cognitive developments. In a similar manner, when a six-year-old masters the "solution" to a complex system of differential equations in the eminently practical form of learning to ride a bicycle, we should spend more than a few moments asking what made such a remarkable conquest possible.

An examination of these and similar examples of complex human learning reveals that in addition to the intrinsic (and still quite mysterious) human potential for developing an ever expanding "life of the mind," there are two important external elements at work. These elements can be described as *supportive-social* and *supportive-physical environments*. In the case of the loquacious two-year-old quoted above, the supportive-social environment was the constant flow of conversation between parents and child as they made their rounds of local garage sales in search of fun bargains. The supportive-physical environment was the set of real places that were visited as the child took part in the fascinating process of finding and acquiring some well-remembered objects, including, of course, a few toys.

The learning-to-ride-a-bicycle phenomenon is supported from the same two bases. The social environment is the neighborhood full of other kids who can handle a two-wheeler and the fun that is promised to anyone who can participate in the local rites of pedal-pushing. The physical environment is the pavement on which to pedal and of course the bicycle. When similar examples connected with older students are analyzed (eg: learning to fly an airplane solo in 10 hours), it is evident that the heritage of ideas built into complex mechanisms is often a crucial part of supportive-learning environments.

It was another example of such environmentally supported human learning that triggered the idea behind the Solo/NET/works project. The example came out of something called the Soloworks project in the mid 1970s. The Soloworks project involved the use of computer technology to support a complex multiplayer version of the popular game Star Trek. (See photo 1.) Written by student Don Simon, the game was nicknamed N-Trek. This was because it allowed a variable number of players to interact in a cooperative simulation/game setting.

In its original version, N-Trek was run on a PDP-11 minicomputer time-sharing system. The general idea of the game was similar to more conventional versions, with the starship Enterprise commissioned to explore the unknown while doing battle with the evil Klingon forces. The big difference was that in N-Trek, the Enterprise really *was* run by a crew. Each member of this crew manned a terminal on the computer system, and depending on how the game was initialized, each crew member played a specific role. Thus, one terminal was run by the commander of the ship, another was manned by the weapons officer, a third was dedicated to navigational tasks, and so on. A separate graphics display showed the various sector maps and status tables of the game, while an added element of feedback was provided by a colored light display and a voice synthesizer that intoned such messages as "RED ALERT" or "SHIELDS UP."

All in all, the many dramatic sessions played on this system were rated as some of the best examples of environmentally supported learning that took place during the project. The word *learning* is used here with deliberation. The rules for handling the various roles in N-Trek

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2a

2b

Photo 2: *The equipment currently available in the Solo/NET/works laboratory. The terminal at the lower left in Photo 2a is used for the WAG display (as explained in the text). To its right is the IMSAI S-100 computer that emulates the unrooted-tree network and performs the managerial WAG functions. Further to the right are the system console and bus-status monitor; the other microprocessors operate as nodes in the network. Photo 2b shows MATSRCH designer Ivan Zatkovitch using an Apple II computer in a version of the game that requires only one player.*

were extremely complex, yet it was possible to bring in a group of neophytes and have them playing well in very short order. The most remarkable thing about this learning was that it took place with surprisingly little explanation time; it happened mostly as a result of doing whatever was necessary to handle the task at hand. It was also a form of learning that prompted students to develop new strategies and theories. It was, to use a phrase we later coined as being particularly appropriate, *inventive learning*.

The Generalization of N-Trek

The new Solo/NET/works project (which like its predecessor is supported in part by the National Science Foundation Development in Science Education program) can be looked upon as an extension and generalization of the N-Trek experience. The goal of the project is to develop a prototype learning environment that will support a variety of multiprocess simulations.

Physically, the environment will consist of a room (or several rooms) in which there is a variety of microcomputers interconnected via a loosely coupled network. The phrase *loosely coupled* is used in two senses. Technically, it means that the microcomputers in the network have independent (and very likely differently designed) system buses, and that they do not share memory. Pedagogically, it is used to mean that each microcomputer node will be running an independent program (ie: process) that uses its own independent memory. The node processes will be able to cooperate, but only in ways determined by the program designers, and only via data communicated over the network.

The reason we have kept the prefix Solo in the project name is to emphasize that the student controlling a given process (which may or may not have been designed by that student) is in charge of that aspect of the overall simulation. The sharing of data and the choice of which processes are to be cooperative is to be a student-team decision, and modifications of this decision will be viewed as an integral part of the learning process. We want the student activities to mirror the team efforts of professional scientific and engineering projects, but with strong emphasis on independent thought within a group effort.

Educational Applications

The tasks we have set in the first phase of the project (1980 thru 1982) are technical in nature. The first issue we must address is that of finding simple ways to interconnect low-cost hardware in a cooperative network setting. For this reason, it is premature to talk about applications. Of course, they will eventually be the most important aspect of the project.

Our approach to applications in this first phase has been to outline scenarios describing how the system might be used, but to do most of our initial network testing with simplified surrogate applications (an example will soon follow). The purpose of the scenarios is to help us verify the accuracy and workability of the various system hardware and software decisions that must be made right away, while helping point the way to the best use of new technology sure to be available by 1982 and beyond.

One example of a scenario we have found useful is based on the use of the Solo/NET/works system to model both realistic and futuristic air traffic-control systems. In this application, some students will play the role of pilots flying a variety of aircraft. Each student will control a microcomputer at a node of the network. The principal process running in the computer at one node will be a program that simulates the flight characteristics of a given (or imagined) aircraft. The other microcomputer nodes will be manned by air-traffic controllers. The principal process running at each of these nodes will be one that interprets data returned from aircraft transponders (a transponder is an "encoded" transmitter located in an aircraft), along with data on the position of ground-based navigational aids.

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DIGITAL PATHWAYS

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There will also be a distinguished node in the network which we call the WAG (*Weltanschauung*, or "world view," Generator). This will calculate all the data needed to generate a graphic display of the total universe within which these pilots and controllers function. Normally, the total WAG display will be visible only to observers or visitors who are *not* engaged in the simulation. However, windows on this universe appropriate to the functions at specific nodes will be available to these nodes. For example, an air-traffic controller will be given a graphic display of the aircraft in the specific sector he controls. This corresponds to the way in which radar displays are actually used today.

What will be learned by students working in such an environment? Specific learning will be in the areas of aerodynamics, navigation and geometry, piloting, and air-traffic control (for those so inclined vocationally). Also involved are large-system design, distributed computing, data-base design, and, of course, the physics and mathematics of Newtonian dynamics.

The Solo philosophy assumes that students will play an active role in the design and modification of the programs for the node processes. More importantly, we believe that the participants who design, develop, debug, and use such a system will learn to be *inventive*—to devise strategies and procedures that transcend anything that even the best teacher or text could hope to transmit.

The ultimate power of a multi-micro network is found in the fact that all the processes are run on general-purpose computers. This means that entirely new applications, and an entirely new set of challenges to be inventive, are only as far away as the imaginations of the users. We have found that visitors often suggest ingenious examples of such applications and that these represent a multitude of disciplines. Some of the other scenarios that we are working on as a result of such discussions are in the areas of corporate-business management, computer-operating systems, economic models, the colonization of space, and models of human physiology that could be used in medical education.

Network-Architecture Considerations

The subject of computer networking is extensive, and a substantial amount of literature detailing a variety of approaches has developed over the years. For our purposes, with our constraint to work with low-cost, off-the-shelf microcomputers, most of the options discussed in the literature were not directly applicable. It also became clear that, as with any new development, the promises of what could be done tended to be ahead of the availability of actual products. However, we spent some time thinking through the consequences of trying to apply the most recent ideas about local-area networking to our application, subject to the constraint that costs had to be minuscule compared to those associated with the commercial and scientific networks in use today.

We decided that even with this constraint, it would be advantageous to work *conceptually* with the unrooted-tree *passive-bus* configuration, considered one of the most powerful local-network architectures. Another name for this arrangement is the *global multiple-access*

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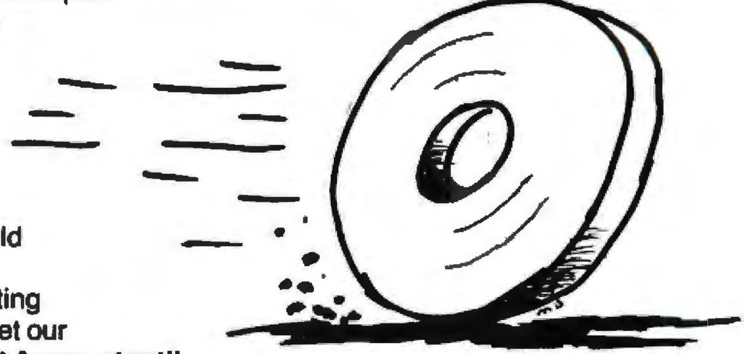

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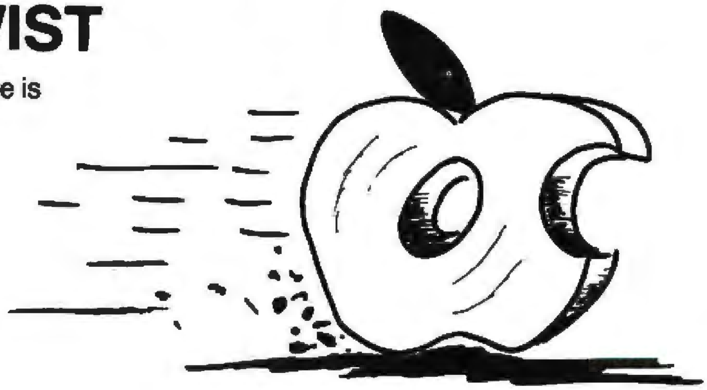

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bus. Recent applications of this architecture are the Xerox Company's Ethernet, and the Ungermann-Bass Net/One system.

Figure 1 gives a brief summary of some of the network architectures in use today. Although the passive-bus configuration appears to lack the complexity of the others, it is in reality a very general arrangement. This is because the bus (the heavy horizontal line) is assumed to be a wideband communications medium (usually a coaxial cable) to which any node can be connected by means of a transceiver. The transceiver contains sophisticated circuitry that allows the nodes to contend for access to other nodes without waiting for their turn in a polling scheme. This circuitry also allows for flexible addressing schemes that allow the access paths in the network to be configured in any way desired. Logically, this configuration is equivalent to a fully connected distributed system, with no limitations or dependencies on which nodes are to act as control centers.

Since it is not yet possible to buy low-cost bus hardware such as transceivers off-the-shelf for use with the popular microcomputers, we are simulating the passive bus-architecture with an S-100 microcomputer. The other node microcomputers in the network connect to standard serial I/O (input/output) ports on the S-100 machine. The idea is to have a program segment running in the S-100 computer that makes these ports appear to be "taps" onto a passive bus. Actually, all communications from the nodes will be via RS-232C ports which are available at a low cost. In the spirit of limiting costs even further, we are experimenting with having the same S-100 computer also act as one of the nodes.

Hardware and Software

There are many ways to put together a system that acts like a general microcomputer network. One approach would be to use a single machine running a sophisticated operating system like UNIX (a development of the Bell System Laboratories), which allows the various users on the system to set up "pipelines" with each other. Bill Gates of Microsoft has indicated that they will soon have such a system for use on the newer 16-bit microcomputers. This product will undoubtedly be worth investigating when it becomes available.

Two other products we considered were the Nestar system and the Corvus Constellation system. The Nestar system is designed specifically for Apple computers and the Apple II bus. The Corvus system was not in use anywhere that we could visit. Although both these products are ingenious developments, we felt that with the lack of generality and experience with their use, it would not be wise to acquire the Corvus and Nestar systems at this time. This decision was further supported by our equipment-budget limitations and our desire to test the feasibility of using a variety of low-cost microcomputers as network nodes. Once we have a better feel for the capabilities of the various machines, we will not be hesitant in choosing the models that perform the best for us. It is pretty clear that trying to accommodate all the differences found in the various brands of microcomputers today can create lots of problems.

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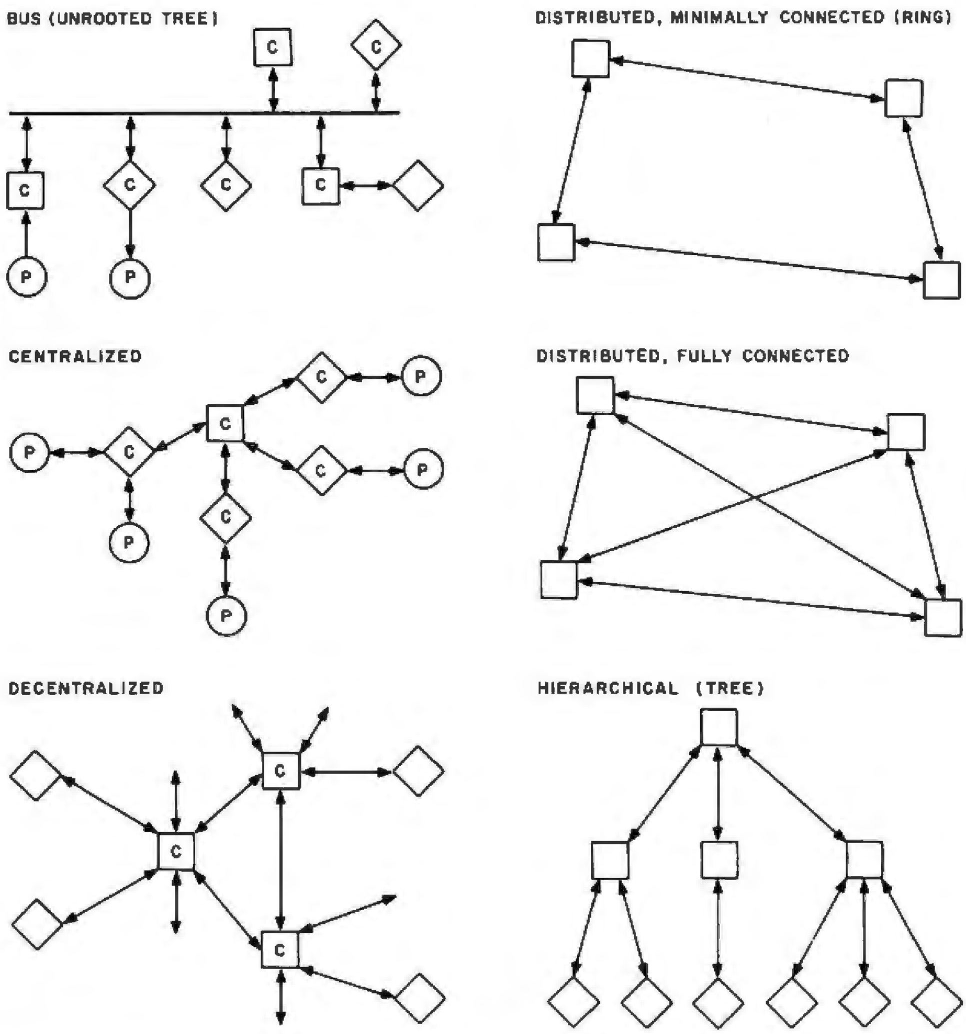

Figure 1: *Examples of network architecture. A network consists of nodes that are linked through communications channels. In these diagrams, square boxes represent nodes that act as resources in the network, circles represent users of these resources, and diamonds show devices or persons that act as intermediaries (buffers, terminals, displays, etc). The letters P and C indicate that the node is a person or a computer; a blank node means that the nature of the node is not specified.*

Fortunately, the lack of standardization is not as severe a problem with microcomputer languages and operating systems, and we had no misgivings about using Microsoft BASIC running under CP/M in the S-100 computer. Both products have proven to be sophisticated and reliable. Being able to count on this kind of stability has been a big plus. We may look into using the C or Pascal languages later on, but the microcomputer versions of these are still relatively new.

The simplest choice of system software for low-cost computers like the Apple, Atari, and Radio Shack's TRS-80 is to use whatever is supplied by the manufacturer. This can cause problems, however, and since it is now possible to add the CP/M-Microsoft BASIC combination to both the Apple and TRS-80, we may take this route later on. For the time being, we are trying to work with the system software supplied with each of these machines, supplementing it where necessary with bus interface programs written in machine language.

Surrogate Applications

By now it should be clear that putting together a system of this type is a complex job, especially for a small staff. Some of this complexity can be sorted out by recognizing that we (and, later on, others who wish to replicate the system) must wear three hats. The most important of these will eventually be that of the educator who uses the system. The second will be that of the application-program designer. The third is the one we are wearing most of the time at present, namely that of a multisystem designer. The job of a multisystem designer has to come first since the others build on its products. The problem is that any decisions at the system level can't be made without experience at the application level.

At this time, our strategy for dealing with this dilemma is to give consideration to a variety of educational applications, but to hold off on implementing them fully. A considerable effort in software engineering will be needed to implement the more advanced applications we have in

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mind, and for these we feel that it is wisest to confine ourselves to the highest level of the application design process at present. The catch to this strategy is that it doesn't get into the nitty-gritty detail that can have important repercussions on network-level design decisions. To handle this obstacle, we are also working with the complete design and testing of what we call surrogate applications. These are highly simplified but fairly accurate mappings of what we believe will be the essential ingredients of real applications.

The first surrogate application we have worked with is a game called MATSRCH. It was designed by Ivan Zatkovich as an undergraduate. He has since graduated and moved on to bigger and better things as a computer scientist. His application was designed to work with a minimal system in which an S-100 computer provides the network-bus function, while also handling several node tasks.

The arrangement of components used in MATSRCH is shown in figure 2 and photos 2a and 2b. The S-100 computer consists of an IMSAI mainframe equipped with an Ithaca Intersystems Z80 processor board and memory boards, and a Morrow disk controller and I/O boards. The computer runs Microsoft 5.1 BASIC under CP/M. The nodes controlled by persons P1, P2, P3, and so on, are equipped with low-cost machines such as the Apple II, the Atari 800, and the TRS-80. The processes in each of these machines are written in the BASIC supplied with the machine (usually a variant of Microsoft BASIC).

The idea of MATSRCH is to allow several players, each with his own computer, to move a spaceship through a world defined by a matrix-like coordinate system. Players issue commands that move their ships, ask for scans of the area in which they are located, and rendezvous with other ships. The program running in the S-100 computer performs three tasks: it manages the communication of data between nodes (ie: it emulates the network bus function), it keeps track of where everybody is in the matrix world of the game (supplying this information to the WAG display), and it displays bus-status information on the system console. This last function is not essential to the game, but it is a revealing way to keep tabs on where the bottlenecks in communications occur.

The present version of this simplified net monitor shows whether the S-100 program is doing network polling (and buffer management), interpreting data received from the nodes, or handling the WAG display.

The programs in the spaceship nodes are quite simple at present. They allow the players to issue commands that control the motion of their ships, and ask for information about the presence of other ships. The game limits the range that a player may ask to scan. In effect, individual nodes are able to look into small windows on the global space known to the WAG. Each node application program is also able to call upon a suitable driver program that can transmit or receive data from the bus. The programs in the nodes are actually parallel processes that cooperate in the MATSRCH game. The important point to note is that these processes can be expanded to take advantage of all the power of the microcomputer in which they reside. This is an important point; the local nodes

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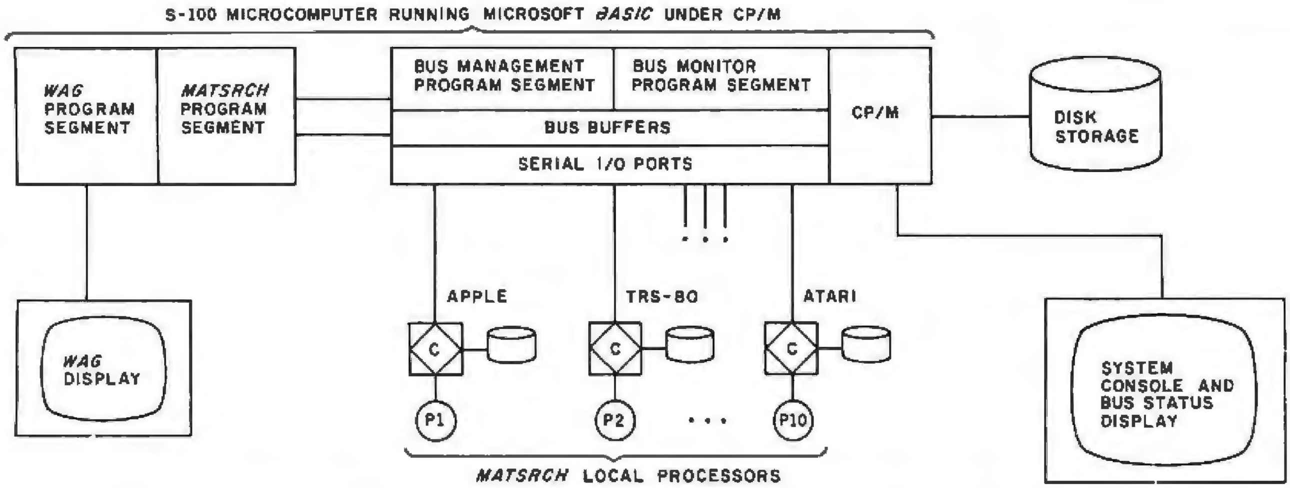


Figure 2: *The hardware and software arrangement for MATSRCH. This application uses an S-100 computer (indicated at the top of the diagram) for a variety of functions: the segment labeled "BUS" is involved in emulating the unrooted-tree network shown in figure 1. Each microprocessor node has a principal function (the task assigned to that node, indicated by a square) and a driver program that handles communications (indicated by a diamond).*

are *not* just terminals connected to a central processor.

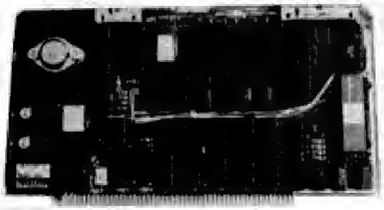
As was noted earlier, all communications between nodes are via RS-232C serial lines. Thus, even though our work is primarily concerned with a local network, there is still the capability of connecting several schools together via telephone lines and modems. The potential of interscholastic simulation gaming between several local high schools and colleges is intriguing, especially in terms of the higher levels of supportive social environments that could result. ■

Acknowledgments; Further Information

The Solo/NET/works project derives many of its ideas from its two predecessors, Project Solo and the Soloworks Laboratory. All three projects were funded in part by the Education Directorate of the National Science Foundation. Examples of early curriculum units from Project Solo were reprinted in Creative Computing *in 1979 and 1980. Articles describing some of the activities of Soloworks appeared in BYTE in December 1976, August 1977, March 1978, and May 1978. A description of the educational ideas that underlie the Solo philosophy was given in the article "Books As an Antidote to the CAI Blues" which appeared in the Education Forum of BYTE in June 1980, page 74.*

Documentation of the Solo/NET/works project will initially be in the form of working papers. These are for internal use only, but revised versions will later be submitted for publication in the Education Forum of BYTE. If you'd like to be placed on a mailing list for a notice of what has been published and where it appeared, send your name and address to Margot Critchfield, Department of Computer Science, University of Pittsburgh, Pittsburgh PA 15260. However, please understand that it will be some time before a complete list is available.

The material in this preliminary report is based in part on working papers by faculty associate Dr Sig Treu, and project staff members Margot Critchfield, Bob Hoffman, and Blaise Liffick. The material on the MATSRCH application was derived from a paper in preparation by Ivan Zatkovich.



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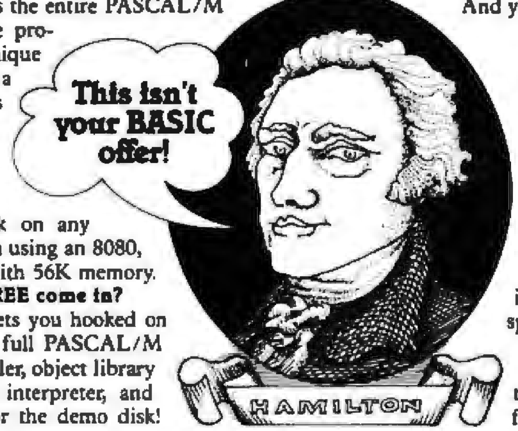

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System Review

The HP-41C: A Literate Calculator?

Brian P Hayes
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Calculator vs Computer

The computer and the programmable calculator seem to be following paths of convergent evolution. As the one is made smaller while the other gains in capability, the line of demarcation between them becomes more and more arbitrary. For now at least, the programmable calculator remains a distinct and lesser species, but it shares many of the attributes of the computer. Moreover, the shared attributes are chiefly the ones that make the computer an interesting machine. Both devices offer an intimate acquaintance with the powers and pleasures of algorithms. Both exhibit an enigmatic unpredictability: the response of the machine to any given stimulus is wholly deterministic, yet the behavior of a large program can be full of surprises, often to the frustration of the programmer.

Photo 1: *Components of the Hewlett-Packard HP-41C calculator system. Shown here are the calculator itself and three peripheral devices: a magnetic-card reader, a wand for reading printed bar codes, and a thermal dot-matrix printer. The peripheral units plug into four ports at the top of the calculator, which can also receive modules containing additional memory or precoded applications programs. The HP-41C alone costs about $300; a system including all three peripheral devices and two memory or applications modules is about $1000. (Photo by Ed Crabtree.)*

The HP-41C, which was introduced by the Hewlett-Packard Company about a year ago, is among the programmable calculators that lie closest to the computer borderline. It comes close enough for the jargon of computers to be useful in describing it. At the Corvallis Division of Hewlett-Packard, where the HP-41C is made, they refer to the calculator itself as the "mainframe" and to its accessory devices as the "peripherals." The calculator comes equipped with four input/output (I/O) ports, through which the various elements of the system are interconnected. Because the peripherals do some data processing internally, the system might even be said to have "distributed intelligence."

When compared with a computer, most programmable calculators have a rich instruction set, but they are deficient in memory capacity and in facilities for communication with the user. A calculator comes with such amenities as trigonometric, logarithmic, and statistical functions built in; with a computer, even floating-point arithmetic must usually be constructed out of software. On the other hand, no calculator has the memory needed to store large tables or other data structures. And it is the communication problem that most seriously limits the utility of the calculator. A display that can represent only the 10 digits, a decimal point, and a minus sign does not have much range of expression. Even for problems that have entirely numerical results, such a display is not always adequate, since without labeling of any kind it is easy to become confused about what a number means.

The HP-41C

In the HP-41C, the instruction set is at least the equal of that in any other calculator and the potential memory space is large (although it can never be large enough). The most conspicuous distinguishing features, however, have to do with communications and "human factors" (or, in other words, those things that aid in writing programs and in interpreting their results).

All three of the peripheral units now available serve to get information into or out of the HP-41C; they are a printer, a magnetic-card reader, and a wand for reading bar codes. But perhaps the most significant innovation of all is in the calculator itself: a liquid-crystal display that can represent not only numerals but also the complete uppercase alphabet and a few lowercase letters and other

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symbols. The letterforms are crude but perfectly legible; what they bring to the calculator is literacy, and it makes all the difference in man-machine relations.

The architecture of the HP-41C is not fundamentally different from that of its predecessors in the Hewlett-Packard line. There is a four-level stack of registers where pending operands are generally held; other registers are identified by a 2- or 3-digit address. The internal memory consists of 63 registers, but this number can be increased by plugging memory modules into the ports. Each module adds 64 registers, so that a full complement of four modules yields a total capacity of 319 registers; with all the ports occupied, however, no peripheral devices can be connected.

The memory available can be divided in any way desired between data storage and program storage. When allocated to data memory, a register holds a single floating-point number (10-digit mantissa and 2-digit exponent). Program capacity is more difficult to measure because instructions have varying space requirements. Without extra memory and with a reasonable allowance for data storage, the maximum for an unassisted HP-41C usually falls between 150 and 200 program lines. By adding three modules and keeping the same data space, the program capacity is expanded to about 1200 lines.

An additional wider register is dedicated to alphabetic operations. Up to 24 characters can be accumulated in the alpha register, although only 12 at a time fit in the liquid-crystal display; the extra characters scroll in to the left, marquee-style. The alphabetic capability is not a mere frill. The extent to which it is called upon in the everyday operation of the calculator can be illustrated by considering one of the curious challenges of calculator design.

Mnemonic Functions

The problem is that most scientific calculators have more instructions than they have keys; in the case of the HP-41C, there are more than 130 instructions and only thirty-five keys. A *shift* function doubles the number of distinguishable key sequences, but that still leaves almost half the instruction set without a home on the keyboard. Rather than further increase the number of keys or the number of shifted modes, Hewlett-Packard has adopted a solution familiar in larger systems: all instructions, whether or not they appear on the keyboard, can be executed by spelling out their mnemonic in the display. Programs resident in memory and instructions associated with peripheral devices can be executed in the same way.

Execution of a mnemonic label has the significant advantage of eliminating all dependence of the instruction set on the layout of the keyboard. It also has certain potential drawbacks that the designers of the HP-41C have gone to some lengths to remedy, largely by exploiting the alphabetic display. For example, if the spelling of a mnemonic is forgotten, a complete listing of the instruction set can be called up by the CATALOG function.

Another objection is that repeatedly spelling out a function can be tiresome on a keyboard smaller than the human hand. This burden has been relieved by the radical strategy of allowing all the keys to be redefined by the user. Any instruction (with the exception of a few program-editing pseudoinstructions) and any program can be assigned to any key.

The fluid indeterminacy of the keyboard leads to a further possible complaint: the user may lose track of what function has been assigned to a particular key. Two devices come to the aid of the forgetful. A keyboard overlay slides into place to relabel the keys according to the chosen assignments; if several programs require different key assignments, a separate overlay can be made up for each one. The second aid is more elegant: the current function of any key can be verified merely by pressing the key and holding it down a moment. The mnemonic of the function appears in the display. If the key is released, the function is executed; otherwise, the word "null" appears and the command is canceled.

[A third aid to the use of the HP-41C keyboard is the selection of the user/standard mode. The key redefinitions are valid only when the calculator is in the user mode. To use a key that has been redefined for its original function, the user has only to press the USER key to toggle the calculator back to its standard mode. In the standard mode, the HP-41C behaves as it would before any keys were assigned, thus giving the user the best of both worlds. . . . GW]

Further Features for the Programmer

The versatility of the liquid-crystal display is exploited in several other ways to make the HP-41C friendly and fool-resistant. A row of indicators below the main display provides various indications of mode and status. Error messages can be reasonably explicit: an attempt to divide by 0 elicits "data error," and a number greater than 10^{99} is flagged as "out of range." When a conditional

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test, such as "X = 0?", is executed from the keyboard, *the display* answers the question "yes" or "no."

Alphabetic text can also have a valuable role within a program. How it is employed is largely up to the programmer, but two obvious uses are prompting for inputs and labeling outputs.

Even with the best of keyboard technologies, entering a long program is inevitably tedious. A feature of the HP-41C that helps in avoiding needless repetition of effort is a *continuous memory*, which maintains all data and programs even when the calculator is turned off. Key assignments, the settings of flags, and other status information (such as the angular mode) are also preserved. A program that is run frequently can be kept in the calculator. Memory resources are finite, however, and on occasion a program must be cleared to make room for another and later reloaded. It is for such purposes that the magnetic-card reader and the bar-code reader are intended.

Using Cards

The magnetic-card reader, which occupies one port, is a small unit that clips onto the top of the calculator and can be left in place. The cards are the standard 1 by 7 cm magnetic strips (slightly smaller than a stick of chewing gum) that are also employed by the HP-67 and HP-97 and by some Texas Instruments calculators. They are inserted in a slot at the side of the reader and pulled through by a motor for retrieval on the other side. Each card has two tracks and each track holds the contents of 16 registers, which can be either data or programs. A long program requires several cards, and a routine that saves the state of the entire machine sometimes calls for a whole deck of them.

Cues provided by the calculator make operations with the cards almost mindless. When writing a program onto cards, a message in the display indicates how many tracks will be needed; when reading a program, the same message gives the lowest-numbered track that has yet to be read. The cards can be inserted in any sequence, and the information is sorted out internally. A defective card or an unsuccessful pass through the slot generates an appropriate error message.

Cards can be both written and read at the command of a running program. For example, a data card might be requested during an initialization routine, and new values might be written onto the card at the end of a calculation. Or one of several possible subroutines might be appended to a running program once the program had determined which subroutine was needed. Unfortunately, all these procedures still require human intervention for the actual insertion of the card. Thus, the user must attend the machine and feed it by spoonfuls on demand.

An amusing feature of the card reader is its ability to create "private" program cards. When such a card is read back into the calculator, the program appears in the catalog and becomes available for execution, but it cannot be examined, modified, or copied onto another card. Any attempt to do so is blocked by the imperious message "private." The security measures seem to be effective (although I have not worked seriously at penetrating them); how often they will be needed is another question. In the realm of very-small-scale systems, the major worry is theft of hardware, not software.

Software Compatibility

The introduction of a new model computer often raises questions of software compatibility. In this case, Hewlett-Packard has made the new machine compatible with the old software by including a translator routine in the card reader. Magnetic cards written on the HP-67 or HP-97 can be entered into the HP-41C and, with no intervention by the user, will be converted into HP-41C programs. Thus, the machine has access to the large body of software written for the earlier calculators, including more than 3000 programs in a users' library administered by Hewlett-Packard.

An incidental benefit is the addition of more than a dozen instructions peculiar to the HP-67 and HP-97 that become available on the HP-41C whenever the card reader is plugged in, even though most of those instructions have nothing directly to do with card operations. For example, there is a block-memory swap that comes in handy occasionally.

Bar-Code Wand

One drawback of magnetic-card recording is the cost of the medium: roughly fifty cents a card, plus the considerable expense of the card reader itself. There is also the delicacy of the iron-oxide surface, which necessitates careful storage and the maintenance of duplicate copies for backup. A second input device for the HP-41C, the bar-code reader, relies on the most inexpensive of all known storage media, ink on paper. The reader is a

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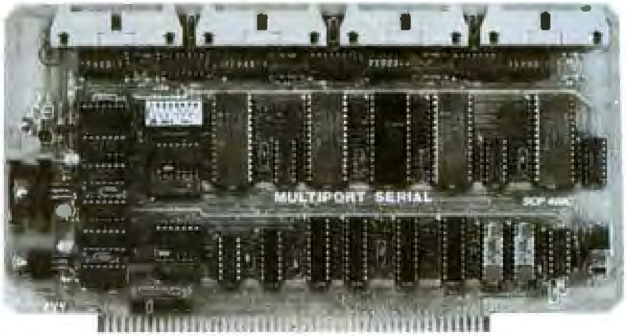

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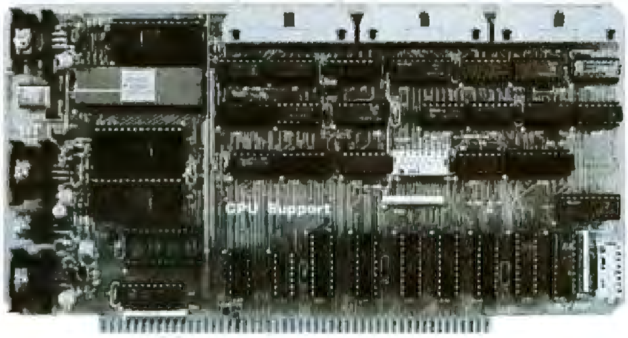

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hand-held wand similar to a general-purpose one introduced some months ago (the Hewlett-Packard HEDS-3000), but it has an interface and a plug specifically adapted to the HP-41C.

With programs encoded and printed by Hewlett-Packard, the wand works extremely well. A line of code can be scanned in either direction, although multiple lines must be read in sequence. The calculator display prompts for the lowest-numbered line not yet read. Even more helpful is audible confirmation. After each successful pass, the calculator emits a high-pitched beep; a failure results in a lower-pitched tone. The speed and orientation of the wand are not critical, and with practice the success rate becomes quite high.

The wand can also do a few things besides the straightforward loading of programs. Individual instructions can be executed from a "paper keyboard" (which is a table of bar codes, each of which is a single HP-41C instruction); data can be entered directly into designated storage registers; subroutines can be appended and programs merged. One wand function, instead of translating the scanned bar code into HP-41C operation codes, displays the actual binary value represented by the bars.

Printed machine-readable code is an ideal medium for the mass distribution of programs, and Hewlett-Packard will reportedly make all its software for the HP-41C available in this form. Programs from the users' library will also be offered in bar code, presumably at a lower price than programs on magnetic cards. For frequent users of such prepared software, bar code seems to be the medium of choice.

The situation is somewhat different, however, for those whose main interest is in writing their own programs rather than in running other people's. The trouble is that bar code, for now, remains largely a one-way channel of communication.

It is possible to assemble by hand a bar-code representation of a program. The basic materials are adhesive labels, each bearing the code for a single instruction or a single numeric or alphabetic character. [*The "paper keyboard" can also be photocopied, with a program being created by cutting and pasting photocopied bar-code keystrokes. . . .* GW] A long program, however, would require several hundred labels; moreover, they must be scanned as a series of many short strokes. The ability to reproduce the program by photocopying might sometimes compensate for this inconvenience, although the wand owner's manual warns that such copies may not always give acceptable results. (Three copying machines I tried all produced readable images, although the error rate was somewhat higher than with originals.)

For those who have access to a computer system that includes a daisy-wheel printer or a plotter, Hewlett-Packard will supply programs in BASIC or FORTRAN that will generate bar code in the HP-41C format. A far more appealing method would be to produce the bar code on the printer in the HP-41C system; if that could be done, the wand might entirely displace the magnetic-card reader. The HP-41C printer can readily be made to generate patterns that superficially resemble bar codes. In several weeks of experimenting, however, I have been unable to persuade the wand to recognize those patterns

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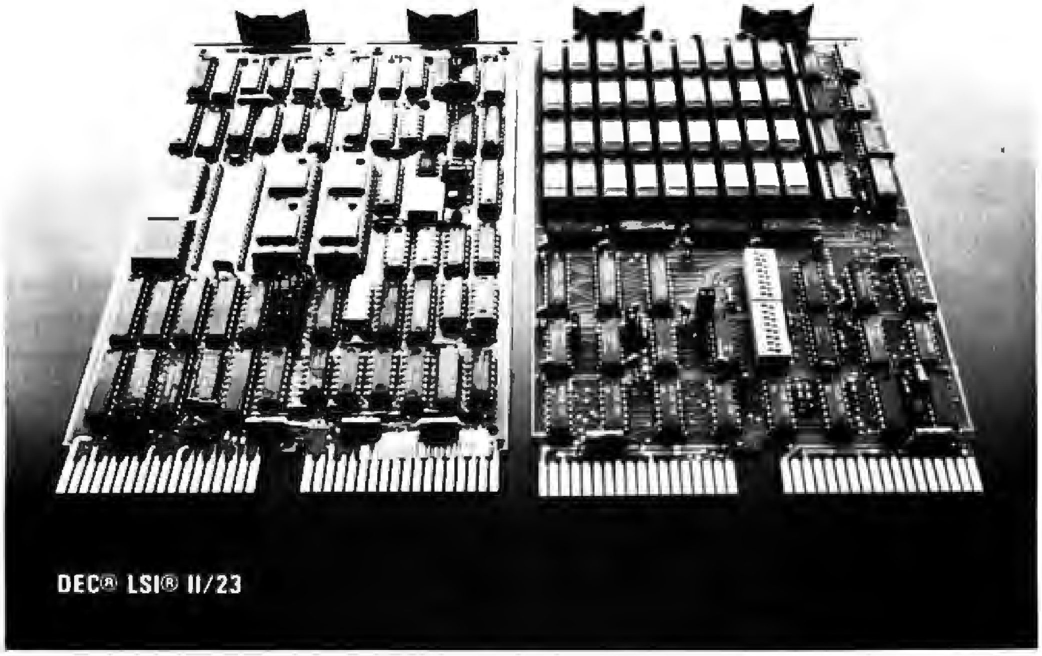

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reliably. The printer output itself, which is made up of blue or purple characters, is not recognized at all by the wand, and photocopies give erratic results.

Even if the problems of color, contrast, and resolution could be solved, there would remain other impediments. The bar pattern for most of the instruction codes exceeds the capacity of the print buffer; what is more, with no means of summoning up operation codes from program memory, printing the bar-code representation of a program would necessarily entail manual translation. With the system in its present configuration, bar-code output from the printer does not seem to be practical, although it is tantalizingly close.

The mere possibility of obtaining hard copy greatly enhances the utility of the calculator . . .

The Printer

The printer is easily the most engaging component of the HP-41C system. The mere possibility of obtaining hard copy greatly enhances the utility of the calculator, since it relieves the operator of the need to transcribe results as they become available. The printer for the HP-41C does more than that: it will reproduce anything that appears in the display and much else besides.

The print mechanism is a thermal, dot-matrix one; 24-character lines are printed on rolls of heat-sensitive paper about 6 cm wide. There is a standard set of 127 characters, including full uppercase and lowercase alphabets, the ten numerals, a few Greek letters, and miscellaneous other symbols and punctuation marks. All characters can be printed in a standard 5 by 7 matrix or in a double-width format. A few of the standard calculator instructions trigger printing and, in addition, the printer has its own repertoire of about twenty-five instructions.

Programs can be listed in their entirety, or a designated number of lines can be printed out; in either case, the listing shows the same mnemonics that appear in the display. The path followed by the calculator through a program being executed can be traced, providing a record of all instructions and operands; this is a useful facility when the program does not function as expected. The contents of the operand stack can be printed out with a single command; so can the contents of all allocated memory registers, or of a defined block of registers. In addition, assignments of nonstandard functions to the keyboard and the status of all flags can be listed. All of these functions can be executed manually or within a program.

The most commonly invoked print functions are those that print the contents of the *X* register (roughly equivalent to an accumulator), the alpha register, or a print buffer. The variations offered by these instructions allow the output of a program to take almost any format within the physical capabilities of the printer. The main limitations are the time and space the programmer wishes to dedicate to format commands. It is easy to list a series of variable names, each followed by a colon or an equals sign and a value. Tabulating two or three columns of numbers so they line up vertically on their decimal points

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The dot-matrix print head is a single vertical row of print elements that sweeps across the paper forming characters as a series of columns (see table 1a). A special set of printer instructions brings this process under program control so that nonstandard characters can be created. Indeed, the printer reproduces any pattern that can be defined by a matrix 7 dots high and no more than 40 dots wide. If the pattern fits in a 7 by 7 box, it can be treated as a special character, stored in a register, and called up as needed. In principle, a complete font could be built up in this way, although its usefulness might be somewhat impaired by the limited capacity of the print buffer: only 6 special characters per line can be printed. A more practical application is the creation of schematic symbols and markers, such as playing-card suits, chess pieces, or the phases of the moon (see table 1b).

Another capability of the printer is the plotting of graphs for any function that can be expressed in the form $y = f(x)$. The graph is drawn under the direction of a program called PRPLOT (print plot), which is committed to read-only memory in the printer. When PRPLOT is executed (see listing 1), it first asks the user to supply certain information that determines the form of the graph, such as the range of x and y. It then calls on a named program, also supplied by the user, that for each given value of x must return a value $f(x)$. The resulting graphs cannot compare to the product of an x,y plotter, but they can be run off quickly and are adequate for gauging the basic form and range of a function. PRPLOT can also be executed from within a program without the prompting for input values, and various parts of it can be called independently.

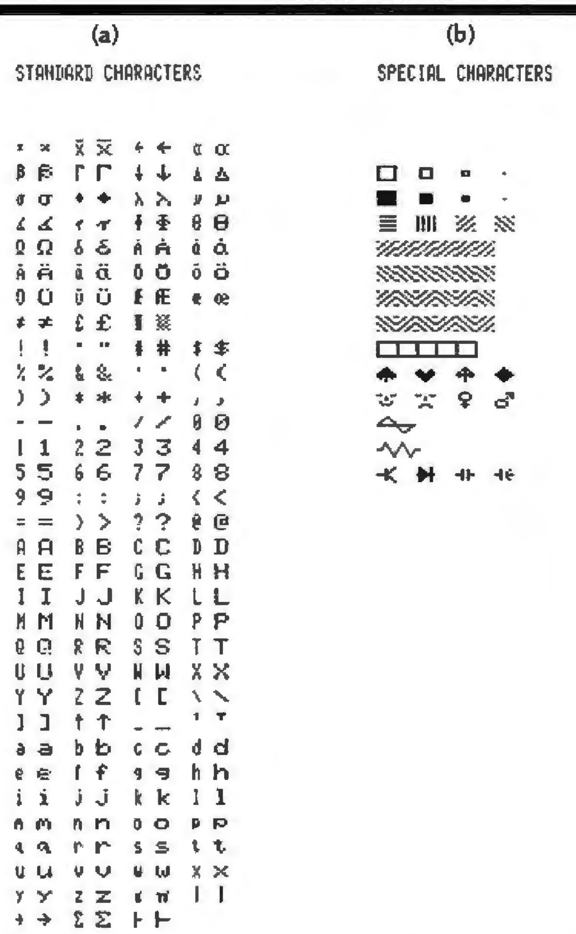


Table 1: *Character set as printed by the HP-41C printer. The standard character set, shown in table 1a, contains 127 letters, numbers, and other symbols. About sixty of them, including the full uppercase alphabet, can also be represented in a somewhat different form in the display of the HP-41C itself. Each character can be printed in a standard 5 by 7 dot matrix or in a double-width format. Special characters (table 1b) can also be created by specifying the pattern of dots in each column of the character.*

Programming with Labels

An organizing principle of programs for the HP-41C is that all references and transfers of control are made by means of *labels*. The name given to a program constitutes a global label, one that can be accessed from any point in program memory. By invoking the name, a program can be called as a subroutine and can even call itself, although there are limits to such recursion.

Labels within programs are generally local, so that the same labels can be repeated in different programs without interference. Subroutine calls and branches can be made only to a label; there is no absolute addressing by line number. As a result, all programs and procedures within programs can be relocated at will. Lines can also be freely inserted or deleted without adjusting references elsewhere.

Instructions that require an address or a numerical argument can be given it either directly or indirectly. The addressing modes are uniform for all memory operations, subroutine calls, branching, loop control, the setting, clearing, and testing of flags, and even such functions as setting the display format and determining the pitch of the beeper. A subroutine is called by the XEQ (execute) function, which must be followed by a local label or the name of a program.

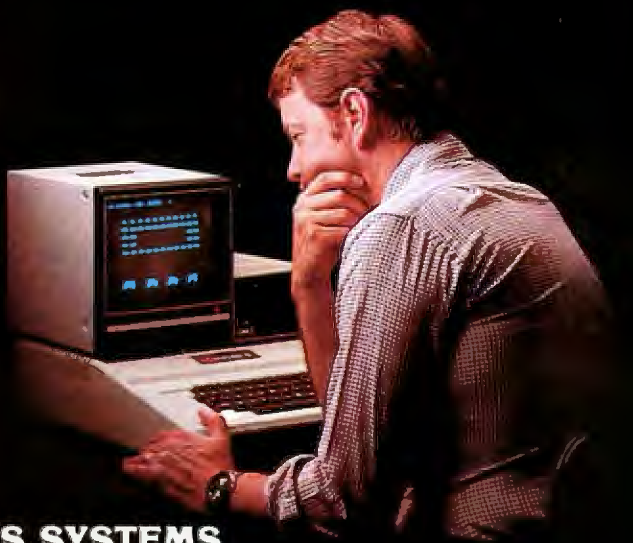
If the instruction is an indirect one (XEQ IND), the 2-digit number that follows is interpreted as the register where the subroutine name or label will be found. Any register, including those of the stack, can hold the indirect address. Subroutines can be nested six levels deep before the return address of the highest-level routine is lost.

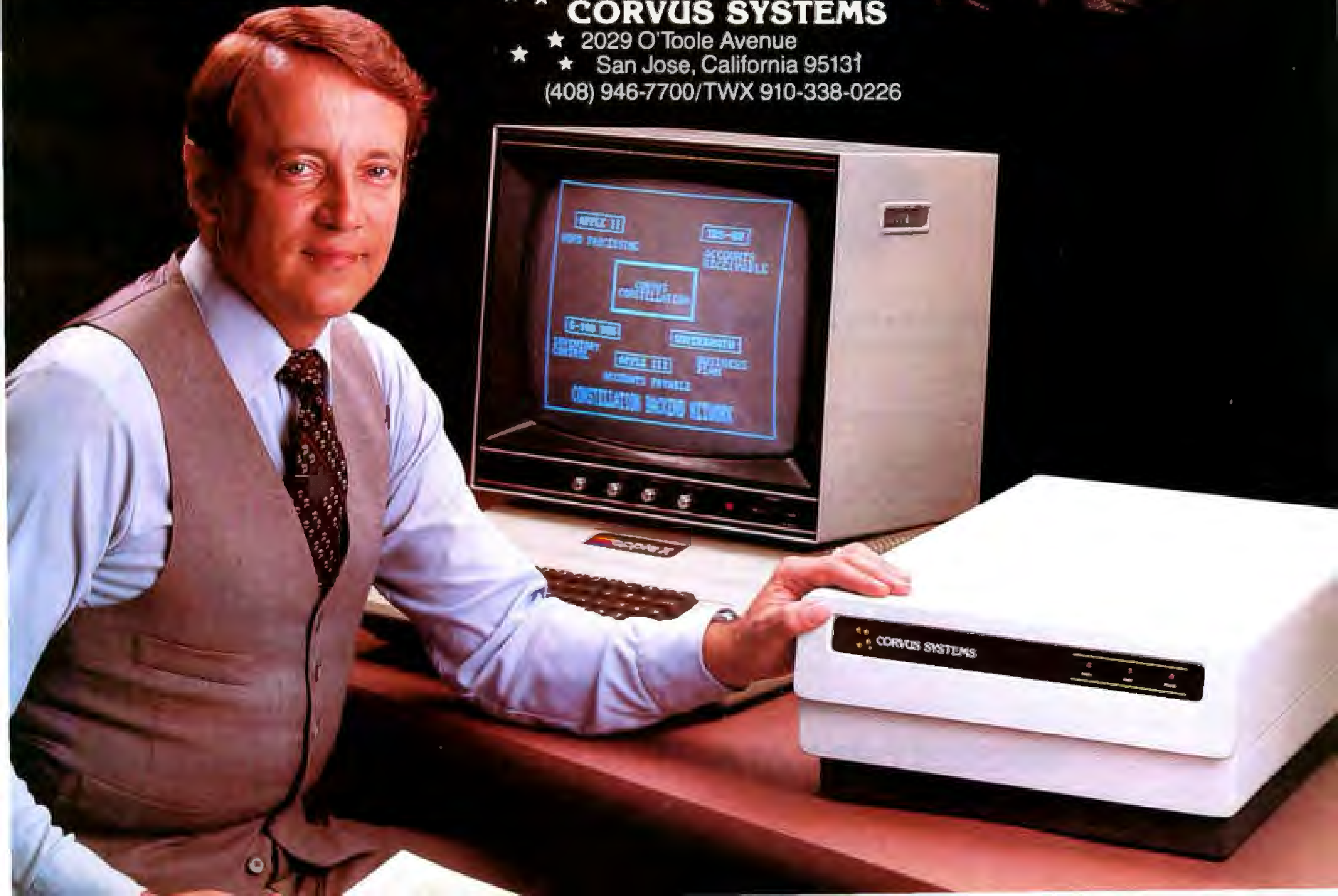
Conditional tests of numerical data include various combinations of "less than," "greater than," "equal to," and "not equal to"; alphabetic strings can also be compared, but only for equivalence. All the tests have the same format, in which a false result causes the instruction following the test to be skipped. Tests of flags (set or clear) employ the same scheme. The complement of fifty-six flags seems particularly generous. Eleven flags are completely unencumbered for use in programs; the rest control the status of the HP-41C and its peripherals, thereby affording the calculator a valuable amount of self-knowledge.

Loops

The control of loops in HP-41C programs is facilitated by two instructions that store all the needed information in a single register. The instructions, ISG (increment, skip if greater) and DSE (decrement, skip if equal), refer

Circle 79 on inquiry card. →





CORVUS SYSTEMS

directly or indirectly to a register holding a number of the form *nnnnn.tttcc*. Here *nnnnn* is the number to be tested, *ttt* is the value against which it is tested, and *cc* is the amount by which *nnnnn* is incremented, or decremented. The compacted form is a convenience, although I find it odd that the incremented number has a range of up to 99,999, whereas a jump must take place whenever it exceeds 999.

Other Programming Features

The HP-41C cannot realistically be said to support structured programming, not as I understand the term. The rule that all procedures should have a single entry point and a single exit, which is one of the precepts of structured programming, cannot be observed without extreme awkwardness. On the other hand, the program-control structures of the HP-41C strongly encourage the composition of modular programs, where each procedure is a self-contained unit, small enough to be fully understood and capable of being tested independently. In a program longer than a few hundred lines, some such technique for imposing order is obligatory.

In the end, the capabilities of the HP-41C can be exhibited best by real programs and their output. A few short utility routines and a longer program, called CHART, are given in listings 2 and 3. CHART, which incidentally shows off to good advantage the versatility of the printer, produces a bar graph, a form of display that is more appropriate for some kinds of data than the line graphs of PRPLOT.

The main program in CHART (listing 2), which is confined to the first 20 lines, is little more than a list of XEQ statements. It first prompts the user for needed information, then does some preliminary calculations and prints a header that will identify the graph. An external program (see listing 4) is then called once for each bar; it is expected to return a value defining the length of the bar and a label of not more than 4 characters.

It is worth noting that the actual calculation of the bar length is a trivial operation. The bulk of the program is taken up with input and output routines, which are intended to minimize the burden on the user's memory and faculties of interpretation. A bar graph generated by the CHART program is shown for data on the distribution of digits obtained from the RDM LN pseudorandom-number generator; see listing 5.

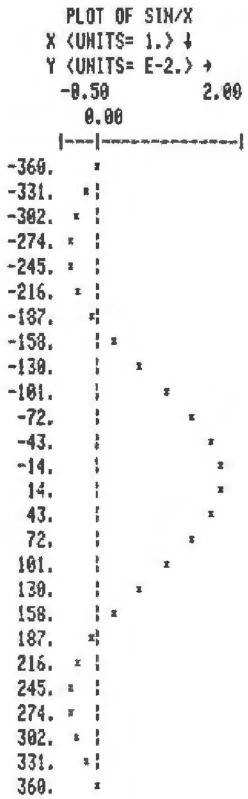
Next Generations

What more can one ask for in a programmable calculator? Quite a lot; there is much to look forward to in the next generation. More memory is always near the top of such a wish list. One way of supplying it, which might be compatible with the present mainframe, would be in a double-density memory module. The entire address space could then be utilized without filling all the ports.

The very existence of ports inspires thoughts of other

Text continued on page 136

Listing 1: *Graph of the function (sin x)/x was drawn by PRPLOT, a program that resides in read-only memory in the HP-41C printer. The function itself is defined by a separate program (at bottom), which evaluates the expression each time it is supplied with a value of x and called PRPLOT.*



```
01•LBL "SIN/X"
02 RCL X
03 SIN
04 X<>Y
05 /
06 END
```

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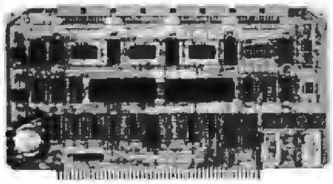

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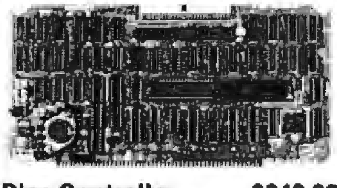

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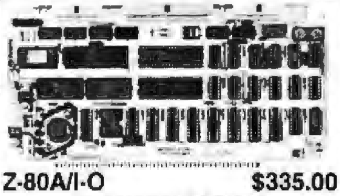

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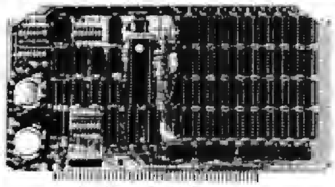

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Listing 2: *A bar-graph program. CHART, the HP-41C program for generating bar graphs, is written as a series of modules. The first of these prompts the user to supply certain initial information that will determine the form of the graph. An alternative entry point, CHARTP, is intended for occasions when the bar-graph routine is called from another program; this entry point bypasses the prompting. For each bar drawn, CHART calls on a user-supplied program, which must return two items, the value to be plotted in the X register and a label for the bar no more than 4 characters long in the alpha register. The bar is actually formed in subroutine 08 out of a standard character and additional print columns for fine adjustment of the length.*

```
01♦LBL "CHART"
02♦LBL a
03 XEQ 00
04♦LBL "CHARTP"
05 XEQ 01
06 XEQ 02
07 XEQ "BAR"
08♦LBL A
```

Initialization; can be executed from the keyboard by pressing "A."

```
09 XEQ 03
10 XEQ 04
11 XEQ 05
12♦LBL 30
13 XEQ 07
14 RCL 18
15 INT
16 XEQ IND 11
17 XEQ 08
18 ISG 18
19 GTO 30
20 XEQ 07
21 GTO 50
```

Main calculation and printing of bars. Calls a user program whose name is stored in register 11.

```
22♦LBL 00
23 CF 23
24 "PGM NAME?"
25 AON
26 PROMPT
27 FS? 23
28 ASTO 11
29 AOFF
30 CF 22
31 "NO. OF BARS?"
32 PROMPT
33 FS?C 22
34 STO 12
35 "Y MIN?"
36 PROMPT
37 FS?C 22
38 STO 13
39 "Y MAX?"
40 PROMPT
41 FS?C 22
42 STO 14
43 "AXIS?"
44 PROMPT
45 FS? 22
46 STO 15
47 RTN
```

Subroutine that prompts for inputs. In each case the prompting message appears in the display but is not printed. If no value is input following the prompt, the program assumes the value supplied on the previous run is still valid.

```
48♦LBL 01
49 RCL 12
50 1
51 -
52 1 E3
53 /
54 STO 18
```

Set up register for looped calls to user program.

```
55 137
56 RCL 14
57 RCL 13
58 -
59 /
60 STO 16
```

Calculate coefficient relating Y-axis scale to graph width of 137 columns.

```
61 RCL 15
62 XEQ 10
63 STO 17
64 5
65 X<>Y
66 X<=Y?
67 ST- 17
68 132
69 X<>Y
70 X>Y?
71 ST- 17
72 RTN
```

Calculate absolute position of axis; if beyond the range of the graph, axis is suppressed.

```
73♦LBL 02
74 ADV
75 ADV
76 "P"
77 ACA
78 SF 13
79 "LOT OF "
80 ACA
81 CF 13
82 SF 12
83 RCL 11
84 ACX
85 CF 12
86 PRBUF
87 RTN
```

Print identifying header: "Plot of 'PGM NAME' "

```
88♦LBL 03
89 SF 12
90 "X"
91 ACA
92 7
93 ACCHR
94 29
95 SKPCOL
96 "Y"
97 ACA
98 125
99 ACCHR
100 CF 12
101 PRBUF
102 RTN
```

Print labels for X and Y axes.

```
103♦LBL 04
104 RCL 13
105 ACX
106 XEQ 11
107 STO 10
108 RCL 14
109 XEQ 11
110 ST+ 10
111.144
112 RCL 10
113 -
114 SKPCOL
115 RCL 14
116 ACX
117 ADV
118 RTN
```

Labels extrema of Y axis.

```
119♦LBL 05
120 0
121 STO 10
122 RCL 17
123 X=0?
124 RTN
125 119
126 ACCOL
127 RDN
128 RCL 15
129 XEQ 11
130 ST+ 10
131 2
132 /
133 -
134 5
135 X>Y?
136 GTO 52
137 RDN
138 132
139 RCL 10
140 -
141 X<Y?
142 GTO 52
143 RDN
144♦LBL 52
145 INT
146 SKPCOL
147 ST+ 10
148 RCL 15
149 ACX
150 XEQ 12
151 RTN
```

Labels axis within graph, if it has not been suppressed.

```
152♦LBL 07
153 119
154 ACCOL
155 0
156 STO 10
157 XEQ 17
158 XEQ 12
159 RTN
```

Accumulates markers for the extrema points and the axis in spaces between bars.

```
160♦LBL 08
161 ACA
162 3
163 SKPCOL
164 RDN
165 XEQ 10
166 X<=0?
167 GTO 07
168 127
169 ACCOL
170 RDN
171 136
```

Master subroutine for accumulating and printing a bar. Checks if the length is zero; if so, executes LBL 07. Checks if the length is

Listing 2 continued on page 134

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- WHILE
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Listing 2 continued:

```
X<=Y?
GTO 09
RDN
STO 10
XEQ 15
RDN
XEQ 16
127
ACCOL
XEQ 17
XEQ 12
RTN
```

greater than the maximum; if so, executes LBL 09. Otherwise, the bar is built up by LBL 15 and LBL 16.

```
♦LBL 09
STO 10
XEQ 15
RDN
XEQ 16
127
ACCOL
ADV
RTN
```

Special routine for a bar that must fill the entire width of the graph.

```
♦LBL 15
7
X>Y?
RTN
X=Y?
RTN
31
ACCHR
RDN
-
GTO 15
```

Accumulates the maximum integer number of gray-tone characters (standard character 31) that will fit in the bar.

```
♦LBL 16
1
X>Y?
RTN
X=Y?
RTN
42
ACCOL
RDN
-
1
X>Y?
RTN
X=Y?
RTN
85
ACCOL
RDN
-
GTO 16
```

Finishes a bar by accumulating individual columns until actual length equals specified length.

```
♦LBL 17
RCL 10
1
+
RCL 17
X≠0?
X<=Y?
RTN
STO 10
X<>Y
-
SKPCOL
119
ACCOL
RTN
```

Inserts space from end of bar to maximum *Y* then adds a marker for maximum *Y*

```
♦LBL 10
RCL 13
-
RCL 16
*
FIX 0
RND
FIX 2
RTN
```

Calculates the length of the bar.

```
♦LBL 11
ABS
SF 25
LOG
CF 25
INT
5
+
.7
*
RTN
```

Calculates width of a number (eg: axis or extrema labels) in number of columns.

```
♦LBL 12
135
RCL 10
-
SKPCOL
119
ACCOL
ADV
RTN
```

Adds space to fill out a line, other than a line with a bar, then prints a *Y*-maximum marker.

```
♦LBL 50
ADV
ADV
BEEP
END
```

Beeps to mark finish.

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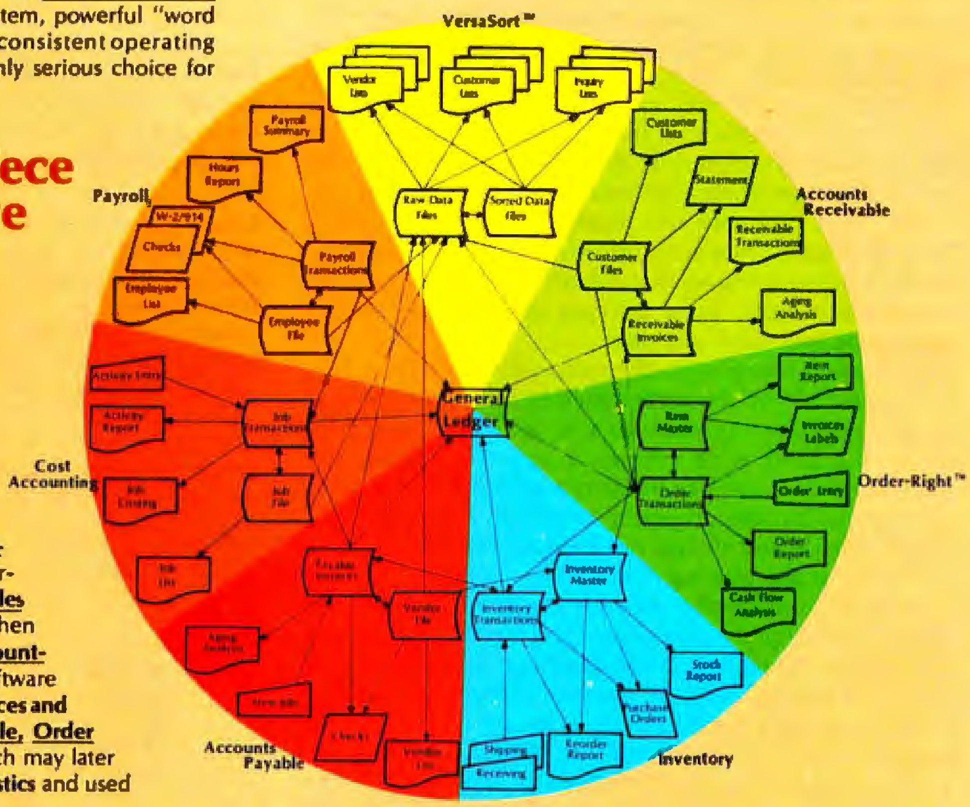

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Text continued from page 130:
peripheral devices. A cassette recorder could provide mass storage and would make feasible operations on large blocks of data. An x,y plotter could be driven very efficiently by the HP-41C, albeit at a leisurely pace. With a fairly simple interface, it should be possible to connect the calculator to a computer system. The likelihood that any of these products will ever be forthcoming is unknown. It is probably too much to ask that Hewlett-Packard release technical information on the signals available at the ports so that others could develop plug-compatible devices. Some intrepid experimenter with a logic probe may do it anyway.

There are a few gaps in the instruction set of the HP-41C that should not be perpetuated in future calculators. For example, there are tests for $x < y$, for $x \leq y$ and for $x > y$, but there is no test for $x \geq y$. Of course, any desired logic function can be fabricated out of the existing instructions, but the programmer should not have to go to that trouble and should not have to remember which of the tests is the missing one.

The most fundamental defect in the architecture of the HP-41C, inadequate numerical precision, is a serious flaw indeed. Numbers are represented, both internally and in the display, with 10 decimal digits; there are no guard digits. As a result, inaccuracies are quite often introduced into the least-significant digit. For example, $(\sqrt{2})^2$ is evaluated by the calculator as 1.999999999. For operations on some data, the corruption goes still deeper and 2 or 3 digits become suspect. There is something absurd about the world's fanciest calculator not being able to give results accurate to more than seven or eight decimal places.

Actually, a subsidiary problem is more serious than that. Conditional tests on data are carried out on the full 10-digit representation. Consequently, a test that effectively asks "Is $(\sqrt{2})^2$ equal to 2?" will give a false result, which can lead a program far astray.

Listing 3: *Utility routines for the HP-41C. These two routines are the kinds of programs that can remain in memory as resources to be drawn on by other programs, somewhat like macro instructions in an assembly language. BAR simply prints a heavy bar across the width of the paper to separate different kinds of information. TAB handles the spacing of numbers to be printed in vertical columns. It must be supplied with the number to be printed (in the X register) and the number of character spaces to be measured from the present position in the line of print to the decimal point. TAB was employed in formatting the random-number data in listing 2.*

```
01•LBL "BAR"
02 ADV
03 .023
04 31
05•LBL 01
06 ACCHR
07 ISG Y
08 GTO 01
09 PRBUF
10 ADV
11 ADV
12 END
```

```
01•LBL "TAB"
02 ABS
03 SF 25
04 LOG
05 CF 25
06 X<=0?
07 CLX
08 INT
09 1
10 +
11 RCL X
12 3.1
13 /
14 INT
15 +
16 CHS
17 +
18 SKPCHR
19 END
```

Listing 4: *Random-number routines for the HP-41C. These two random-number generators, standard coding exercises for programmable calculators, both calculate a pseudorandom real value, then select a single pseudorandom digit for return to the calling program. RDM LC employs the standard linear-congruential method, which has virtues and failings that are well understood. In this example,* R_{n+1} *is equal to* $(24{,}298R_n + 99{,}991)_{mod\ 199{,}017}$.

RDM LN is an algorithm the author stumbled upon but has not seen in the literature. R_{n+1} *is defined as* $1/\ln R_n$. *Experimental runs of up to several thousand iterations have given good results, but the behavior of the algorithm is not understood. A sample test is shown in listing 5.*

```
01•LBL "RDM LN"
02 RCL 20
03 ABS
04 LN
05 1/X
06 STO 20
07 1 E3
08 *
09 FRC
10 10
11 *
12 INT
13 ABS
14 END
```

```
01•LBL "RDM LC"
02 RCL 20
03 24298
04 *
05 99991
06 +
07 199017
08 MOD
09 STO 20
10 1 E3
11 /
12 FRC
13 10
14 *
15 INT
16 END
```

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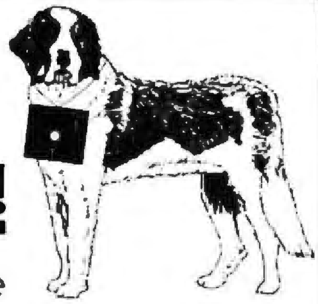

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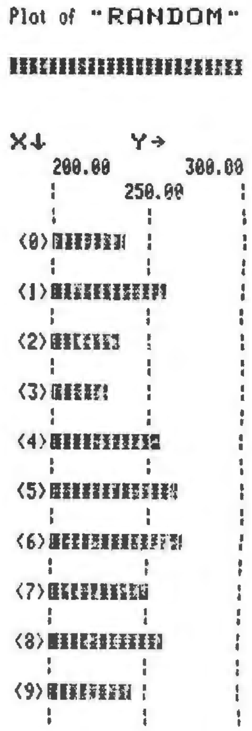
Listing 5: *Bar-graph results of the CHART program, given in listing 2. The graph represents pictorially the distribution of the 10 digits in a sample of 2500 pseudorandom numbers. The numbers were generated by another program, RDM LN (shown in listing 4), with the bookkeeping done by a third program.*

```
Test of "RDM LN"

Number of trials 2500

Seed = 1.234567890


DIGIT  COUNTS

MEAN =         250.00

 <0> =         237.
 <1> =         259.
 <2> =         234.
 <3> =         228.
 <4> =         256.
 <5> =         265.
 <6> =         268.
 <7> =         251.
 <8> =         259.
 <9> =         243.

RUNS OF 2:     211.
RUNS OF 3:      14.
RUNS OF 4:       3.
RUNS OF 5:       0.

 STATISTICS

CHI SQUARED =    6.8240
HIGH/LOW =       1.0593
ODD/EVEN =       0.9936
```



It is easy to imagine that some programmable calculator evolved from the HP-41C would have instructions much like those of a higher-level language. Having introduced named programs, the next obvious step is named variables, which would relieve the programmer of much tedious worry over memory allocation. Let the machine keep track of where the numbers are; it does so better than people can. The existing conditional tests, which act directly on particular registers, might be recast as a more general *if . . . then . . . else* construction, employing the named variables. Also, *do . . . while* and *repeat . . . until* commands would be a welcome addition; indeed, the loop-control instructions of the HP-41C already come close.

One essential capability must be added to the calculator before such higher-level commands can be made available. A higher-level language is a program whose output is another program, and so it is necessary that instructions be allowed to operate not only on data but also on other instructions. In this context, it seems significant that the inability of a calculator to alter its own instructions is what most clearly distinguishes calculators from computers. ■

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No.18

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All Lifeboat programs require CP/M, unless otherwise stated.

Software with Manual / Manual Alone

☐ **CP/M* FLOPPY DISK OPERATING SYSTEM**—Digital Research's operating system configured for many popular micro-computers and disk systems:

System	Version	Price
Apple II* SoftCard* with Z80 Microsoft BASIC version 5 with high resolution graphics	2.x	349/NA ◇
North Star Single Density	2.x	170/25
North Star Double/Quad	2.x	170/25
Durango F-85	2.x	170/25
iCOM Micro-Disk 2411	1.4	145/25
iCOM 3712 for MITS 88-2SIO Console	1.4	170/25 *
iCOM 3712 for 3P + S/MITS SIO Rev non-zero console	1.4	170/25 *
iCOM 3812	2.x	225/25
iCOM 3812	1.4	170/25 *
iCOM 4511/Pertec D3000	2.x	375/25 *+
Mits 3202/Altair 8800	1.4	145/25
Heath H8 + H17	1.4	145/25
Heath H89 by Magnolia	2.x	249/25 ◇
Ohio Scientific C3	2.x	200/25
Ohio Scientific C3-C	2.x	250/25
Onyx C8001 Standard	2.x	250/25
Onyx C8001 Enhanced	2.x	330/25
TRS-80 Model I	1.4	145/25
TRS-80 Model II	2.x	170/25
TRS-80 Model II + Corvus	2.x	250/25
Processor Technology Helios II	1.4	145/25
Intel MDS Single Density	2.x	170/25
Intel MDS Double Density	2.x	170/25
New Micropolis Mod I	2.x	200/25
New Micropolis Mod II	2.x	200/25
Mostek MDX STD Bus System	2.x	350/25 **

HARD DISK OPTIONS (items with ⓢ) when purchased with CP/M 2.X system.

Corvus .... Add 80.
Konan Phoenix .... Add 80.
ICOM 4511/Pertec D3000 .... Add 80.

*Software consists of the operating system, text editor, assembler, debugger and other utilities for file management and system maintenance. Complete set of Digital Research's documentation and additional implementation notes included. Systems marked * and ** include firmware on 2708 and 2716. Systems marked + include 5440 media charge. Systems marked ⓢ require the special ⓢ versions of software in this catalog. ◇ Includes hardware addition to allow our standard versions of software to run under it.*

☐ **Z80 DEVELOPMENT PACKAGE**—Consists of: (1) disk file line editor, with global inter and intra-line facilities; (2) Z80 relocating assembler, Zilog/Mostek mnemonics, conditional assembly and cross reference table capabilities; (3) linking loader producing absolute Intel hex disk file .... $95/$20

☐ **ZDT**—Z80 Monitor Debugger to break and examine registers with standard Zilog/Mostek mnemonic disassembly displays. $35 when ordered with Z80 Development Package .... $50/$10

AVOCET SYSTEMS

☐ **XASM-68**—Non-macro cross-assembler with nested conditionals and full range of pseudo operations. Assembles from standard Motorola MC6800 mnemonics to Intel hex .... $200/$25

☐ **XASM-65**—As XASM-68 for MOS Technology MCS-6500 series mnemonics .... $200/$25

☐ **XASM-48**—As XASM-68 for Intel MCS-48 and UPI-41 families .... $200/$25

☐ **XASM-18**—As XASM-68 for RCA 1802 .... $200/$25

☐ **DISTEL**—Disk based disassembler to Intel 8080 or TDL/Xitan Z80 source code, listing and cross reference files, Intel or TDL/Xitan pseudo ops optional. Runs on 8080 .... $65/$10

☐ **DISILOG**—As DISTEL to Zilog/Mostek mnemonic files .... $65/$10

☐ **SMAL/80** Structured Macro Assembler Language—Package of powerful general purpose text macro processor and SMAL structured language compiler. SMAL is an assembler language with IF-THEN-ELSE, LOOP-REPEAT-WHILE, DO-END, BEGIN-END constructs. Not compatible with CP/M version 2 or greater. .... $75/$15

New ☐ **RAID**—8080/8085 debugging aid and general system utility program. Both a software emulator and real-time debug monitor. Features multiple breakpoints, symbolic input, symbolic display and altering of registers, built-in assembler & dis-assembler, tracing, single-stepping, memory protection, histograms, memory search, direct disk access. Requires 32K CP/M .... $250/$25

PHOENIX SOFTWARE ASSOCIATES

☐ **PASM***—Z80 macro assembler, Intel/TDL mnemonics. Generates Intel hex format or relocatable code in either TDL Object Module format or PSA Relocatable Binary Module format. Supports text insertion, conditional branching within macros, recursive macro calls and parameter passing .... $129/$25

☐ **EDIT**—Character oriented text file editor. Includes macro definition capabilities. Handles insertion, deletion, searching, block move, etc. for files of any length. Does not require a CRT. .... $129/$25

☐ **PLINK***—Two pass **disk-to-disk linkage editor/loader** which can produce re-entrant, ROMable code. Can link programs that are larger than available memory for execution targeted on another machine. Full library capabilities. Input can be PSA Relocatable Binary Module, TDL Object Module or **Microsoft REL files**. Output can be a COM file, Intel hex file, TDL Object Module or PSA Relocatable file. .... $129/$25

☐ **BUG* and µBUG***—Z80 interactive machine level debugging tools for program development. BUG has full mnemonic trace and interactive assembly (mnemonics compatible with PASM). Dynamic breakpoints and conditional traps while tracing (even through ROM!). µBUG is a subset of BUG and is used in memory limited situations .... $129/$25

DIGITAL RESEARCH

☐ **MP/M**—Installed for single density MDS-800. Multi-processing derivative of the CP/M operating system. Manual includes CP/M2 documentation .... $300/$50

☐ **MAC**—8080 Macro assembler. Full Intel macro definitions. Pseudo Ops include RPC, IRP, REPT, TITLE, PAGE, and MACLIB. Produces absolute hex output plus symbol table file for use by SID and ZSID (see below) .... $120/$15

☐ **SID**—8080 Symbolic debugger. Full trace, pass count and breakpoint program testing. Has backtrace and histogram utilities. When used with MAC, provides full symbolic display of memory labels and equated values .... $105/$15

☐ **ZSID**—Z80 Symbolic debugger with all features of SID .... $130/$15

☐ **TEX**—Text output formatter to create paginated, page-numbered and justified copy. Output can be directed to printer or disk .... $105/$15

☐ **DESPOOL**—Utility program to permit simultaneous printing from text files while executing other programs .... $60/$10

☐ **tiny C**—Interactive interpretive system for teaching structured programming techniques. Manual includes full source listings .... $105/$50

☐ **BDS C COMPILER**—Supports structures, unions, 2 dimensional arrays, pointers, recursion and overlays. Features optimized code generator, variable sized buffers for file I/O, and capability to produce ROMable code. Includes macro package to enable user to produce linkable modules with MAC (see under Digital Research). Floating point functions, full run-time package and machine code library sources provided. Linker, library manager and textbook included. Compiler lacks initializers, statics, floats and longs. .... $145/$25

☐ **WHITESMITHS C COMPILER**—The ultimate in systems software tools. Produces faster code than a pseudo-code Pascal with more extensive facilities. Conforms to the full UNIX* Version 7 C language, described by Kernighan and Ritchie, and makes available over 75 functions for performing I/O, string manipulation and storage allocation. Linkable to Microsoft REL files. Requires 60K CP/M .... $630/$30

MICROSOFT

☐ **BASIC-80**—Disk Extended BASIC, ANSI compatible with long variable names, WHILE/WEND, chaining, variable length file records. MBASIC version 4.51 also included on disk. .... $325/$25

☐ **BASIC COMPILER**—Language compatible with BASIC-80 and 3-10 times faster execution. Produces standard Microsoft relocatable binary output. Includes MACRO-80. Also linkable to FORTRAN-80 or COBOL-80 code modules .... $350/$25

☐ **FORTRAN-80**—ANSI 66 (except for COMPLEX) plus many extensions. Includes relocatable object compiler, linking loader, library with manager. Also includes MACRO-80 (see below) .... $425/$25

☐ **COBOL-80**—Level 1 ANSI 74 standard plus most of Level 2. Full sequential, relative, and indexed file support with variable file names. Powerful interactive, formatted screen handling with ACCEPT and DISPLAY verbs. Program segmentation for execution of programs larger than memory and CHAIN command with parameter passing. Full support of CP/M version 2 files. Includes MACRO-80 (see above), linking loader, and relocatable library manager. Requires 48K CP/M .... $700/$25

New ☐ **M/SORT**—Optional sort/merge capability for COBOL-80 which conforms fully to SORT/MERGE, Level II of the 1974 ANSI COBOL standard (except COLLATING SEQUENCE IS alphabet-name). Requires COBOL-80. Sold as an update to COBOL-80 .... $150/$10
COBOL-80 + M/SORT .... $825/$35

☐ **MACRO-80**—8080/Z80 Macro Assembler. Intel and Zilog mnemonics supported. Relocatable linkable output. Loader, Library Manager and Cross Reference List utilities included .... $149/$15

☐ **XMACRO-86**—8086 cross assembler. All Macro and utility features of MACRO-80 package. Mnemonics slightly modified from Intel ASM86. Compatibility data sheet available .... $275/$25

☐ **EDIT-80**—Very fast random access text editor for text with or without line numbers. Global and intra-line commands supported. File compare utility included. .... $89/$15

☐ **muSIMP/muMATH**—muSIMP is a high level programming language suitable for symbolic and semi-numerical processing implemented using a fast and efficient interpreter requiring only 7K bytes of machine code. muMATH is a package of programs written in muSIMP. The package performs sophisticated mathematical functions. Keeps track of up to 611 digits. Performs matrix operations on arrays: transpose, multiply, divide, inverse and other integer powers. Logarithmic, exponential, trigonometric simplification and transformation, symbolic differentiation with partial derivatives, symbolic integration of definite and indefinite integrals. Requires 40K CP/M .... $250/$20

☐ **muLISP-80**—Microcomputer implementation of LISP. The interpreter resides in only 7K bytes of memory yet includes 83 LISP functions. Has infinite precision integer arithmetic expressed in any radix from 2 to 36. muLISP80 includes complete trace facility and a library of useful functions and entertaining sample programs .... $200/$15

☐ **PASCAL/M***—Compiles enhanced Standard Pascal to compressed efficient Pcode. Totally CP/M compatible. Random access files. Both 16 and 32-bit integers. Runtime error recovery. Convenient STRINGs. OTHERWISE clause on CASE. Comprehensive manual (90 pp. indexed). SEGMENT provides overlay structure. INPORT, OUTPORT and untyped files for arbitrary I/O. Requires 56K CP/M. Specify 1) 8080 CP/M, 2) Z80 CP/M, or 3) Cromemco CDOS .... $175/$20

☐ **PASCAL/Z**—Z80 native code PASCAL compiler. Produces optimized, ROMable re-entrant code. All interfacing to CP/M is through the support library. The package includes compiler, relocating assembler and linker, and source for all library modules. Variant records, strings and direct I/O are supported. Requires 56K CP/M .... $395/$25

☐ **PASCAL/MT**—Subset of standard PASCAL. Generates ROMable 8080 machine code. Symbolic debugger included. Supports interrupt procedures, CP/M file I/O and assembly language interface. Real variables can be BCD, software floating point, or AMD 9511 hardware floating point. Includes strings enumerations and record data types. Manual explains BASIC-PASCAL conversion. Requires 32K .... $250/$30 New

☐ **APL/V80**—Concise and powerful language for application software development. Complex programming problems are reduced to simple expressions in APL. Features include up to 27K active workspace, shared variables, arrays of up to 8 dimensions, disk workspace and copy object library. The system also supports auxiliary processors for interfacing I/O ports. Requires 48K CP/M and serial APL printing terminal or CRT .... $500/$30

☐ **ALGOL-60**—Powerful block-structured language compiler featuring economical run-time dynamic allocation of memory. Very compact (24K total RAM) system implementing almost all Algol 60 report features plus many powerful extensions including string handling direct disk address I/O etc. .... $199/$20

☐ **CBASIC-2** Disk Extended BASIC—Non-interactive BASIC with pseudo-code compiler and run-time interpreter. Supports full file control, chaining, integer and extended precision variables, etc. Versions of CRUN for CP/M versions 1.4 and 2.x included on disk. .... $120/$15

MICRO FOCUS

☐ **STANDARD CIS COBOL**—ANSI '74 COBOL standard compiler fully validated by U.S. Navy tests to ANSI level 1. Supports many features to level 2 including dynamic loading of COBOL modules and a full ISAM file facility. Also, program segmentation, interactive debug and powerful interactive extensions to support protected and unprotected CRT screen formatting from COBOL programs used with any dumb terminal .... $850/$50

☐ **FORMS 2**—CRT screen editor. Output is COBOL data descriptions for copying into CIS COBOL programs. Automatically creates a query and update program of indexed files using CRT protected and unprotected screen formats. No programming experience needed. Output program directly compiled by STANDARD CIS COBOL .... $200/$20

New ☐ **NEVADA COBOL**—Subset of ANSI-74. Features fast compilation and execution with small object modules. Has extended arithmetic with 18 digit accuracy. Extended I/O includes random access files and sequential files of both fixed and variable length records, and interactive accept/display verbs. Good error messages and debugging facilities enhance program development. Requires a 32K CP/M system .... $149/$25

EIDOS SYSTEMS

☐ **KBASIC**—Microsoft Disk Extended BASIC version 4.51 integrated with KISS Multi-Keyed Index Sequential and Direct Access file management as 9 additional BASIC commands. KISS included as relocatable modules linkable to FORTRAN-80, COBOL-80, and BASIC COMPILER. Specify CP/M version 1.4 or 2.x when ordering. Requires 48K CP/M $585/$45
To licensed users of Microsoft BASIC-80 (MBASIC) .... $435/$45

☐ **XYBASIC** Interactive Process Control BASIC—Full disk BASIC features plus unique commands to handle byte rotate and shift and to test and set bits. Available in several versions:

Version	Price
Integer ROM squared	$350/$25
Integer CP/M	$350/$25
Extended ROM squared	$450/$25
Extended CP/M	$450/$25
Extended Disk CP/M	$550/$25
Integer CP/M Run Time Compiler	$350/$25
Extended CP/M Run Time Compiler	$450/$25

☐ **RECLAIM**—A utility to validate media under CP/M. Program tests a diskette or hard disk surface for errors, reserving the imperfections in invisible files, and permitting continued usage of the remainder. Essential for any hard disk. Requires CP/M version 2. .... $80/$5

☐ **BASIC UTILITY DISK**—Consists of: (1) CRUNCH-14—Compacting utility to reduce the size and increase the speed of programs in Microsoft BASIC 4.51, BASIC-80 and TRS-80 BASIC. (2) DPFUN—Double precision subroutines for computing nineteen transcendental functions including square root, natural log, log base 10, sine, arc sine, hyperbolic sine, hyperbolic arc sine, etc. Furnished in source on diskette and documentation .... $50/$35

☐ **STRING/80**—Character string handling plus routines for direct CP/M BDOS calls from FORTRAN and other compatible Microsoft languages. The utility library contains routines that enable programs to chain to a COM file, retrieve command line parameters and search file directories with full wild card facilities. Supplied as linkable modules in Microsoft format. $95/$20

☐ **STRING/80** source code available separately— $295/NA

☐ **THE STRING BIT**—FORTRAN character string handling. Routines to find, fill, pack, move, separate, concatenate and compare character strings. This package completely eliminates the problems associated with character string handling in FORTRAN. Supplied with source .... $65/$15

☐ **VSORT**—Versatile sort/merge system for fixed length records with fixed or variable length fields. VSORT can be used as a stand-alone package or loaded and called as a subroutine from CBASIC-2. When used as a subroutine, VSORT maximizes the use of buffer space by saving the TPA on disk and restoring it on completion of sorting. Records may be up to 255 bytes long with a maximum of 5 fields. Upper/lower case translation and numeric fields supported .... $175/$20

New ☐ **IBM/CPM**—Program to transfer IBM 3741 data set files to CP/M files or CP/M files to IBM 3741 data sets. Easy to use. Requires two eight inch diskette drives, 24K memory, and a 24 by 80 CRT terminal .... $175/$5

CPAids*

☐ **MASTER TAX**—Professional tax preparation program. Prepares schedules A, B, C, D, E, F, G, R/RP, SE, TC, ES and forms 2106, 2119, 2210, 3468, 3903, 2441, 4625, 4726, 4797, 4972, 5695 and 6251. Printing can be on readily available, pre-printed continuous forms, on overlays, or on computer generated, IRS approved forms. Maintains client history files and is interactive with CPAids GENERAL LEDGER II (see below) .... $995/$30
Annual Update Fee $350

☐ **STANDARD TAX**—As above for schedules A, B, C, D, E, G, R/RP, SE, TC and forms 2106 and 2441. Also, does not maintain client history files .... $495/$30
Annual Update Fee $175

Neu in der Schweiz Lifeboat Associates GmbH, Aegeristr. 35, CH 6340 Baar **Telefon 042/31 2931**

Software with Manual / Manual Alone

□ **GENERAL LEDGER II**—Designed for CPA's. † Stores complete 12 month detailed history of transactions. Generates financial statements, depreciation, loan amortizations, journals, trial balances, statements of changes in financial position, and compilation letters. Includes payroll system with automatic posting to general ledger. Prints payroll register, W2's and payroll checks . . . . . $450/$30

□ **T/MAKER**—Powerful new tool for preparing management reports with tabular data. Makes financial modeling projects easy. Do you want a weekly profitability report? Set up the table and compute. Just change the sales figures for next week and compute. You have a new report! T/MAKER includes a full screen editor for setting up tables which pages left, right, up and down. Compute includes standard arithmetic, percents, exponents, common transcendental functions, averages, maxima, minima, projections, etc. Requires 48K CP/M, CBASIC-2, CRT terminal with addressable cursor positioning . . . . . $275/$25

□ **ESQ-1**—Professional time and billing for the ① legal profession. Designed for use by the first-† time computer user. Records billable and non-billable time. Complete system includes transaction entry, posting, billing, reports, and client analysis. Records cash receipts, escrow receipts, and escrow transfers. Requires 48K CP/M system, 480K of disk storage space, cursor addressable CRT, and CBASIC-2 . . . . . $1495/$50 *New!*

□ Complete demonstration system for ESQ-1 ① † . . . . . $75/$50

□ **BSTAM**—Utility to link one computer to another ⑧ also equipped with BSTAM. Allows file transfers at full data speed (no conversion to hex) with CRC block control check for very reliable error detection and automatic retry. We use it! It's great! Full wildcard expansion to send *. COM, etc. 9600 baud with wire. 300 baud with phone connection. **Both** ends need one. Standard and ⑧ versions can talk to one another. This software requires a knowledge of assembler language for installation . . . . . $150/$10

□ **BSTMS**—Intelligent terminal program for ⑧ CP/M systems. Permits communication between micros and mainframes. Sends character data files to remote computers under complete control. System can record character data sent from remote computer systems and data banks. Includes programs to EXPAND and COMPRESS binary files for transmission. This software requires a knowledge of assembler language for installation . . . . . $200/$25 *New!*

□ **WHATSIT?***—Interactive data-base system using associative tags to retrieve information by subject. Hashing and random access used for fast response. Requires CBASIC-2 . $175/$25

□ **SELECTOR III-C2**—Data Base Processor to † create and maintain multi-key data bases. ⑧ Prints formatted sorted reports with numerical summaries or mailing labels. Comes with sample applications, including Sales Activity, Inventory, Payables, Receivables, Check Register, and Client/Patient Appointments, etc. Requires CBASIC-2. Supplied in source . . . . $295/$20

□ **GLECTOR**—General Ledger option to SELECTOR III-C2. Interactive system provides for customized COA. Unique chart of transaction types insure proper double entry bookkeeping. Generates balance sheets, P&L statements and journals. Two year record allows for statement of changes in financial position report. Supplied in source. Requires SELECTOR III-C2, CBASIC-2 and 56K system . . . . . $350/$25

□ **MAGSAM III**—Sophisticated keyed access file ① support system. Supports random, sequential, and generic retrieval by key. Also, multiple secondary keys. Dynamic allocation and extension of files with automatic free space reclamation. Interactive tutorial included to get the user started. Complete with documentation and quick reference card. Specify CBASIC or Microsoft BASIC version. Requires 48K system . . . . . $145/$25 *New!*

□ **MAGSAM IV**—High speed machine code version of MAGSAM III for CBASIC only. Distributed as pre-loaded modules and Microsoft relocatable object modules . . . . . $295/$25 *New!*

DMA

□ **CBS**—Configurable Business System is a † comprehensive set of programs for defining custom data files and application systems without using a programming language such as BASIC, FORTRAN, etc. Multiple key fields for each data file are supported. Set-up program customizes system to user's CRT and printer. Provides fast and easy interactive data entry and retrieval **with transaction processing**. Report generator program does complex calculations with stored and derived data, record selection with multiple criteria, and custom formats. Sample inventory and mailing list systems included. **No support language required** . . . . . $395/$40

MICROPRO

□ **SUPER-SORT I**—Sort, merge, extract utility as ① absolute executable program or linkable module in Microsoft format. Sorts fixed or variable records with data in binary, BCD Packed Decimal, EBCDIC, ASCII, floating & fixed point, exponential, field justified, etc. Even variable number of fields per record! . . . . . $225/$25

□ **SUPER-SORT II**—Above available as abso- ① lute program only . . . . . $175/$25

□ **SUPER-SORT III**—As II without SELECT/ ① EXCLUDE . . . . . $125/$25

□ **DATASTAR**—Professional forms control entry ① and display system for key-to-disk data capture. Menu driven with built-in learning aids. Input field verification by length, mask, attribute (i.e. upper case, lower case, numeric, auto-dup, etc.). Built-in arithmetic capabilities using keyed data, constant and derived values. Visual feedback for ease of forms design. Files compatible with CP/M-MP/M supported languages. Requires 32K CP/M and CRT with addressable cursor . . . . . $350/$35

□ **WORD-STAR**—Menu driven visual word pro- ① cessing system for use with standard terminals. Text formatting performed on screen. Facilities for text paginate, page number, justify, center and underscore. User can print one document while simultaneously editing a second. Edit facilities include global search and replace, Read/Write to other text files, block move, etc. Requires CRT terminal with addressable cursor positioning . . . . . $445/$40

□ **WORD-STAR-MAIL-MERGE**—As above with ① option for production mailing of personalized documents with mail lists from DATASTAR or NAD . . . . . $575/$40

□ **WORD-MASTER** Text Editor—In one mode ① has superset of CP/M's ED commands including global searching and replacing, forwards and backwards in file in video mode, provides full screen editor for users with serial addressable-cursor terminal . . . . . $145/$25

□ **MAGIC WAND***—Word processing system with simple, easy to use full screen text editor and powerful print processor. Editor has all standard editing functions including text insert and delete, global search and replace, block move and library files for boiler plate text. Print processor formatting commands include automatic margins, pagination, headings & footings, centered and justified text. Also prints with true proportional spacing, merges with data files for automatic form letters, and performs run-time conditional testing for varied output. Requires 32K CP/M and CRT terminal with addressable cursor . . . . . $395/$40

□ **TEXTWRITER III**—Text formatter to justify and ⑧ paginate letters and other documents. Special features include insertion of text during execution from other disk files or console, permitting recipe documents to be created from linked fragments on other files. Has facilities for sorted index, table of contents and footnote insertions. Ideal for contracts, manuals, etc. Now compatible with Electric Pencil* and Word-Star prepared files . . . . . $125/$20

□ **DATEBOOK**—Program to manage time just like an office appointment book but using the speed and memory of a computer. Keeps track of three appointment schedules (three dental chairs, three attorneys, etc.) at once. Appointments consist of name, reason for the appointment, the date and time, and the length of the appointment. System can be quickly customized for the individual user. Many helpful features for making, changing, finding, and reporting appointments. Requires 48K CP/M and 180K bytes diskette storage. Requires 80×24 cursor addressable terminal. Specify 8080 CP/M, Z80 CP/M or Cromemco CDOS . . . . . $295/$25 *New!*

PEACHTREE SOFTWARE*

□ General accounting software for small busi- ① nesses. Each product can be used alone or with † automatic posting to the General Ledger. Supplied in source for Microsoft BASIC 4.51.

GENERAL LEDGER	$530/$40
ACCOUNTS PAYABLE	$530/$40
ACCOUNTS RECEIVABLE	$530/$40
PAYROLL	$530/$40
INVENTORY	$860/$40

□ Other application products supplied in source ① for Microsoft BASIC 4.51.

† MAILING ADDRESS	$530/$40
PROPERTY MANAGEMENT	$925/$40

GRAHAM-DORIAN SOFTWARE SYSTEMS

□ Comprehensive accounting software written in ① CBASIC-2 and supplied in source code. Each ⑧ software package can be used as a stand- † alone system or integrated with the General Ledger for automatic posting to ledger accounts. Requires CBASIC-2.

GENERAL LEDGER	$805/$40
ACCOUNTS PAYABLE	$805/$40
ACCOUNTS RECEIVABLE	$805/$40
INVENTORY SYSTEM	$555/$40
JOB COSTING	$805/$40
APARTMENT MANAGEMENT	$805/$40
CASH REGISTER	$805/$40

□ **POSTMASTER**—A comprehensive package ⑧ for mail list maintenance that is completely menu driven. Features include keyed record extraction and label production. A form letter program is included which provides neat letters on single sheet or continuous forms. Includes NAD file translator. Requires CBASIC-2 . . . . . $150/$20

STRUCTURED SYSTEMS GROUP

□ Complete interactive accounting software for † business. Each product can be used standalone or with automatic posting to the general ledger. Each product is thoroughly tested and very well documented.

GENERAL LEDGER	$820/$40
ACCOUNTS RECEIVABLE	$820/$40
ACCOUNTS PAYABLE	$820/$40
PAYROLL	$820/$40
INVENTORY CONTROL	$820/$40

□ **ANALYST**—Customized data entry and report- † ing system. User specifies up to 75 data items per record. Interactive data entry, retrieval, and update facility makes information management easy. Sophisticated report generator provides customized reports using selected records with multiple level breakpoints for summarization. Requires a disk sort utility such as QSORT, SUPER-SORT or VSORT and CBASIC-2 . . . . . $250/$15

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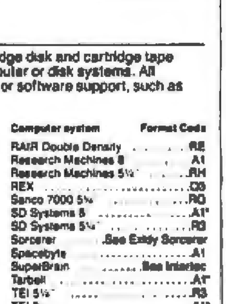

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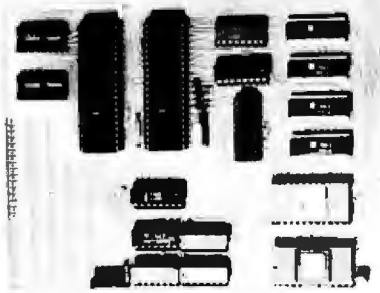

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To see how the TI-59 stores numbers contained in the data register in the program-step memory, enter the following, repartitioning to 100 data memories, 0 steps:

```
1234567891
STO 99
0
Op 17
GTO 000
LRN
```

Examine the *LRN* mode using *SST;* keep in mind that originally there was nothing in the *LRN* mode. Now, we examine the following locations:

```
000 90
001 00
002 00
003 91
004 78
005 56
006 34
007 12
```

The code in location 000 represents the type of number that was entered. In this case, the 9 stands for a number that consumed 9 memory locations (location 007 represents memory location 1, location 6 represents memory locations 2 and 3, location 5 is for memory locations 4 and 5, etc). Notice that the number entered as 1234567891 is stored as 9178563412 (starting at location 003). The empty registers 001 and 002 are used for the storage of up to thirteen digits (in location 001, the rightmost digit is always 0). If you entered 1234567891 and stored it in data register 98, your *LRN* mode would look like this:

```
000 00   008 90
001 00   009 00
002 00   010 00
003 00   011 91
004 00   012 78
005 00   013 56
006 00   014 34
007 00   015 12
```

Circle 90 on inquiry card.

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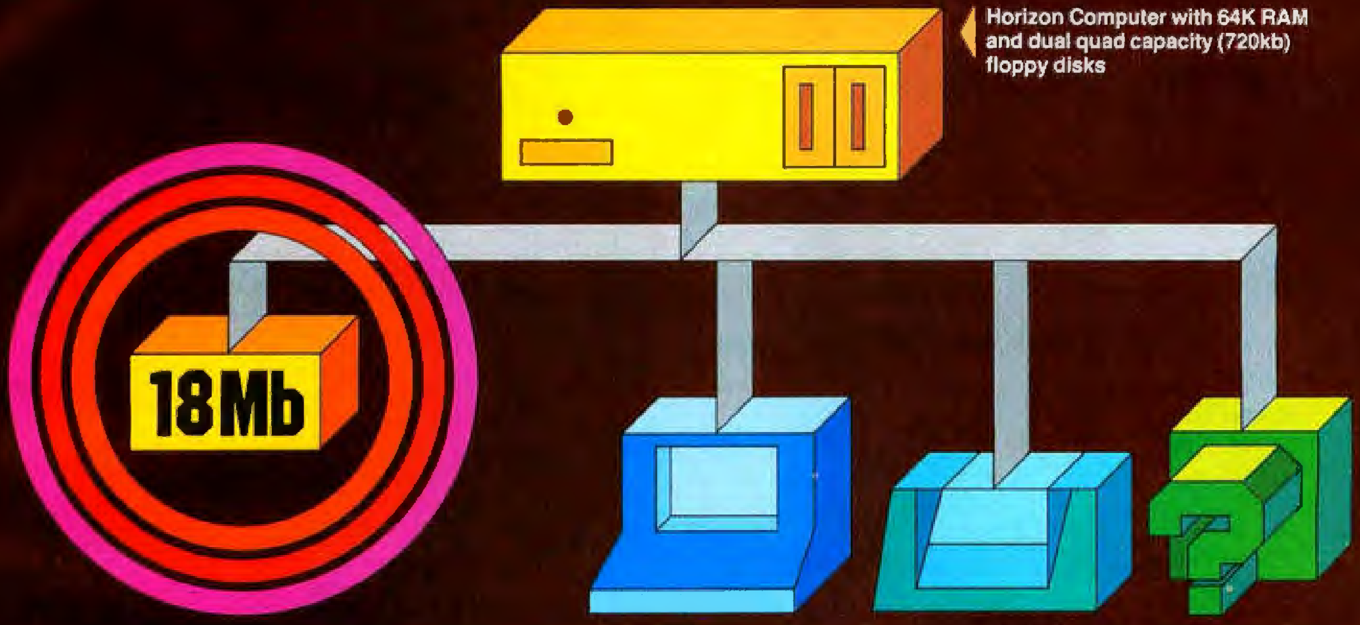

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Storing the same number in data register 97 would use memory locations 016 thru 023, and so on. This scheme continues throughout, with data register 00 taking up memory locations 952 thru 959.

To apply this principle, try the following example:

9
Op 17
8166950185
+
.686
=
STO 99
0
Op 17
RST

Now examine the *LRN* mode and notice the following:

000 90 List
001 60 Deg
002 68 Nop
003 85 +
004 01 1
005 95 =
006 66 Pause
007 81 RST

This is a counting program. Press *RST*, *R/S*, 1 . . . 2 . . . 3 . . . 4 . . . etc. The .686 was added because neither the *Deg* nor the *Nop* have any effect on numbers that are "carried" from one step to another.

There are drawbacks to this storage system. For instance, if the number 1 is stored in memory 99, all program locations 001 thru 006 are cleared, erasing everything between 000 and 007. Also, the instruction 000 90 appears to be troublesome and cannot be changed to a useful code; all it does is take up space. In addition, the code in 002 always has a 0 on the rightmost side, which disables the code. Keep in mind that this also applies to codes 008 and 009, 017 and 018, all the way up through 952 and 953.

Listing 1 is an actual program that will first begin as a counting program, then, after adding 1, it will modify its instructions so that it becomes a subtraction program. ■

Listing 1: *A demonstration program showing self-modifying code on the Texas Instruments TI-58 or TI-59 programmable calculators. When run, the program adds 1 to the number on the display, then continually subtracts until R/S is pressed. Begin execution at step 950. As soon as the program begins, hold down the Pause key to see the program work. After the program has been run, examine the LRN mode to observe how the code has been modified.*

Step	Code	Key
000	76	Lbl
001	12	B
002	05	5
003	69	Op
004	17	17
005	01	1
006	01	1
007	06	6
008	01	1
009	09	9
010	05	5
011	00	0
012	01	1
013	07	7
014	05	5
015	85	+
016	93	.
017	06	6
018	08	8
019	06	6
020	95	=
021	42	STO
022	00	00
023	00	00
024	69	Op
025	17	17
026	61	GTO
027	09	949
028	49	—
.	.	.
.	.	.
949	32	x≷t
950	76	Lbl
951	11	A
952	85	+
953	01	1
954	95	=
955	32	x≷t
956	61	GTO
957	12	B

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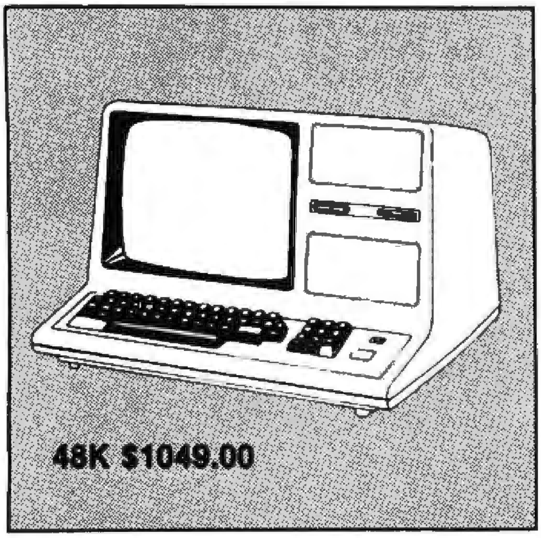

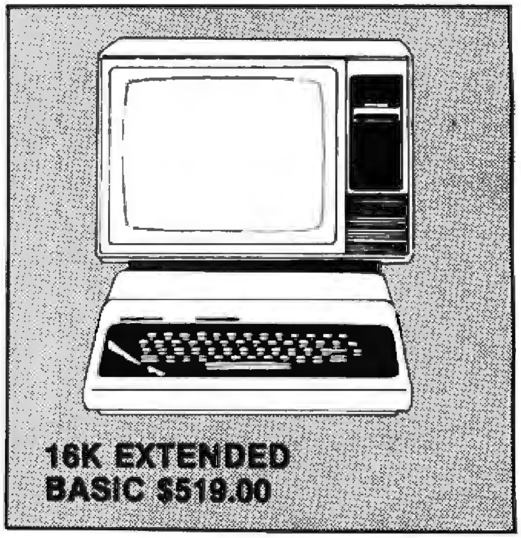

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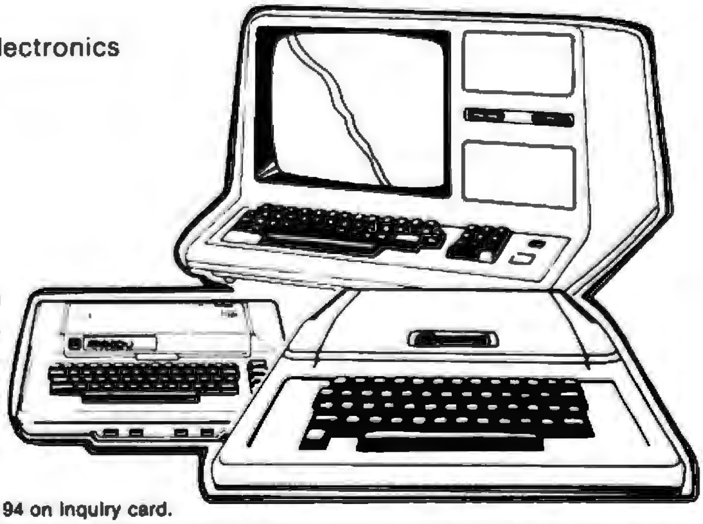

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Generating Bar Code in the Hewlett-Packard Format

Thomas McNeal
Hewlett-Packard
Cupertino Integrated Circuits Operation
10900 Wolfe Rd
Cupertino CA 95014

The HP-41C is Hewlett-Packard's newest entry in the hand-held programmable calculator race. The main feature that distinguishes it from Hewlett-Packard's earlier calculators is its modular design, which allows the HP-41C to be extended by a line of peripheral devices. Up to *four* peripherals can be plugged into the calculator, and these include a magnetic card reader, a thermal printer, memory modules to increase the amount of memory available to the user, and "application pacs" that contain software for particular applications in read-only-memory module form. In addition, Hewlett-Packard has introduced the 82153A Optical Reader (also called a Wand), which is capable of reading bar codes that contain HP-41C programs, data, or function definitions.

This article describes the HP-41C bar-code format and includes a BASIC program that converts an HP-41C program into a series of bar-code rows that can be printed using a high-quality printer with incremental spacing.

HP-41C Bar-Code Format

The bar code that is read by the Wand is simply binary information represented by wide and narrow bars (representing 1 and 0, respectively). The space between each bar is nominally the width of the narrow bar and serves as a benchmark for the current unit bar width. The unit bar width must be greater than 15 mils. A narrow bar may be up to 20% wider than the unit bar width, which is established by the previous bar and space. A wide bar should be twice the unit bar width, and a wide bar should vary no more than 20% from its standard value.

The bars are logically grouped into 8-bit bytes, and a bar-code program is organized into rows of a maximum of 16 bytes, with 3 bytes of header information and up to 13 bytes of data per row. Associated with each row are pairs of start and stop bits (binary 00 and 10, respectively) that allow the rows to be read in either direction. Figure 1 shows the format for a single row of program bar code.

The 13 data bytes contain the machine language of the HP-41C instruction set. Table 1 lists these instructions, with the first 8-bit byte of each instruction determining the instruction type. Additional bytes, if any, contain alphanumeric character data, numeric or stack operands, or linkage information.

All indirect instructions are 2 bytes long, with the high-order bit of the second byte set to 1 to signify an indirect operand. In the case of indirect numeric GOTO and EXECUTE instructions, the high-order bit is set to 1 for an EXECUTE instruction and cleared to 0 for a GOTO instruction.

The size of an instruction is determined by its position in the table. In order to save room in the HP-41C, some instructions may have two completely different representations, depending on the value of the operand associated with that instruction. For example, the numeric label instruction is represented by 1 byte if the operand is less than 15 and, otherwise, by 2 bytes. The XROM (EXECUTE read-only-memory module) instructions seen in the function table also save room when a reference to an alpha label within a read-only-memory module is made by an EXECUTE instruction. The XROM instruction is a compact, 2-byte reference to a table of alphanumeric labels within the read-only-memory module; this replaces the EXECUTE instruction originally entered by the user.

HP-41C Internal Representation

The instructions generally are 1, 2, or 3 bytes long, with the 4 high-order bits of the first byte indicating the instruction length. The exceptions to this rule are the instructions containing alphanumeric character data. The HP-41C has an alphanumeric display that allows the definition of instructions with nonnumeric operands. These functions include an alphanumeric label instruction, which contains a label of up to seven characters, GOTO and EXECUTE instructions with alphanumeric label operands, and a text-entry instruction. This last instruction will either append or replace character data in a special alphanumeric register and may contain up to fifteen characters.

All character data is represented in ASCII (American Standard Code for Information Interchange), with one character per byte and a few exceptions for special characters not found in the ASCII character set. Since character-oriented instructions are of indeterminate length, their size is

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VALUE	00	nnnnnnnn	nnnn	nnnn	nnnn	← (UP TO 13 BYTES) →	nnnn	10
FUNCTION	START BITS	CHECKSUM	TYPE	SEQUENCE NUMBER	LEADING PARTIAL FCN BYTES	DATA	TRAILING PARTIAL FCN BYTES	STOP BITS
NUMBER OF BITS	2	8	4	4	4	UP TO 104	4	2

Figure 1: *Format for Hewlett-Packard bar codes. A maximum of 13 bytes can be encoded into one row of bar code.*

embedded within a word in the instruction itself. For alphanumeric label operands, the number of characters is held in the 4 low-order bits of the second or third byte, with the 4 high-order bits set to hexadecimal F. The position of this byte is indicated in the documentation of the compile routine of the bar-code generating program. (See listing 1.) This convention allows differentiation between an alphanumeric label instruction and an end instruction, in which the third word contains a hexadecimal F in the low rather than the high 4 bits.

In addition, the alphanumeric label and end instructions contain pointers that link them with other alphanumeric label and end instructions, creating an alphanumeric label chain. This chain is used to identify the position of labels and program boundaries within the HP-41C program memory and establishes entry points for each program. The chain is recompiled by the Wand software, so the bytes containing the chain pointers are set to 0 by this program.

For a detailed discussion of the function table and other internal features of the HP-41C, refer to a series of articles that appeared in the Corvallis Division Column of the *PCC Journal* beginning on September 6, 1979. The *PPC Journal* is a publication of the PPC (Personal Programmable Calculator), an independent user group for Hewlett-Packard programmable calculators. Further information may be obtained by writing to:

Richard Nelson, Editor
PPC Journal
2541 W Camden Pl
Santa Ana CA 92704

The header information necessary for a bar-code program is contained in the left-most 3 bytes of each bar code row. The first byte is a parity check in the form of a running checksum (a summation modulo 256, with wrap-around carry, of the checksum of the preceding row and all other bytes of the current row).

The second byte is split into two parts. The 4 high-order bits contain the program type (1=nonprivate, 2=private), and the 4 low-order bits contain the sequence number, which is the bar-code row number minus 1, modulo 16. The sequence number will be inspected by the Wand software to assure that the correct row is being read.

Text continued on page 172

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HIGH ORDER 4 BITS ↓ / LOW ORDER 4 BITS →	0	1	2	3	4	5	6	7	
0	NULL	LBL 00	LBL 01	LBL 02	LBL 03	LBL 04	LBL 05	LBL 06	1 BYTE (rows 0–8)
1	digit 0	1	2	3	4	5	6	7	
2	RCL 00	RCL 01	RCL 02	RCL 03	RCL 04	RCL 05	RCL 06	RCL 07	
3	STO 00	STO 01	STO 02	STO 03	STO 04	STO 05	STO 06	STO 07	
4	+	–	*	/	X<Y?	X>Y?	X< =Y?	Σ+	
5	LN	X^2	SQRT	Y^x	CHS	e^x	LOG	10^x	
6	1/X	ABS	FACT	X≠0?	X>0?	LN(1+X)	X<0?	X=0?	
7	CL	X< >Y	PI	CLST	R↑	RDN	LASTX	CLX	
8	DEG	RAD	GRAD	ENTER↑	STOP	RTN	BEEP	CLA	
9	RCL nn	STO nn	ST+ nn	ST– nn	ST* nn	ST/ nn	ISG nn	DSE nn	2 BYTES (rows 9–C)
A	XROM	XROM	XROM	XROM	XROM	XROM	XROM	XROM	
B		GTO 00	GTO 01	GTO 02	GTO 03	GTO 04	GTO 05	GTO 06	
C	← ALPHA LABEL AND END INSTRUCTIONS →								
D	← GTO nn →								3 BYTES (rows D–E)
E	← XEQ nn →								
F		TEXT 1	TEXT 2	TEXT 3	TEXT 4	TEXT 5	TEXT 6	TEXT 7	UP TO 16 BYTES

Table 1: *A table for the HP-41C instruction set. Instructions in the HP-41C are stored as one or more 8-bit bytes.*

Table 1 continued on page 154.

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0	LBL 07	LBL 08	LBL 09	LBL 10	LBL 11	LBL 12	LBL 13	LBL 14	1 BYTE
1	8	9	.	EEX	(digit entry) CHS	GTOα	XEQα		1 BYTE
2	RCL 08	RCL 09	RCL 10	RCL 11	RCL 12	RCL 13	RCL 14	RCL 15	1 BYTE
3	STO 08	STO 09	STO 10	STO 11	STO 12	STO 13	STO 14	STO 15	1 BYTE
4	Σ−	HMS+	HMS−	MOD	%	%CH	P−R	R−P	1 BYTE
5	$e^x - 1$	SIN	COS	TAN	ASIN	ACOS	ATAN	DEC	1 BYTE
6	INT	FRAC	D−R	R−D	HMS	HR	RND	OCT	1 BYTE
7	X=Y?	X≠Y?	SIGN	X< =0?	MEAN	SDEV	AVIEW	CLD	1 BYTE
8	ASHF	PSE	CLRG	AOFF	AON	OFF	PROMPT	ADV	1 BYTE
9	VIEW nn	REG nn	ASTO nn	ARCL nn	FIX n	SCI n	ENG n	TONE n	2 BYTES
A	SF nn	CF nn	FS?C nn	FC?C nn	FS? nn	FC? nn	GTO/XEQ IND		2 BYTES
B	GTO 07	GTO 08	GTO 09	GTO 10	GTO 11	GTO 12	GTO 13	GTO 14	2 BYTES
C	→	→	→	→	→	→	X<>nn	LBL nn	2 BYTES
D	→	→	→	→	→	→	→	→	3 BYTES
E	→	→	→	→	→	→	→	→	3 BYTES
F	TEXT 8	TEXT 9	TEXT 10	TEXT 11	TEXT 12	TEXT 13	TEXT 14	TEXT 15	UP TO 16 BYTES

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Listing 1: *Bar-code generating program. This program accepts up to 2240 HP-41C program steps in mnemonic form, converts them to HP-41C machine language, and generates the necessary bar-code program rows. This program runs on an HP-9845A minicomputer attached to a Diablo 1650 printer; the print wheel used is a Titan 10 metallic daisy-wheel printer.*

```
5     ! ************************************************************
10    !                HP41C USER LANGUAGE COMPILER
15    !                AND BAR CODE GENERATION PROGRAM
20    !       THIS PROGRAM PROMPTS FOR NUMBERED HP41C INSTRUCTIONS AND STORES
25    !       THE SAME FOR LATER COMPILATION TO BE INITIATED UPON COMMAND.
30    !       THE INSTRUCTION NUMBERS MAY BE FROM 1 TO 2240 (THE TOTAL NUMBER
35    !       OF BYTES AVAILABLE FOR USE IN A PROGRAM) AND MUST BE INTEGERS.
40    !       THE COMPILED CODE WILL BE USED TO DRIVE A BAR CODE GENERATION
45    !       ROUTINE WHICH WILL CALCULATE THE BIT PATTERN FOR A ROW OF BAR
50    !       CODE.  THIS BIT PATTERN WILL APPEAR WITHIN A LOOP, AT WHICH
55    !       POINT THE USER WILL BE ABLE TO CALL HIS OWN PLOTTING ROUTINES
60    !       TO GENERATE 41C BAR CODE.  THE COMMANDS AVAILABLE IN THIS
65    !       PROGRAM ARE:
70    !       1)"NUMBER":  THIS WILL GENERATE LINE NUMBERS FOR 41C INSTRUCTIONS
75    !       2)"LIST":  THIS WILL LIST THE INSTRUCTIONS CURRENTLY ENTERED
80    !       3)"RUN":  CHECKS FOR PRESENCE OF COMPILED CODE AND PRODUCES
85    !         THE BAR CODE BIT PATTERN.
90    !       4)"COMPILE":  COMPILES THE CURRENT TEXT INTO MACHINE CODE
95    !       5)"RENUMBER": ALTERS THE 41C INSTRUCTION NUMBER SEQUENCE
100   !       6)"SAVETEXT": SAVES THE CURRENT TEXT ON CASSETTE TAPE
105   !       7)"GETTEXT": RETRIEVES THE TEXT FROM CASSETTE TAPE
110   !       8)"SAVEPROG": SAVES THE COMPILED MACHINE CODE ON TAPE
115   !       9)"GETPROG": RETRIEVES THE COMPILED CODE FROM TAPE
120   !       10)"EXIT": HALTS THE USER LANGUAGE COMPILER PROGRAM
125   !       11)"DELETE": DELETES THE NAMED INSTRUCTION NUMBER FROM THE
130   !          CURRENT TEXT.
135   !       12)"SCRATCH": ERASES THE CURRENT INSTRUCTIONS ENTERED
140   !       13)"RUNPRIVATE": GENERATES BAR CODE FOR A PRIVATE PROGRAM
145   !
150   ! **************************************************************
155   !
160   INTEGER I,J,K,L,V,R,R1,C,C1,C2(60),T,P(2240),M(2240),M1,P1,P2,K1(2240)
165   INTEGER F1,F2,F3,F4,F5,F6,F7,F8,F9,E,E1,E2,E3(15),E4,I1(103),D,X,Y,Z
170   INTEGER I5,B1,B2,B3,T5,H1,H2,P5,L5,C5,S3,S1(16),B(132),V1,V2,V3
175   DIM T$[60],T1$[30],T2$[30],S$[50],A$[1500],B$[915]
180   DIM S1$(27)[1],I$(104)[6],H1$[3],H2$[3],H4$[9],C$(60)[1]
185   !
190   ! * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
195   !
200   !      MAIN PROGRAM:  WRITES PROMPT FOR TEXT OR COMMAND ENTRY AND
205   !                     EITHER DECODES THE INSTRUCTION NUMBER AND ENTERS
210   !                     THE TEXT INTO THE TEXT ARRAY, OR USES THE COMMAND
215   !                     COMMAND JUMP TABLE TO JUMP TO THE CORRECT COMMAND
220   ON ERROR GOTO 4250
225   H1$=CHR$(27)&CHR$(31)&CHR$(2)      !SET UP DIABLO CONTROL CODES
230   H2$=CHR$(27)&CHR$(83)
235   H4$="        "
237   T$=T1$=T2$=""
240   !
245   FOR I=1 TO 26          !READ LOCAL LABELS & STACK REGISTER MNEMONICS INTO S1$
250    READ S1$(I)
255   NEXT I
260   FOR I=1 TO 103         !READ SORTED INSTRUCTION MNEMONICS INTO I$, INSTRUC.
265    READ I$(I),I1(I)      !VALUES INTO I1 FOR TABLE DRIVER
270   NEXT I
275   FOR I=1 TO 60          !READ IN VALID CHARACTER TABLES FOR CHARACTER CHECK
280    READ C$(I),C2(I)      !CHARACTERS IN C$; CHARACTER CODE IN C2
285   NEXT I
290   !
295   FOR I=1 TO 2240
300    P(I)=-1               !INITIALIZE ARRAY OF POINTERS INTO TEXT STRING
305    M(I)=-1               !INITIALIZE COMPILED PROGRAM ARRAY
310   NEXT I
315   A$=""
317   T=F6=F8=0              !INITIALIZE TEXT STRING POINTER AND FLAGS
320   !
322   INPUT "DO YOU WANT A LIST OF THE AVAILABLE COMMANDS?",T1$
323   IF (T1$="N") OR (T1$="NO") THEN 350
324   IF T$="SCRATCH" THEN 350
325   GOTO 3500              !PRINT OUT REFERENCE TABLE
330   ! *     *     *     *     *     *     *     *     *     *     *
335   !
340   !           BEGIN PROMPTER SECTION:  ASK FOR COMMAND OR INSTRUCTION
345   !
350   INPUT ">",T$
355   I=POS(T$," ")          !SET I TO FIRST WORD OF INPUT
360   V=K=D=0
365   P5=1                   !SET PRIVACY FLAG TO INDICATE A NON-PRIVATE PROGRAM
370   IF I=0 THEN 530        !ONE WORD COMMAND
375   !
380   T1$=T$[1,I-1]          !EXTRACT FIRST WORD OF INPUT
385   IF T1$<>"DELETE" THEN 405    !CHECK FOR A DELETE COMMAND
390   T1$=TRIM$(T$[I+1])
395   I=LEN(T1$)+1
400   D=1
402   !
405   IF I-1>4 THEN 510          !CALCULATE INSTRUCTION NUMBER VALUE
410   FOR J=I-1 TO 1 STEP -1
415     IF (T1$[J,J]<"0") OR (T1$[J,J]>"9") THEN 500
420     V=V+(NUM(T1$[J,J])-48)*10^K
425     K=K+1
430   NEXT J
435   IF V>2240 THEN 510
440   !
450   IF D<>1 THEN 465       !DELETE INSTRUCITON IF FLAG IS SET
455   P(V)=-1
460   GOTO 350
461   !
465   T$=TRIM$(T$[I+1])      !ENTER TEXT AND DELIMITER INTO TEXT ARRAY AND STORE
470   A$=A$&T$&"!"           !POINTER AT THE INDEX GIVEN BY INSTRUCTION NUMBER
475   P(V)=T
480   T=T+LEN(T$)+1
485   GOTO 350
490   !
495        ! ERROR MESSAGES
500   PRINT "?? - GIVE NUMBERED STATEMENT OR A COMMAND"
505   GOTO 350
510   PRINT "STATEMENT NUMBER VALUE TOO LARGE"
515   GOTO 350
520   !
525   !      ***  COMMAND JUMP TABLE  ***
530   IF T$="NUMBER" THEN 670
535   IF T$="LIST" THEN 785
540   IF T$="RUN" THEN 925
545   IF T$="COMPILE" THEN 1855
550   IF T$="??" THEN 3500
555   IF T$="RENUMBER" THEN 3710
560   IF T$="SAVETEXT" THEN 3845
565   IF T$="GETTEXT" THEN 3935
570   IF T$="SAVEPROG" THEN 4055
575   IF T$="GETPROG" THEN 4140
580   IF T$="SCRATCH" THEN 295
585   IF T$="EXIT" THEN STOP
590   IF T$<>"RUNPRIVATE" THEN 605
595   P5=2
600    GOTO 925
```

Listing 1 continued on page 158

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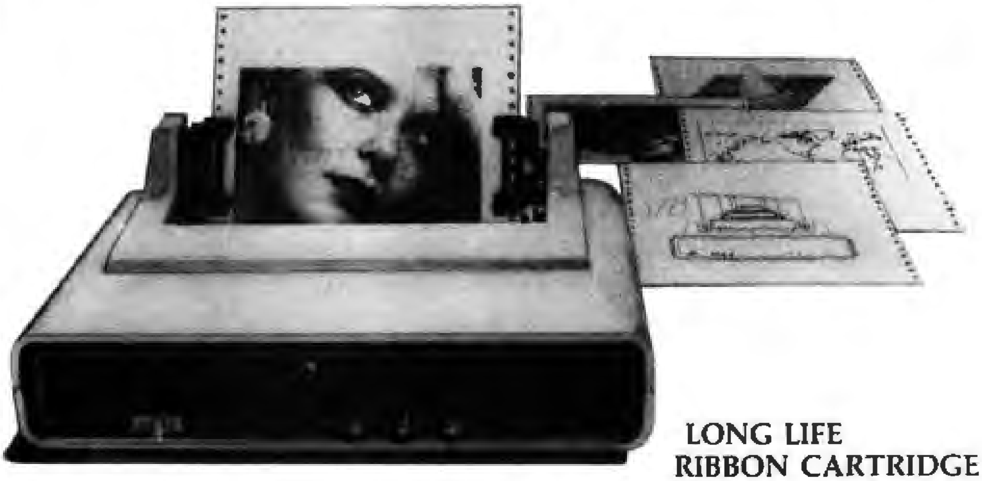

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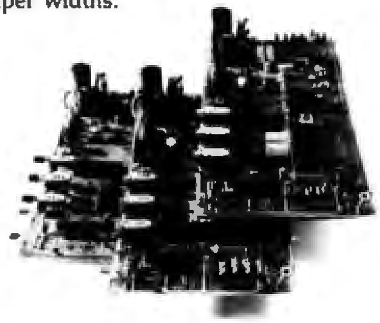
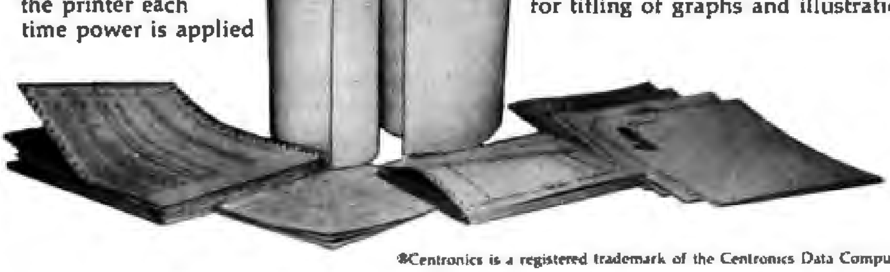


MICROPROCESSOR CONTROLLED INTERFACE

The microprocessor array provides the intelligence for a dual RS232 serial and a Centronics* type parallel interface. Both inputs are fully buffered to allow the 88G to receive data and print simultaneously. A 1K character buffer is standard with a 2K buffer available as an option.

The short line thruput of the 88G has been increased by incorporation of a *Quick Cancel* feature that fully utilizes the bidirectional/unidirectional printing capabilities. Built-in diagnostic and self-test capabilities allow the user to easily pinpoint system problems and a *Power On* confidence test verifies operational status of the printer each time power is applied



VERSATILITY

The 88G prints a full upper and lower case 96 character ASCII set with a crisp, clear 7x7 matrix in 80, 96, or 132 column formats. For text processing and correspondence applications, an 11x7, 80 column serif style matrix can be selected by switch or software command. The dual tractor/pressure-feed paper drive system allows the user to choose either pin-feed, roll, or single sheet papers up to 9.5 inches wide.

Complete forms control allows the 88G to be quickly configured for printing single or multiple-ply invoices, purchase orders, checks, or any type of preprinted form. Optional paper roll holders and single sheet feeders can be quickly attached.

The wide use range of the 88G makes it the perfect companion for business systems, data processing, RO teleprinter and terminal printer applications.

GRAPHICS

A high-resolution, dot-addressable graphics option can be added for applications requiring plotting, printing of screen graphics, drawings, illustrations, etc. Single dot print resolution greatly extends the usefulness of the graphics capability. Selection of one of the four horizontal dot densities available customizes the graphic printout, and alphanumerics can easily be included for titling of graphs and illustrations.

LONG LIFE RIBBON CARTRIDGE

Ribbon difficulties are minimized through use of a continuous loop cartridge with a five million character life. It is easily changed without opening the case, and without any complicated or messy threading operations.

PRICE

Every detail is directed toward providing a heavy-duty, commercial quality printer for only $749.00. No other printer on the market today can provide its quality, features and performance at a comparable price. The 88G is an obvious industry leader.

mpi

Micro Peripherals, Inc.
4426 South Century Drive
Salt Lake City, Utah 84107
Phone (801) 973-6053

*Centronics is a registered trademark of the Centronics Data Computer Corp

Circle 100 on inquiry card.

Listing 1 continued:

```
605  PRINT '?? - UNRECOGNIZABLE COMMAND'
610  GOTO 350                         !GO BACK TO PROMPTER
615  !
620  ! * * * * * * * *  END OF MAIN PROGRAM * * * * * * * * * * * *
625  !
630  !
635  !
640  !
645  ! * * * * * * * * *  'AUTO' ROUTINE * * * * * * * * * * * * * * * * *
650  !
655  !  THIS ROUTINE AUTOMATICALLY NUMBERS THE 41C INSTRUCTIONS AND
660  !  THEN INTO THE TEXT ARRAY.  TO LEAVE THIS ROUTINE, TYPE 'EXIT'.
665  !
670  INPUT "GIVE THE STARTING VALUE AND SIZE OF THE INCREMENT",V,X1
675  IF V>2240 THEN 730
680  PRINT ">";V                      !PRINT THE PROMPT AND THE LINE NUMBER
685  INPUT T$
690  IF T$="EXIT" THEN 340           !LEAVE ROUTINE AND GO TO NORMAL PROMPT
695  !
700  A$=A$&T$&"!"                     !ENTER INSTRUCTION INTO TEXT ARRAY
705  P(V)=T
710  T=T+LEN(T$)+1
715  V=V+X1
720  GOTO 675
725  !
730  PRINTER IS 16                    !ERROR MESSAGE FOR STATEMENT NUMBER
735  PRINT "STATEMENT NUMBER VALUE TOO LARGE"
740  GOTO 340                         !RETURN TO NORMAL PROMPT
745  !
750  ! * * * * * * * * * * END OF 'AUTO' ROUTINE * * * * * * * * * * * * *
755  !
760  !
765  !
770  !
775  ! * * * * * * * * *  "LIST' ROUTINE * * * * * * * * * * * * * *
780  !
781  ! THIS ROUTINE LISTS THE CURRENT PROGRAM HELD IN THE TEXT STRING
782  !
785  FOR I=1 TO 2240              !STEP THROUGH POINTER TABLE AND PRINT
790   IF P(I)<0 THEN 810          !OUT TEXT IF A VALID POINTER IS SEEN
800   T1$=FNI$(A$,P(I))
805   PRINT I;T1$
810  NEXT I
815  GOTO 350
820  !
825  ! * * * * * * * * * * END OF 'LIST' ROUTINE * * * * * * * * * * * *
830  !
835  !
840  !
845  ! * * * * * * * * * * * *  'RUN' ROUTINE * * * * * * * * * * * * * * * *
850  !
855  !     BAR CODE DATA GENERATION ROUTINE: THIS ROUTINE TAKES THE COMPILED
860  !     PROGRAM HELD IN THE 'M' ARRAY AND CONVERTS IT INTO THE BIT PATTERN
865  !     REPRESENTING THE 41C BAR CODE.  THE BIT PATTERN APPEARS WITHIN A
870  !     LOOP IN 16 BYTE SEGMENTS, INCLUDING 3 BYTES OF HEADER DATA AND
875  !     START AND STOP BITS.  OTHER INFORMATION SEEN AT THAT POINT WILL
880  !     BE:
885  !      1)THE NUMBER OF BYTES IN THE CURRENT SEGMENT (HELD IN 'B2')
890  !      2)THE LINE NUMBER OF THE FIRST INSTRUCTION IN THE CURRENT SEGMENT
895  !        (HELD IN 'L5')
900  !      3)THE LINE NUMBER OF THE LAST INSTRUCTION SEEN IN THE CURRENT
905  !        SEGMENT (HELD IN 'I5')
910  !      4) THE BAR CODE ROW NUMBER ('HELD IN 'S3')
915  !
925  IF F6=1 THEN 940              !CHECK FOR PREVIOUS COMPILATION
930  PRINT "A PROGRAM MUST BE COMPILED FIRST!"
935  GOTO 350
936  !
940  INPUT "ENTER THE TITLE OF THE PROGRAM (60 CHARACTERS OR LESS)",T$
941  !
942  ! ******THIS SECTION WRITES OUT TO THE DIABLO 1650 *********
943  PRINTER IS 9               !SET PRINTER TO DIABLO LU
945  PRINT CHR$(12)
950  PRINT USING "10X,50A";T$
955  PRINT " "
960  X=S2 DIV 7                 !S2 CONTAINS THE NUMBER OF BYTES IN THE PROGRAM
965  IF S2 MOD 7>0 THEN X=X+1
970  PRINT "            PROGRAM REGISTERS NEEDED: ";X
975  PRINT " "
977  PRINTER IS 16              !RESET PRINTER BACK TO CRT
980 ! *********       END OF THE DIABLO OUTPUT CODE       *********
983 !
985  I5=0                       !START 41C INSTRUCTION COUNTER AT 0
990  B1=0                       !START COMPILED DATA ARRAY 'M' POINTER AT 0
995  B2=3                       !START BAR CODE ROW BYTE POINTER AT 3
1000 B3=0                       !START INSTRUCTION LENGTH COUNTER AT 0
1005 T5=0                       !START # OF WORDS SINCE LAST INST. COUNTER AT 0
1010 S3=0                       !START BAR CODE ROW COUNTER AT 0
1015 H1=0                       !START LEADING PARTIAL FCN. BYTE COUNTER AT 0
1020 H2=0                       !START TRAILING PARTIAL FCN. BYTE COUNTER AT 0
1025 L5=1                       !START FIRST INSTRUCTION OF ROW COUNTER AT 0
1030 C5=0                       !START CHECKSUM COUNTER (SUM MOD 256) AT 0
1035 FOR I=1 TO 132             !ZERO OUT THE BIT PATTERN ARRAY
1040  B(I)=0
1045 NEXT I
1050 B$=""
1055 !
1060 !
1065 !     INSTRUCTION TRANSLATION SECTION:  LOAD INSTRUCTIONS INTO A
1070 !          BAR CODE ROW AND KEEP COUNTERS FOR THE HEADER DATA
1075 !          (NOTE THAT B3 IS SET TO THE NUMBER OF BYTES EXPECTED TO
1080 !           COMPLETE THE CURRENT INSTRUCTION, AND SERVES AS A FLAG
1085 !           FOR THE BEGINNING OF THE NEXT INSTRUCTION)
1090 !
1095 S1(B2+1)=M(B1+1)          !TRANSFER WORD FROM 'M' INTO 16 BYTE BUFFER S1
1100 B1=B1+1                   !UPDATE VARIABLES
1105 B2=B2+1
1110 B3=B3-1
1115 !
1120 IF B3<>0 THEN 1135     !IF B3=0 THEN INSTRUCTION ENDS; RESET COUNTER
1125 T5=0
1130 GOTO 1435
1132 !
1135 IF B3>0 THEN 1155      !IF B3>0 THEN INSTRUCTION CONTINUES
1140 T5=T5+1
1145 GOTO 1435
1150 !
1155 IF S1(B2)>0 THEN I5=I5+1 !IF B3<0 THEN INSTRUCTION IS STARTING; INCREMENT
1160 IF M(B1)>143 THEN 1300    !COUNTER IF NON-NULL INST. AND CHECK FOR LENGTH
1165 !
1170 !                ** PROCESS ONE BYTE INSTRUCTIONS**
1175                           ! CHECK FOR AN ALPHA EXECUTE OR A GOTO ALPHA
1180 !                         !INSTRUCTION.  (GET SIZE FROM SECOND BYTE)
1185 IF (M(B1)<>29) AND (M(B1)<>30) THEN 1215
1190 B3=M(B1+1) MOD 16+1
1195 T5=T5+1
1200 GOTO 1435
1205 !
1210                           ! CHECK FOR A DIGIT ENTRY INSTRUCTION
1215 IF (M(B1)<16) OR (M(B1)>28) THEN 1270
1220 I=B1+1
1225 IF (M(I)<16) OR (M(I)>28) THEN 1240
```

Listing 1 continued on page 160

COMPUSTAR™

INTERTEC'S NEW $2500 MULTI-USER SMALL BUSINESS COMPUTER

At last, there's a multi-user microcomputer system designed and built the way it should be. The CompuStar™. Our new, low-cost "shared-disk" multi-user system with mainframe performance.

Unlike any other system, our new CompuStar offers what we believe to be the most practical approach to almost any multi-user application. Data entry. Distributed processing. Small business. Scientific. Whatever! And never before has such powerful performance been available at such modest cost. Here's how we did it . . .

The system architecture of the CompuStar is based on four types of video display terminals, each of which can be connected into an auxiliary hard disk storage system. Up to 255 terminals can be connected into a single network! Each terminal (called a Video Processing Unit) contains its own microprocessor and 64K of dynamic RAM. The result? Lightning fast program execution! Even when all users are on-line performing different tasks! A special "multiplexor" in the CompuStar Disk Storage System ties all external users together to "share" the system's disk resources. So, no single user ever need wait on another. An exciting concept . . . with some awesome application possibilities!

CompuStar™ user stations can be configured in almost as many ways as you can imagine. The wide variety of terminals offered gives you the flexibility and versatility you've always wanted (but never had) in a multi-user system. The CompuStar Model 10 is a programmable, intelligent terminal with 64K of RAM. It's a real workhorse if your requirement is a data entry or inquiry/response application. And if your terminal needs are more sophisticated, select either the CompuStar Model 20, 30 or 40. Each can be used as either a stand-alone workstation or tied into a multi-user network. The Model 20 incorporates all of the features of the Model 10 with the addition of two, double-density mini-floppies built right in. And it boasts over 350,000 bytes of local, off-line user storage. The Model 30 also features a dual drive system but offers over 700,000 bytes of disk storage. And, the Model 40 boasts nearly 1½ million bytes of dual disk storage. But no matter which model you select, you'll enjoy unparalleled versatility in configuring your multi-user network.

Add as many terminals as you like - at prices starting at less than $2500. Now that's truly incredible!

No matter what your application, the CompuStar can handle it! Three disk storage options are available. A tabletop 10 megabyte 8" winchester-type drive complete with power supply and our special controller and multiplexor costs just $4995. Or, if your disk storage needs are more demanding, select either a 32 or 96 megabyte Control Data CMD drive with a 16 megabyte removable, top loading cartridge. Plus, there's no fuss in getting a CompuStar system up and running. Just plug in a Video Processing Unit and you're ready to go . . . with up to 254 more terminals in the network by simply connecting them together in a "daisy-chain" fashion. CompuStar's special parallel interface allows for system cable lengths of up to one mile . . . with data transfer rates of 1.6 million BPS!

Software costs are low, too. CompuStar's disk operating system is the industry standard CP/M*. With an impressive array of application software already available and several communication packages offered, the CompuStar can tackle even your most difficult programming tasks.

Compare for yourself. Of all the microcomputer-based multi-user systems available today, we know of only one which offers exactly what you need and should expect. Exceptional value and upward growth capability. The CompuStar™. A true price and performance leader!

INTERTEC DATA SYSTEMS®
2300 Broad River Rd Columbia, SC 29210
(803) 798-9100 TWX 810-666-2115

*Registered trademark of Digital Research Inc.

Listing 1 continued:

```
1230 I=I+1                        !STEP THROUGH INSTRUCTIONS UNTIL END OF
1235 GOTO 1225                    !DIGIT ENTRY HAS BEEN SEEN
1240 B3=I-B1-1
1245 T5=T5+1
1250 IF B3<>0 THEN 1435            !CHECK FOR SINGLE DIGIT INSTRUCTION
1255 T5=0
1260 GOTO 1435
1265 !
1270 B3=0                         !PROCESS ALL OTHER ONE BYTE INSTRUCTIONS
1275 T5=0
1280 GOTO 1435
1285 !
1290 !              **PROCESS TWO BYTE INSTRUCTIONS**
1295 !
1300 IF M(B1)>207 THEN 1370       !CHECK FOR ALPHA LABEL AND END INSTRUCTIONS
1305 IF (M(B1)<192) OR (M(B1)>205) THEN 1345
1310 T5=T5+1
1315 IF B1+2<S2 THEN 1330         !CHECK FOR THE END INSTRUCTION
1320 B3=2
1325 GOTO 1435
1330 B3=M(B1+2) MOD 16+2          !ALPHA LABEL:GET SIZE FROM THIRD BYTE
1335 GOTO 1435
1340 !
1345 B3=1                         !PROCESS SHORT FORM GTO'S (TWO BYTES LONG)
1350 T5=T5+1
1355 GOTO 1435
1360 !
1365 !              **PROCESS THREE BYTE INSTRUCTIONS**
1370 IF M(B1)>240 THEN 1395       !PROCESS LONG FORM GTO'S AND XEQ'S
1375 B3=2
1380 T5=T5+1
1385 GOTO 1435
1390 !
1395 B3=M(B1) MOD 16              !PROCESS ALPHA DATA ENTRY INSTRUCTIONS
1400 T5=T5+1                      !(GET LENGTH FROM FIRST BYTE)
1405 !
1410 !
1415 !     BAR CODE ROW SETUP SECTION:  TAKE DATA FOR THIS ROW AND
1420 !          CALCULATE THE HEADER DATA AND OTHER VARIABLES
1425 !
1430                              ! CHECK FOR A COMPLETED ROW (A FILLED BUFFER)
1435 IF (B2<16) AND (B1<S2) THEN 1095
1440 !
1445 H1=H2                        !UPDATE PARTIAL FUNCTION COUNTERS
1450 H2=B3
1455 S1(3)=H1 MOD 16*16+T5 MOD 16
1460 !
1465                              ! ENTER PRIVACY VALUE AND SEQUENCE NUMBER
1470 S1(2)=P5*16+S3 MOD 16
1475 !
1480 FOR I=2 TO B2                !CALCULATE CHECKSUM (A CUMULATIVE SUM MOD 256)
1485  C5=C5+S1(I) MOD 256
1490  IF C5>=256 THEN C5=C5 MOD 256+1
1495 NEXT I
1500 S1(1)=C5
1505 !
1510 !
1515 !     CONVERSION SECTION: CONVERT THE CURRENT ROW OR SEGMENT INTO A
1520 !          BIT PATTERN REPRESENTING THE BAR CODE.
1525 !
1530 S3=S3+1
1535 FOR I=1 TO B2                !CONVERT DECIMAL DATA TO A BINARY PATTERN
1540  X=S1(I)
1545  FOR Y=2+I*8 TO 3+(I-1)*8 STEP -1
1550   B(Y)=X MOD 2
1555   X=X DIV 2
1560  NEXT Y
1565 NEXT I
1570 !
1575 B(1)=0                       !ADD START AND STOP BITS
1580 B(2)=0
1585 B(B2*8+3)=1
1590 B(B2*8+4)=0
1595 !
1600 !
1605 !    AT THIS POINT, THE ARRAY 'B' HOLDS A SERIES OF 1'S AND 0'S
1610 !    REPRESENTING A SINGLE ROW OF 41C PROGRAM BAR CODE, INCLUDING
1615 !    THE START AND STOP BITS. OTHER DATA WILL BE FOUND IN THE
1620 !     VARIABLES B2,S3,L5 AND I5 AS EXPLAINED ABOVE.
1625 !
1630 !    ***THIS IS THE BAR CODE GENERATION AND OUTPUT SECTION USED BY***
1635 !    ***HP FOR BAR CODE GENERATION ON A DIABLO 1650 DAISY WHEEL******
1640 !    ***PRINTER WITH A TITAN 10 96-CHARACTER METALLIC DAISY WHEEL****
1645 !
1650 T1$=FNP$(S3+1-1,L5,I5)
1652 PRINTER IS 9                 !SET PRINTER TO DIABLO LU
1655 PRINT USING "3X,20A";T1$
1660 L=B2*8+4
1665 GOSUB 4460                   !GENERATE BAR PATTERN FROM BIT PATTERN
1670 PRINT USING "3X,3A,10A,915A,2A";H1$,H4$,B$,H2$
1675 PRINT " "
1680 IF S3 MOD 18=0 THEN PRINT CHR$(12)
1682 PRINTER IS 16                !RESET PRINTER TO CRT
1683 !        *****    END OF DIABLO OUTPUT SECTION   *****
1685 !
1690 !     CLEANUP SECTION:  THIS SECTION RESETS VARIABLES TO PREPARE FOR
1695 !          GENERATION OF THE NEXT ROW OF BAR CODE.
1700 !
1705 FOR I=1 TO 16                !ZERO OUT THE 16 BYTE BAR CODE ROW BUFFER
1710  S1(I)=0
1715  B(I)=0
1720 NEXT I
1725 FOR I=17 TO 132              !ZERO OUT THE BIT PATTERN ARRAY
1730  B(I)=0
1735 NEXT I
1740 B2=3                         !RESET S1 BUFFER POINTER TO 3
1745 L5=I5                        !UPDATE FIRST INSTR. COUNTER TO CURRENT INSTR.
1750 IF B3=0 THEN L5=L5+1         !CHECK FOR THE START OF A NEW INSTRUCTION
1755 IF B1<S2 THEN 1095
1760 !
1762 PRINT "BAR CODE GENERATION COMPLETED"
1765 GOTO 350                     !GO BACK TO PROMPT IF BAR CODE GENERATION HAS
1770                              ! BEEN COMPLETED
1775 !
1780 ! * * * * * * * * * * * * END OF 'RUN' ROUTINE * * * * * * * * * * * *
1785 !
1790 !
1795 !
1800 !
1805 ! * * * * * * * * * *  COMPILE  ROUTINE * * * * * * * * * * * * * * * *
1810 !
1815 !  HP41C INSTRUCTION INTERPRETATION ROUTINE:  THIS ROUTINE INTERPRETS
1820 !  THE INSTRUCTIONS ENTERED IN THE TEXT ARRAY AND LOADS THE MACHINE
1825 !  CODE INTO THE 'M' ARRAY.  THE INTERPRETER IS TABLE DRIVEN EXCEPT
1830 !  FOR THOSE INSTRUCTIONS WHOSE OPERANDS CHANGE THE LENGTH OF THE
1835 !  INSTRUCTION (GTO'S,LBL'S OR XEQ'S), DIGIT ENTRY INSTRUCTIONS,
1840 !  OR INSTRUCTIONS INVOLVING ALPHANUMERIC TEXT. THE PROCESS MAY BE
1842 !  ABORTED IF AN ERROR IS ENCOUNTERED BY TYPING 'ABORT' IN RESPONSE
1843 !  TO THE ERROR MESSAGE.
1845 !
1850 !
```

Listing 1 continued on page 162

Pump Up Your TRS-80 with the ES/F Mass Storage System

▲ Actual Size

Actual Thickness ▼

THESE FACTS SPEAK FOR THEMSELVES!

	CASSETTE	ES/F	MINI-DISK
SPEED (Seconds to load "Blackjack")	56	6 (5' wafer)	6½
CAPACITY (thousands of bytes)	38 (C-20)	64 (75' wafer)	59 (TRSDOS)
RELIABILITY (Designed for digital data?)	NO	YES	YES
SYSTEM COST (First unit plus interface)	$60	$250	$800
MEDIA COST (In quantities of ten)	$3.10 cassette	$3.00 wafer	$3.20 disk

Let's face it. Cassette players were not designed to store digital data and programs. That's why we designed a digital storage system using a continuous tape loop: the Exatron Stringy/Floppy (ES/F) and the Wafer. There's no expensive interface to buy—the ES/F comes ready to pump up your TRS-80.*

Once your TRS-80* is pumped up by our ES/F . . . you won't want to deflate it. We're so sure, that we offer an unconditional 30-day money-back guarantee and a one-year limited warranty. Over 2,000 TRS-80* owners have met the wafer . . . why don't you?

TRS-80*

EXATRON'S STRINGY/FLOPPY...

SPEED, CAPACITY AND RELIABILITY FOR ONLY $249.50

CALL
OUR HOTLINE
(800)-538-8559

IN CALIFORNIA,
CALL (408)-737-7111

exatron, inc.
181 Commercial Street
Sunnyvale, Calif. 94086

*TRS-80 is a registered trademark of Tandy Corp.

Listing 1 continued:

```
1870 !
1875 FOR J=1 TO 2240             !LOOP THROUGH THE INSTPUCTION POINTER ARRAY
1880  IF P(J)=0 THEN 3335        !AND LOOK FOR A VALID POINTER
1885  T$=FNI$(A$,P(J))           !THEN EXTRACT THE INSTRUCTION FROM THE TEXT ARRAY
1887  E4=M1                      !SAVE CURRENT MACHINE CODE ARRAY POINTER
1890 !
1895 !      SCANNER SECTION: THIS SECTION SCANS THE INSTRUCTION AND SENDS
1900 !      THE DECODED TEXT TO THE INTERPRETING SECTION.  IT ALSO SETS
1905 !      SEVERAL FLAGS (F1-F6) FOR THE FOLLOWING CONDITIONS,RESPECTIVELY:
1910 !      ALPHA APPEND INSTRUCTION, ANY TEXT INSTRUCTION, ANY ONE WORD
1915 !      INSTRUCTION, ANY ALPHA OPERAND,ANY INDIRECT OPERAND, AND ANY
1920 !      DIGIT ENTRY INSTRUCTION.
1925 !
1930 T1$=T2$=" "                 !INITIALIZE FLAGS AND TEXT VARIABLES
1935 P1=P2=0
1937 V=-1
1940 IF F6<>1 THEN 1955          !ADD A NULL INSTRUCTION BETWEEN ADJACENT DIGIT
1945 M(M1)=0                     !ENTRY INSTRUCTIONS
1950 M1=M1+1
1955 F1=F2=F3=F4=F5=F6=0
1960 S$=T$
1965 IF (T$="END") OR (T$=".END.") THEN 3355
1970                             ! CHECK FOR A TEXT ENTRY INSTRUCTION
1975 IF (T$[1,1]<>"'") AND (T$[1,2]<>"A'") THEN 2055
1980 IF T$[1,2]<>"A'" THEN 2000
1985 T$=T$[2]                    !CHECK FOR ALPHA APPEND TEXT INSTRUCTION
1990 F1=1
1995 !
2000 L=LEN(T$)                   !FIND END OF TEXT AND CHECK FOR ERRORS
2005 IF L<18 THEN 2020
2010  PRINT "ALPHA STRING TOO LONG IN LINE # ";J
2015  GOTO 2030
2020 IF T$[L,L]="'" THEN 2040
2025 PRINT "ERROR IN ALPHA REGISTER ENTRY INSTRUCTION AT LINE # ";J
2030 GOSUB 3400
2035 GOTO 1930
2040 F2=1                        !SET TEXT FLAG
2045 GOTO 2275
2050 !
2055 FOR I=1 TO LEN(T$)          !CHECK FOR A DIGIT ENTRY INSTRUCTION
2060  T1$=T$[I,I]
2065  IF (T1$>="0") AND (T1$<="9") THEN 2085
2070  IF ((T1$="+") OR (T1$="-")) AND (LEN(T$)>1) THEN 2085
2075  IF (T1$=" ") OR (T1$="E") OR (T1$=".") THEN 2085
2080  GOTO 2105                  !NOT A DIGIT ENTRY INSTR.; CONTINUE SCAN
2085 NEXT I
2090 F6=1                        !SET DIGIT ENTRY FLAG
2095 GOTO 2275
2100 !
2105 P1=POS(T$," ")              !LOOK FOR AN OPERAND OF THE INSTRUCTION
2110 IF P1<>0 THEN 2130          !SET FLAG AND RETURN IF ONLY ONE WORD LONG
2115 F3=1
2120 GOTO 2275
2125 !
2130 T1$=TRIM$(T$[P1+1])         !GET FIRST OPERAND AND CHECK FOR AN ALPHA STRING
2135 T$=T$[1,P1-1]
2140 L=LEN(T1$)
2145 IF (T1$[1,1]<>"'") OR (T1$[L,L]<>"'") THEN 2175
2150 IF L>9 THEN 2010            !CHECK FOR LENGTH OF OPERAND
2155 T1$=T1$[2,L-1]
2160 F4=1
2165 GOTO 2275
2170 !
2175 P2=POS(T1$," ")             !GET SECOND OPERAND AND CHECK FOR INDIRECTION
2180 IF P2=0 THEN 2220
2185 T2$=T1$[1,P2-1]
2190 IF T2$="IND" THEN 2210
2195 PRINT "OPERAND ERROR IN LINE # ";J
2200 GOSUB 3400
2205 GOTO 1930
2210 F5=1                        !SET INDIRECTION FLAG AND EXTRACT NUMERIC OPERAND
2215 T1$=TRIM$(T1$[P2+1])
2220 IF LEN(T1$)<=2 THEN 2275
2225 PRINT "ERROR IN NUMERIC OPERAND IN LINE # ";J
2230 GOSUB 3400
2235 GOTO 1930
2240 !
2245 !
2250 !      INTERPRETING SECTION:  THIS SECTION TAKES THE DECODED TEXT HELD IN
2255 !      T$,T1$ AND T2$, INTERPRETS THE INSTRUCTION AND ENTERS THE MACHINE
2260 !      CODE INTO THE ARRAY 'M' AT THE POSITION GIVEN BY THE POINTER 'M1'.
2265 !      AN ERROR CAUSES A MESSAGE TO BE PRINTED WHICH REQUESTS A CORRECTION.
2270 !
2275 IF F2<>1 THEN 2395         !CHECK FOR A TEXT ENTRY INSTRUCTION
2285 M(M1)=240+L-2               !ENTER LENGTH OF TEXT
2290 IF F1=1 THEN M(M1)=M(M1)+1  !ADD COUNTER FOR EXTRA BYTE IF APPEND INST.
2295 M1=M1+1
2300 X=1
2305 Y=59
2310 !
2315 IF F1<>1 THEN 2335          !IF ALPHA APPEND, PUT 127 IN 2ND BYTE
2320 M(M1)=127
2325 M1=M1+1
2330 !
2335 FOR I=2 TO L-1              !CHECK FOR VALID CHARACTERS AND ADD TO INST.
2340  Z=FNS(X,Y,(T$[I,I]),C$(*))
2345  IF Z<>0 THEN 2370
2350   PRINT "INVALID CHARACTER IN LABEL OR TEXT"
2355   GOSUB 3400
2365   GOTO 1930                         !IF ERROR EXISTS
2370  M(M1)=C2(Z)                        !ENTER VALID CHARACTER
2372  M1=M1+1
2375 NEXT I
2380 GOTO 3335
2385 !
2390 !
2395 IF F6<>1 THEN 2660          !CHECK FOR DIGIT ENTRY INSTRUCTION
2400 F9=0
2410 IF (T$[1,1]<>"+") AND (T$[1,1]<>"-") THEN 2435
2415 IF T$[1,1]<>"-" THEN 2430 !CHECK FOR MINUS SIGN
2420  M(M1)=28
2425  M1=M1+1
2430 T$=T$[2]
2435 L1=POS(T$," ")              !LOOK FOR EXPONENT
2440 L2=POS(T$,"E")
2445 IF L1=0 THEN L1=LEN(T$)
2450 IF L2<>0 THEN L1=L2-1
2455 !
2460 FOR I=1 TO L1               !ENTER MANTISSA INTO MACHINE CODE ARRAY
2465  IF T$[I,I]<>"." THEN 2495!CHECK FOR THE DECIMAL POINT
2470  IF F9=1 THEN 2530
2475  F9=1
2480  M(M1)=26
2485  M1=M1+1
2490  GOTO 2510
2495  IF (T$[I,I]<"0") OR (T$[I,I]>"9") THEN 2490
2500  M(M1)=NUM(T$[I,I])-32
2505  M1=M1+1
2510 NEXT I
2515 !
2520 IF (L1=LEN(T$)) AND (L2=0) THEN 3335!CHECK FOR ERRORS IN MANTISSA
2525 IF (I=L1) OR (I=L2) THEN 2555
```

Listing 1 continued on page 164

Orange Micro

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CENTRONICS 737 (RADIO SHACK LINE PRINTER IV)

Word Processing Print Quality

• 18 x 9 dot matrix; suitable for word processing • Underlining • proportional spacing • right margin justification • serif typeface • 50/80 CPS • 9½" Pin Feed/Friction feed • Reverse Platen • 80/132 columns

CENTRONIC 737-1 .... (List $995) $Call

MALIBU

The Small Business Printer; Letter Quality & Speed.

• 10 x 9 dot matrix • Letter quality print; Lower case descenders • High speed; 165 CPS, Bidirectional, Logic seeking • Wide carriage, Adjustable tractors to 16" • Vertical forms control • Variable line spacing • User programmable character set • Dot Resolution Graphics

MALIBU 165 .... (List $2495) $2195

EPSON MX80

Low-Priced Professional Print Quality

• 9 x 9 dot matrix • Lower case descenders • 80 CPS • Bidirectional, Logic seeking • 40, 66, 80, 132 columns per line • 64 special graphic characters: TRS-80 Compatible • Forms handling • Multi-pass printing • Adjustable tractors

EPSON MX80 .... (List $645) $Call

ANACOM

Low Cost, High Speed, Wide Carriage

• 9 x 9 dot matrix • Lower case descenders • Wide carriage • Adjustable tractors to 16" • 150 CPS, Bidirectional, Logic Seeking

ANACOM 150 .... (List $1350) $ Call

EPSON TX80

• 5 x 7 dot matrix • 125 CPS • Double wide characters • Dot resolution graphics & 64 special graphic characters • 6/8 line per inch • Vertical forms control • Adustable tractors • Heavy Duty — Highly reliable

EPSON TX80 .... (List $799) $Call

OKIDATA MICROLINE SERIES

TRS-80 Graphics Compatibility

• 9 x 7 dot matrix • 80 CPS • 80, 132 columns — 64 shapes for charts, graphs & diagrams • Double wide characters • 6/8 lines per inch • Up to 3 part copy • Friction & pin feed • 200 M character head warranty

OKIDATA MICROLINE 80 .... (List $800) $599

THE SMALL COMPUTER PRINTER by Brent Weston

This illustrated booklet provides the information you need about today's small printers. There are many printers available, each with different features and capabilities. *The Small Computer Printer* will guide you in determining which printer best fits your applications. A complete feature comparison chart is included representing over 40 small printers. A printer is a big investment — learn all about them before you buy one. $7.95

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Orange Micro, Inc.
3148 E. La Palma, Suite E
Anaheim, CA 92806

Listing 1 continued:

```
2530 PRINT "DIGIT ENTRY INSTRUCTION ERROR IN LINE # ";J
2535 GOSUB 3400
2545 GOTO 2400
2550 !
2555 T$=TRIM$(T$[1])              !ENTER EXPONENT IF IT EXISTS
2560 IF T$[1,1]<>"E" THEN 2530
2565 M(M1)=27
2570 M1=M1+1
2575 T$=T$[2]
2580 IF T$[1,1]<>"-" THEN 2600 !CHECK FOR NEGATIVE EXPONENT
2585 M(M1)=28
2590 M1=M1+1
2595 !
2600 IF (T$[1,1]="-") OR (T$[1,1]="+") THEN T$=T$[2]
2605 T$=TRIM$(T$)
2610 L=LEN(T$)                    !ADD EXPONENT TO MACHINE CODE ARRAY
2615 IF L>2 THEN 2530
2620 FOR I=1 TO L
2625  IF (T$[I,I]<"0") OR (T$[I,I]>"9") THEN 2530
2630  M(M1)=NUM(T$[I,I])-32
2635  M1=M1+1
2640 NEXT I
2645 GOTO 3335
2650 !
2655 !
2660 L=LEN(T1$)                    !OTHER INSTRUCTIONS: CALCULATE VALUE OF OPERANDS
2665 IF F3=1 THEN 3265            !ONE WORD FLAG
2670 IF F4=1 THEN 2805            !ALPHA OPERAND FLAG
2675 !
2680 IF L<=2 THEN 2705            !NUMERIC OPERAND SEEN
2685 PRINT "NUMERIC OPERAND TOO LONG IN LINE # ";J
2690 GOSUB 3400
2695 GOTO 1930
2700 !
2705 IF L<2 THEN 2740             !CHECK FOR DOUBLE DIGIT OPERAND
2710 V=(NUM(T1$[1,1])-48)*10+NUM(T1$[2,2])-48
2715 IF (V>=0) AND (V<=99) THEN 2805
2720 PRINT "INCORRECT NUMERIC OPERAND IN LINE # ";J
2725 GOSUB 3400
2730 GOTO 1930
2735 !
2740 V=0
2745 FOR I=1 TO 26                !CALCULATE STACK REGISTER OR LOCAL LABEL VALUE
2750  IF T1$=S1$(I) THEN V=I+101
2755 NEXT I
2760 IF V<>0 THEN 2805
2765 V=NUM(T1$)-48                !CALCULATE SINGLE DIGIT OPERAND VALUE
2770 IF (V>=0) AND (V<=9) THEN 2805
2775 PRINT "INCORRECT STACK OR SINGLE DIGIT OPERAND IN LINE # ";J
2780 GOSUB 3400
2785 GOTO 1930
2790 !
2795 !
2800                               ! CHECK FOR SPECIAL COMMANDS
2805 IF F5=1 THEN V=V+128         !ADD INDIRECTION BIT (HIGH ORDER BIT) TO OPERAND
2810 !
2815 IF (T$<>"GTO") AND (T$<>"XEQ") THEN 3020!CHECK FOR 'GTO' OR 'XEQ' COMMAND
2820 !
2825 IF F5<>1 THEN 2860           !CHECK FOR 'GTO IND' OR 'XEQ IND'
2830 M(M1)=174
2835 IF T$="GTO" THEN V=V-128  !SET HIGH BIT FOR 'XEQ IND'
2840 M(M1+1)=V
2845 M1=M1+2
2850 GOTO 3335
2855 !
2860 IF F4<>1 THEN 2955           !START WITH 'GTO/XEQ ALPHA LABEL' COMMAND
2870 X=1
2875 Y=59
2880 M(M1)=29
2885 IF T$="XEQ" THEN M(M1)=30
2890 L=LEN(T1$)
2895 M(M1+1)=240+L                 !ADD LENGTH TO SECOND BYTE (HI ORDER BITS= F HEX)
2900 FOR I=1 TO L
2905  Z=FNS(X,Y,(T1$[I,I]),C$(*))
2910  IF Z<>0 THEN 2935            !CHECK FOR VALID CHARACTERS IN ALPHA STRING
2915   PRINT "INVALID CHARACTER IN ALPHA LABEL"
2920   GOSUB 3400
2930   GOTO 1930
2935  M(M1+I+1)=C2(Z)
2936 NEXT I
2940 M1=M1+L+2
2945 GOTO 3335
2950 !
2955 IF (V>14) OR (T$="XEQ") THEN 2985   !SHORT FORM (2 BYTE) NUMERIC GTO:
2960 M(M1)=177+V                   !SECOND BYTE CONTAINS UNCOMPILED POINTER
2965 M(M1+1)=0
2970 M1=M1+2
2975 GOTO 3335
2980 !
2985 M(M1)=208                     !LONG FORM (3 BYTE) NUMERIC GTO OR NUMERIC XEQ:
2990 IF T$="XEQ" THEN M(M1)=224
2995 M(M1+1)=0                     !SECOND BYTE AGAIN CONTAINS POINTER
3000 M(M1+2)=V                     !THIRD BYTE CONTAINS REGISTER NUMBER
3005 M1=M1+3
3010 GOTO 3335
3015 !
3020 IF T$<>"STO" THEN 3080       !CHECK FOR STORE INSTRUCTION
3025 !
3030 IF V>15 THEN 3055            !SHORT FORM (ONE BYTE) STORE INSTRUCTION
3035 M(M1)=48+V
3040 M1=M1+1
3045 GOTO 3335
3050 !
3055 M(M1)=145                     !LONG FORM (2 BYTE) STORE INSTRUCTION
3060 M(M1+1)=V
3065 M1=M1+2
3070 GOTO 3335
3075 !
3080 IF T$<>"RCL" THEN 3140       !CHECK FOR RECALL INSTRUCTION
3085 !
3090 IF V>15 THEN 3115            !SHORT FORM (1 BYTE) RECALL INSTRUCTION
3095 M(M1)=32+V
3100 M1=M1+1
3105 GOTO 3335
3110 !
3115 M(M1)=144                     !LONG FORM (2 BYTE) RECALL INSTRUCTION
3120 M(M1+1)=V
3125 M1=M1+2
3130 GOTO 3335
3135 !
3140 IF T$<>"LBL" THEN 3265
3145 !
3150 IF F4<>1 THEN 3210           !ALPHA LABEL INSTRUCTION
3160 X=1
3165 Y=59
3170 M(M1)=192                     !UNCOMPILED LABEL CHAIN POINTER IN SECOND BYTE
3175 M(M1+1)=0
3180 L=LEN(T1$)
3185 M(M1+2)=241+L
3190 M(M1+3)=0                     !KEY ASSIGNMENT BYTE (SET TO ZERO FOR BAR CODE)
3195 M1=M1+2
3200 GOTO 2900                     !ADD CHARACTER DATA TO MACHINE CODE ARRAY
```

Listing 1 continued on page 166

dBASE™ II vs. the Bilge Pumps.

by Hal Pawluk

We all know that bilge pumps suck.

And by now, we've found out—the hard way—that a lot of software seems to work the same way.

So I got pretty excited when I ran across **dBASE II**, an assembly-language relational Database Management System for CP/M. It works! And even a rank beginner like myself got it up and running the first time I sat down with it.

If you're looking for software to deal with your data, too, here are some tips that will help:

Tip #1: Database Management vs. File Handling:

Any list or collection of data is, loosely, a data base, but most of those "data base management" articles in the buzzbooks are really about file handling programs for specific applications. A real Database Management System gives you data and program independence (no reprogramming when data changes), eliminates data duplication and makes it easy to turn data into information.

Tip #2: Assembly Language vs. BASIC:

This one's easy: if you're setting up a DBMS, you're going to be doing a lot of sorting, and Basic sorts are s-l-o-w. Run a benchmark on a Basic system like S*-IV against a relational DBMS like **dBASE II** and you'll see what I mean. (But watch it: I've also seen one extremely slow assembly-language file management system.)

Tip #3: Relational vs. Hierarchal & Network DBMS.

CODASYL-like hierarchal and network systems, around since the 1960's, are being phased out on the big machines so why get stuck with an old-fashioned system for your micro? A relational DBMS like **dBASE II** eliminates the predefined sets, pointers and complex data structures of a CODASYL-type DBMS. And you don't need to be a programmer to use it.

dBASE II vs. everything else.

dBASE II really impressed me.

Written in assembly language (with no need for a host language), it handles up to 65,000 records (up to 32 fields and 1000 bytes each), stores numeric data as packed strings so there are no round-off errors, has a super-fast multiple-key sort, and supports ISAM based on B* trees.

You can use it interactively with English-like commands (DISPLAY 10 PRODUCTS), or program it (so when you've set up the formats, your secretary can do the work). Its report generator and user-definable full screen operations mean that you can even use your existing forms.

And if all this makes your mouth water, but you've already got all your data on a disk, that's okay: **dBASE II** reads your ASCII files and adds the data to its own database.

Right now, I'm using **dBASE II** with my word processor for budgeting, scheduling and preparing reports for my clients.

Next come job costing, time billing and accounting.

An Unheard-of Money-Back Guarantee.

dBASE II is the first software I've seen with a full money-back guarantee.

To check it out, just send $700 (plus tax in California) to Ashton-Tate, 3600 Wilshire Blvd., Suite 1510, Los Angeles, CA 90010. (213) 666-4409. Test **dBASE II** doing your jobs on your computer for 30 days. If, for some strange reason, you don't want to keep it, send it back and they'll refund your money.

No questions asked.

They know you don't need your bilge pumped.

Ashton-Tate

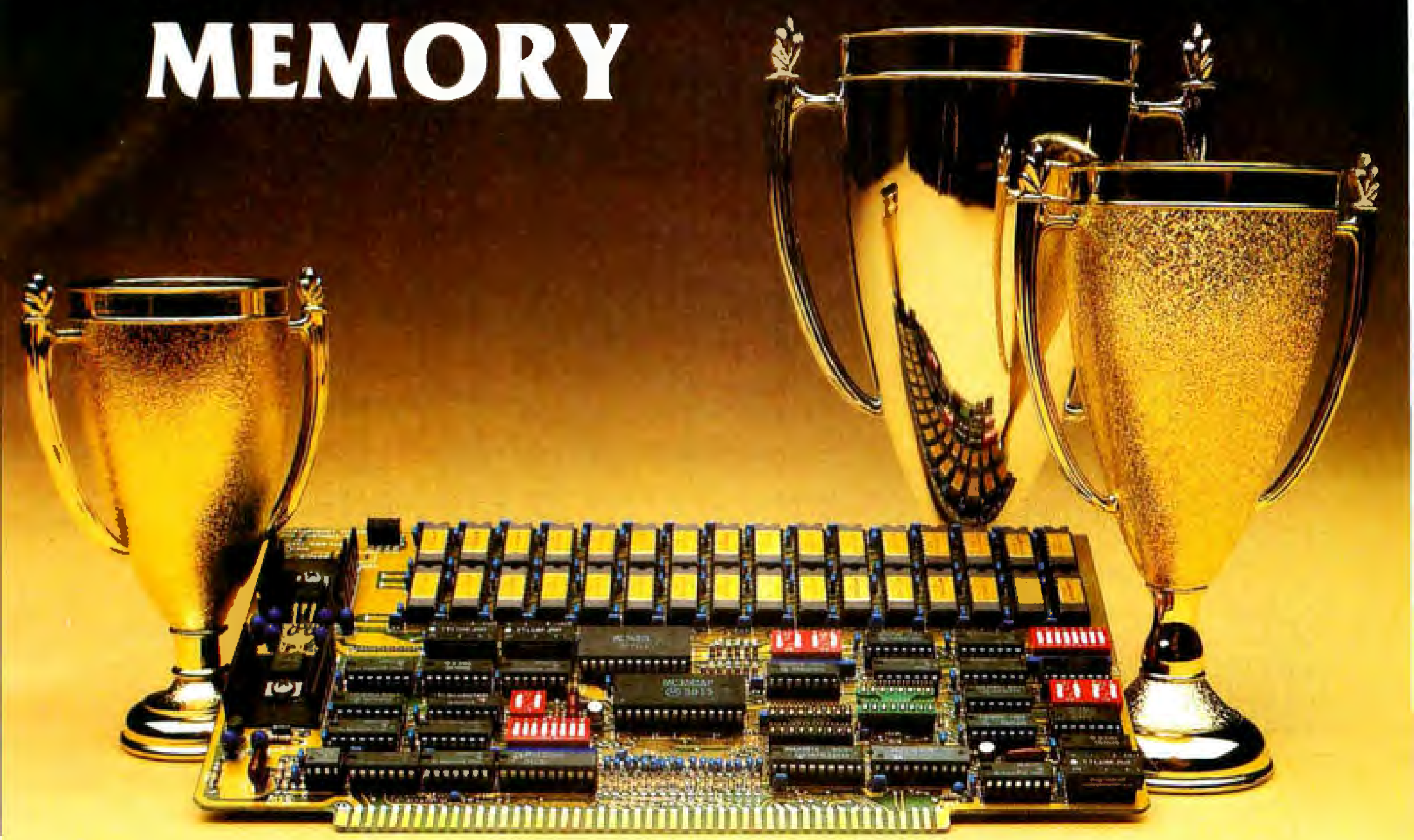
Circle 104 on inquiry card.

Listing 1 continued:

```
3205 !
3210 IF V>14 THEN 3235            !SHORT FORM (ONE BYTE) NUMERIC LABEL
3215 M(M1)=1+V
3220 M1=M1+1
3225 GOTO 3335
3230 !
3235 M(M1)=207                   !LONG FORM (TWO BYTE) NUMERIC LABEL
3240 M(M1+1)=V
3245 M1=M1+2
3250 GOTO 3335
3255 !
3260 !
3265 X=1                                   !ALL OTHER COMMANDS ARE TABLE DRIVEN
3270 Y=103
3275 Z=FNS(X,Y,T$,I$(*))
3280 IF Z<>0 THEN 3310
3285 !
3290 PRINT "UNRECOGNIZABLE INSTRUCTION GIVEN IN LINE # ";J
3295 GOSUB 3400
3300 GOTO 1930
3305 !
3310 M(M1)=I1(Z)                 !STORE INSTRUCTION TYPE IN MACHINE CODE ARRAY
3312 M1=M1+1
3313 !                           !CHECK FOR CORRECT ONE WORD INSTRUCTION
3314 IF (I1(Z)<64) OR (I1(Z)>143) OR F3 THEN 3320
3316 PRINT "ERROR: EXTRANEOUS OPERAND IN INSTRUCTION"
3317 GOSUB 3400
3318 GOTO 1930
3319 !
3320 IF I1(Z)<144 THEN 3335   !CHECK FOR TWO BYTE INSTRUCTION
3321 !                           !FIRST CHECK FOR COMPLETE INSTRUCTION
3322 IF (I1(Z)<144) OR (I1(Z)>191) OR (V<>0) THEN 3327
3323 PRINT "ERROR: MISSING OPERAND"
3324 GOSUB 3400
3325 GOTO 1930
3326 !
3327 M(M1)=V
3330 M1=M1+1
3335 NEXT J                      !***END OF THE INSTRUCTION DECODE LOOP***
3340 !
3345 ! *        *        *        *        *        *        *
3350 !
3355 M(M1)=192                   !ADD FINAL END INSTRUCTION: UNCOMPILED POINTER
3360 M(M1+1)=0                   !IN SECOND BYTE
3365 M(M1+2)=47
3370 S2=M1+2
3375 PRINT "COMPILATION COMPLETED"
3377 F8=1                        !SET COMPILATION DONE FLAG
3380 GOTO 350
3385 !
3390 !
3395 !        ***ERROR CORRECTION SUBROUTINE***
3400 PRINTER IS 16
3402 M1=E4                       !RESET MACHINE CODE ARRAY TO OLD VALUE
3405 PRINT "THE INSTRUCTION GIVEN WAS: ";S$
3407 PRINT "GIVE THE CORRECTED INSTRUCTION (WITHOUT LINE NUMBER)  "
3410 INPUT " (TO ABORT THIS COMPILATION, TYPE 'ABORT'): ",T$
3415 IF T$="ABORT" THEN 350
3420 A$=A$&T$&"!"
3425 P(J)=T
3430 T=T+LEN(T$)+1
3435 RETURN
3440 !
3445 !
3450 ! * * * * * * * * * END OF  COMPILE  ROUTINE * * * * * * * * * * * * *
3455 !
3460 !
3465 !
3470 !
3475 ! * * * - * * * - PROGRAM COMMANDS LIST ROUTINE * * * * * * * * * * *
3480 !
3485 !  THIS ROUTINE LISTS OUT THE COMMANDS AVAILABLE IN THIS PROGRAM AND
3490 !  THE SYNTAX OF THE COMMANDS AND OF INSTRUCTION ENTRY
3495 !
3500 PRINT " "
3505 PRINT "COMMANDS AVAILABLE IN THIS PROGRAM:"
3510 PRINT " "
3515 PRINT "  COMPILE       - COMPILES THE 41C PROGRAM CURRENTLY ENTERED"
3520 PRINT "  DELETE nn     - DELETES THE NUMBERED INSTRUCTION FROM THE PROGRAM"
3525 PRINT "  EXIT          - HALTS THIS PROGRAM OR STOPS NUMBER GENERATOR"
3530 PRINT "  GETPROG       - RETRIEVES THE COMPILED CODE FROM CASSETTE TAPE"
3535 PRINT "  GETTEXT       - RETRIEVES THE PROGRAM INSTRUCTIONS FROM TAPE"
3540 PRINT "  LIST          - LISTS THE ENTIRE 41C PROGRAM CURRENTLY IN MEMORY"
3542 PRINT "  NUMBER        - GENERATES 41C INSTRUCTION NUMBERS - STOPPED BY "
3543 PRINT "                  TYPING 'EXIT'"
3545 PRINT "  RENUMBER      - RENUMBERS THE 41C PROGRAM INSTRUCTION NUMBERS"
3550 PRINT "  RUN           - GENERATES THE BAR CODE FROM THE COMPILED CODE"
3555 PRINT "  RUNPRIVATE    - GENERATES THE BAR CODE FOR A PRIVATE PROGRAM"
3560 PRINT "  SAVEPROG      - STORES THE COMPILED CODE ON CASSETTE TAPE"
3565 PRINT "  SAVETEXT      - STORES THE PROGRAM LISTING ON CASSETTE TAPE"
3570 PRINT "  SCRATCH       - ERASES THE ENTIRE 41C PROGRAM"
3575 PRINT "  ??            - LISTS OUT THE COMMANDS AVAILABLE "
3580 PRINT " "
3585 PRINT "SYNTAX FOR INSTRUCTION ENTRY:"
3590 PRINT " A)INSTRUCTION FORMAT: "
3595 PRINT "      n <41C INSTRUCTION>"
3600 PRINT "      (BLANKS ARE USED AS DELIMITERS)"
3605 PRINT " B)SPECIAL SYMBOLS:"
3610 PRINT "      1) USE '&' INSTEAD OF THE SIGMA SIGN"
3615 PRINT "      2) USE '@' INSTEAD OF THE ANGLE SIGN"
3620 PRINT "      3) USE '#' INSTEAD OF THE 'NOT EQUAL' SIGN"
3625 PRINT "      4) USE SINGLE QUOTES (') INSTEAD OF DOUBLE QUOTES"
3630 PRINT " C)TEXT FORMAT:       '<TEXT ENTRY>'      (NOTE SINGLE QUOTES)"
3635 PRINT "                  OR    A'<TEXT ENTRY>'     (FOR APPENDING TEXT)"
3640 GOTO 350
3645 !
3650 ! * * * * * * * * * * END OF COMMAND LIST ROUTINE * * * * * * * * * *
3655 !
3660 !
3665 !
3670 !
3675 ! * * * * * * * * * * 'RENUMBER' ROUTINE * * * * * * * * * * * * * * *
3680 !
3685 !  THIS ROUTINE RENUMBERS THE 41C INSTRUCTIONS BY REARRANGING THE
3690 !  ARRAY OF POINTERS INTO THE TEXT STRING.  THE STARTING OLD VALUE, NEW
3695 !  STARTING VALUE AND INCREMENT ARE REQUESTED, AND AN NUMBER OVERFLOW
3700 !  (>2240) OR REWRITING OVER EXISTING INSTRUCTIONS WILL ABORT ROUTINE
3705 !
3710   INPUT "ENTER THE OLD STARTING #,NEW STARTING #, AND INCREMENT: ",V1,V2,V3
3711   FOR I=V2+1 TO V1-1               !CHECK FOR OVERWRITTEN INSTRUCTIONS
3712    IF P(I)=-1 THEN 3715
3713    PRINT "ERROR - ATTEMPT MADE TO OVERWRITE EXISTING INSTRUCTIONS"
3714    GOTO 350
3715   NEXT I
3717   FOR I=1 TO 2240                  !CREATE TEMPORARY POINTER ARRAY
3720    P1(I)=P(I)
3725    IF I>=V1 THEN P(I)=-1
3730   NEXT I
3735   K=V1-1
3740   FOR I=V2 TO 2240 STEP V3 !TRANSFER VALID POINTERS BACK TO POINTER ARRAY
```

Listing 1 continued on page 168

THE UNBEATABLE S-100 MEMORY



That's the MEASUREMENT systems & controls DMB Series of S-100 bus memory modules, fully compatible with **ALPHA MICRO, CROMEMCO, DYNABYTE, NORTH STAR, MP/M**, and most other S-100 systems.

Definitely a winner, the DMB Series is available with Bank Select (DMB6400) or without (DM6400) and utilizes industrial quality construction, provides outstanding reliability, and is backed by dedicated customer service and a one year guarantee.

The DMB6400 uses I/O port addressing for the bank select feature. A switch provides the ability to select any one of the 256 I/O ports for addressing the memory banks. The memory is configured as four totally independent 16K software selectable banks, with each bank addressable on any 16K boundary.

Outstanding features such as those listed below make the DMB series the UNBEATABLE S-100 Memory:

- Four independent 16K software selectable banks.
- Each bank is independently addressable on any 16K boundary.
- Switch selectable bank sizes — from 16K to 64K in 16K increments.
- Eight banks (512K) per I/O port for each of the 256 ports.
- Z-80 4MHz operation with no wait states using transparent refresh.
- On-board diagnostic LED's.
- Low power — 8 watts maximum.
- Reliable, tested and burned-in memory.
- IEEE S-100 compatible timing.
- One year guarantee.
- Attractive Dealer & OEM Prices.

See your nearest computer dealer, or contact us for the complete story on the UNBEATABLE S-100 Memory.

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Listing 1 continued:

```
3745     K=K+1
3750     IF K>2240 THEN 350      !CHECK FOR END OF PROCESSING
3755     IF K1(K)<0 THEN 3745
3760     P(I)=K1(K)
3765    NEXT I
3770    PRINT "ERROR: INSTRUCTION NUMBER OUT OF BOUNDS"
3775    FOR I=1 TO 2240
3780     P(I)=K1(I)
3785    NEXT I
3790    GOTO 350
3795 !
3800 ! * * * * * * * * * *  END OF 'RENUMBER' ROUTINE * * * * * * * * * * *
3805 !
3810 !
3815 !
3820 ! * * * * * * * * * * 'SAVETEXT' ROUTINE * * * * * * * * * * * * * * *
3825 !
3830 !   THIS ROUTINE SAVES THE TEXT OF THE 41C INSTRUCTIONS (THE SOURCE
3835 !   FILE) ON CASSETTE TAPE.
3840 !
3845 INPUT "GIVE THE NAME OF THE FILE TO BE SAVED: ",T1$
3850 CREATE T1$,T DIV 64+50
3855 ASSIGN #1 TO T1$
3860 PRINT #1;P(*)              !SAVE THE POINTER ARRAY AND THE TEXT STRING
3865 PRINT #1;A$,END
3870 ASSIGN * TO #1
3875 GOTO 350
3880 !
3885 ! * * * * * * * * * * END OF 'SAVETEXT' ROUTINE * * * * * * * * * * *
3890 !
3895 !
3900 !
3905 !
3910 ! * * * * * * * * * * 'GETTEXT' ROUTINE * * * * * * * * * * * * * * *
3915 !
3920 !   THIS ROUTINE RETRIEVES THE TEXT INSTRUCTIONS (SOURCE FILE) FROM
3925 !   CASSETTE TAPE AND RESETS THE END OF TEXT POINTER.
3930 !
3935 INPUT "GIVE THE NAME OF THE FILE TO BE READ",T1$
3940 ASSIGN T1$ TO #1,I
3945 IF I<>1 THEN 3960
3950 PRINT "FILE NAME NOT FOUND"
3955 GOTO 350
3960 IF I=0 THEN 3980
3965 PRINT "FILE IS PROTECTED OR OF WRONG TYPE"
3970 GOTO 350
3975 !
3980 READ #1;P(*)               !RETRIEVE THE POINTER ARRAY AND TEXT STRING
3985 READ #1;A$
3990 T=LEN(A$)                  !RESTORE POINTER TO END OF TEXT
3995 GOTO 350
4000 !
4005 ! * * * * * * * * * * * END OF 'GETTEXT' ROUTINE * * * * * * * * * * *
4010 !
4015 !
4020 !
4025 !
4030 ! * * * * * * * * * * 'SAVEPROG' ROUTINE * * * * * * * * * * * * * * *
4035 !
4040 !   THIS ROUTINE SAVES THE COMPILED CODE (THE JOB FILE) IN THE 'M' ARRAY
4045 !   ON CASSETTE TAPE FOR LATER USE.
4050 !
4055 INPUT " GIVE THE NAME OF THE FILE TO BE SAVED: ",T1$
4060 CREATE T1$,50
4065 ASSIGN T1$ TO #1
4070 PRINT #1;S2                !SAVE THE NUMBER OF BYTES IN THE PROGRAM
4075 PRINT #1;M(*)
4080 ASSIGN * TO #1
4085 GOTO 350
4090 !
4095 ! * * * * * * * * * END OF 'SAVEPROG' ROUTINE * * * * * * * * * * *
4100 !
4105 !
4110 !
4115 !
4120 ! * * * * * * * * * * 'GETPROG' ROUTINE * * * * * * * * * * * * * *
4125 !
4130 !   THIS ROUTINE RETRIEVES THE COMPILED PROGRAM FROM CASSETTE TAPE
4135 !
4140 INPUT "GIVE THE NAME OF THE FILE TO BE READ",T1$
4145 F8=1                      !SET THE COMPILED PROGRAM PRESENT FLAG
4150 ASSIGN T1$ TO #1,I
4155 IF I<>1 THEN 4170          !CHECK FOR FILE ERRORS
4160 PRINT "FILE NOT FOUND"
4165 GOTO 350
4170 IF I=0 THEN 4190
4175 PRINT "FILE IS PROTECTED OR OF WRONG TYPE"
4180 GOTO 350
4185 !
4190 READ #1;S2                !GET THE NUMBER OF BYTES IN THE MACHINE CODE ARRAY
4195 READ #1;M(*)
4200 ASSIGN #1 TO *
4205 GOTO 350
4210 !
4215 ! * * * * * * * * * END OF 'SAVEPROG' ROUTINE * * * * * * * * * *
4220 !
4225 !
4230 !
4235 !
4240 ! * * * * * * * * ERROR CONDITION HANDLING ROUTINE * * * * * * * * *
4245 !
4250 E1=ERRN                             !SAVE ERROR NUMBER
4255 E2=ERRL                             !SAVE LINE NUMBER WHERE ERROR OCCURED
4260 IF E1<>80 THEN 4275
4265 PRINT "NO TAPE IN TAPE DRIVE.  PLEASE INSERT TAPE"
4270 GOTO 350
4275 IF E1<>64 THEN 4290
4280 PRINT "NOT ENOUGH ROOM ON TAPE. PLEASE USE ANOTHER TAPE"
4285 GOTO 350
4290 IF E1<>83 THEN 4305
4295 PRINT "TAPE IS WRITE PROTECTED. PLEASE FIX"
4300 GOTO 350
4305 IF E1<>53 THEN 4320
4310 PRINT "IMPROPER FILE NAME (SHOULD BE SIX CHARACTERS OR LESS)"
4315 GOTO 350
4320 IF E1<>54 THEN 4360
4325 PRINT "DUPLICATE FILE NAME"
4330 IF (E2<>3850) AND (E2<>4060) THEN 4345
4335 INPUT "DO YOU WISH TO USE THE OLD FILE? ",T2$
4340 IF (T2$="Y") OR (T2$="YES") THEN 4350
4345 GOTO 350
4350 IF E2=3850 THEN 3855
4355 IF E2=4060 THEN 4065
4360 PRINT "ERROR # ";E1;"SEEN AT LINE # ";E2
4365 GOTO 350
4370 !
4375 ! * * * * * * * * * * * END OF ERROR ROUTINE * * * * * * * * * * * *
4380 !
4385 !
4390 !
4395 !
```

Listing 1 continued on page 170

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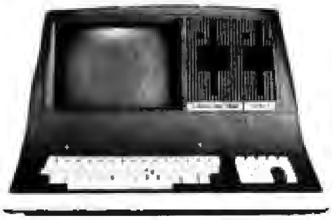

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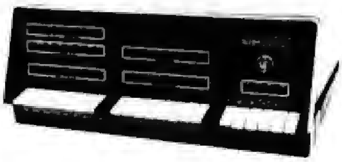

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Listing 1 continued:

```
4400 ! * * * * * * * * * * BAR PATTERN STRING GENERATOR * * * * * * * * * * *
4405 !
4410 !   THIS PROCEDURE GENERATES A STRING REPRESENTING THE BAR CODE PATTERN
4415 !   AS IT WILL BE WRITTEN ON THE DIABLO 1650 DAISY WHEEL PRINTER.  IT
4420 !
4425 !   DECODES THE BIT PATTERN FROM THE ARRAY  B  AND CONCATENATES THE
4430 !   CORRECT NUMBER OF VERTICAL BARS AND BLANKS ONTO THE STRING.  THE
4435 !   PATTERN USED IS:
4440 !     1)NARROW BAR:  2 VERTICAL BARS
4445 !     2)WIDE BAR:  4 VERTICAL BARS
4450 !     3)SPACE:  3 BLANKS
4455 !
4460  B$=" "
4465 FOR I=1 TO L
4470 !  THE VERTICAL BAR ON THE TITAN 10 CHARACTER WHEEL IS AN ">" IN ASCII
4475  IF B(I)=0 THEN B$=B$&">>   "
4480  IF B(I)=1 THEN B$=B$&">>>>   "
4485 NEXT I
4490 RETURN
4495 !
4500 ! * * * * * * * * * * END OF BAR PATTERN GENERATOR * * * * * * * * * * *
4505 !
4510 !
4515 !
4520 ! * * * * * * * * * * * * * DATA * * * * * * * * * * * * * * * * * * * *
4525 !
4530 !     ***LOCAL LABEL AND STACK REGISTER CHARACTERS***
4535 DATA A,B,C,D,E,F,G,H,I,J,T,Z,Y,X,L
4540 DATA " "," "," "," "," "," ",a,b,c,d,e
4545 !
4550 !     ***INSTRUCTION MNEMONICS AND NUMERIC VALUES***
4555 DATA %,76,%CH,77,&+,71,&-,72,&REG,153
4557 DATA *,66,+,64,-,65,/,67,1/X,96,10^X,87,ABS,97
4560 DATA ACOS,93,ADV,143,AOFF,139,AON,140,ARCL,155,ASHF,136,ASIN,92
4565 DATA ASTO,154,ATAN,94,AVIEW,126,BEEP,134,CF,169,CHS,84,CLΣ,112
4570 DATA CLA,135,CLD,127,CLRG,138,CLST,115,CLX,119,COS,90
4575 DATA D-R,106,DEC,95,DEG,128,DSE,151,ENG,158,ENTER ,131,E^X,85
4580 DATA E^X-1,88,FACT,98,FC?,173,FC?C,171,FIX,156,FRC,105
4585 DATA FS?,172,FS?C,170,GRAD,130,HMS,108,HMS+,73,HMS-,74,HR,109
4590 DATA INT,104,ISG,150,LASTX,118,LN,80,LN1+X,101,LOG,86
4595 DATA MEAN,124,MOD,75,OCT,111,OFF,141,P-R,78,PI,114
4600 DATA PROMPT,142,PSE,137,R-D,107,R-P,79,RAD,129,RCL,144,RDN,117
4605 DATA RND,110,RTN,133,R^,116,SCI,157,SDEV,125,SF,168
4610 DATA SIGN,122,SIN,89,SQRT,82,ST*,148
4615 DATA ST+,146,ST-,147,ST/,149,STO,145,STOP,132,TAN,91,TONE,159
4620 DATA VIEW,152,X#0?,99,X#Y?,121,X<0?,102,X<=0?,123,X<=Y?,70
4625 DATA X<>,206,X<>Y,113,X<Y?,68,X=0?,103,X=Y?,120,X>0?,100
4630 DATA X>Y?,69,X^2,81,Y^X,83
4635 !
4640 !     ***VALID 41C CHARACTERS AND CHARACTER CODE***
4645 DATA " ",32,#,29,$,36,%,37,&,126,*,42,+,43,",",44,-,45,.,46,/,47
4650 DATA "0",48,"1",49,"2",50,"3",51,"4",52,"5",53,"6",54,"7",55,"8",56
4655 DATA "9",57,:,58,";",59,<,60,=,61,>,62,?,63,@,13,A,65,B,66,C,67,D,68,E,69
4660 DATA F,70,G,71,H,72,I,73,J,74,K,75,L,76,M,77,N,78,O,79,P,80,Q,81,R,82,S,83
4665 DATA T,84,U,85,V,86,W,87,X,88,Y,89,Z,90,^,94,a,97,b,98,c,99,d,100,e,101
4670 END
4675 ! * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
4680 !
4685 !                    ******  FUNCTION DEFINITIONS ******
4690 !
4695 ! INSTRUCTION EXTRACTION FUNCTION:  THIS FUNCTION LOOKS AT THE TEXT
4700 ! ARRAY AND EXTRACTS THE INSTRUCTION POINTED TO BY THE POINTER AT THE
4705 ! INDEX PASSED TO THE FUNCTION.
4710 !
4715 DEF FNI$(A$,INTEGER I)
4720   INTEGER J
4725   DIM S$[50]
4730   FOR J=1 TO 50
4735    IF A$[I+J;1]=";" THEN 4745
4740   NEXT J
4745   S$=A$[I+1,I+J-1]          !GET TEXT UP TO THE SEMICOLON DELIMITER
4750   RETURN S$
4755 FNEND
4760 !
4775 ! *  *  *  *  *  *  *  *  *  *  *  *  *  *   *  *  *  *  *  *  *  *  *  *
4780 !
4785 !   NUMBER FORMAT FUNCTION:  THIS FUNCTION CONVERTS A NUMBER INTO A
4790 !   CHARACTER STRING.  IT IS USED ONLY IN THE DIABLO PRINTOUT SECTION.
4792 !   PARAMETER NEEDED IS:
4795 !    1) AN INTEGER NUMBER TO BE CONVERTED INTO A CHARACTER STRING
4800 !
4805 DEF FNF$(INTEGER N)
4810  INTEGER I,J,K
4815  DIM N$[5]
4820  IF N>=10 THEN 4840          !CONVERT ONE DIGIT NUMBERS
4825  N$=CHR$(N+48)
4830 RETURN N$
4835 !
4840  IF N>=100 THEN 4860         !CONVERT TWO DIGIT NUMBERS
4845  N$=CHR$(N DIV 10+48)&CHR$(N MOD 10+48)
4850  RETURN N$
4855 !
4860  IF N>1000 THEN 4890
4865  I=N DIV 100
4870  J=N MOD 100 DIV 10
4875  N$=CHR$(I+48)&CHR$(J+48)&CHR$(N MOD 10+48)
4880  RETURN N$
4885 !
4890  I=N DIV 1000
4895  J=N MOD 1000 DIV 100
4900  K=N MOD 100 DIV 10
4905  N$=CHR$(I+48)&CHR$(J+48)&CHR$(K+48)&CHR$(N MOD 10+48)
4910  RETURN N$
4915 FNEND
4920 !
4925 ! *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
4930 !
4935 !   ROW AND INSTRUCTION PRINTOUT FUNCTION:  THIS FUNCTION
4940 !   CREATES A STRING CONTAINING THE ROW NUMBER AND BEGINNING
4945 !   AND ENDING FUNCTION NUMBERS. IT IS USED ONLY IN THE DIABLO
4947 !   PRINTOUT SECTION.  PARAMETERS NEEDED ARE:
4950 !    1)ROW NUMBER
4955 !    2)FIRST INSTRUCTION NUMBER
4960 !    3)LAST INSTRUCTION NUMBER
4965 !
4970 DEF FNP$(INTEGER R,INTEGER I,INTEGER F)
4975  DIM F$[30]
4980  R$="ROW "&FNF$(R)&" ("&FNF$(I)
4985  IF I=F THEN 4995
4990  R$=R$&" - "&FNF$(F)
4995  R$=R$&")"
5000  RETURN R$
5005 FNEND
5010 !
5015 ! *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
5020 !
5025 !
5030 ! BINARY SEARCH FUNCTION:  FUNCTION SEARCHES PASSED CHARACTER ARRAY
5035 !   FOR PASSED KEY AND RETURNS INDEX OF KEY FOUND IN ARRAY OR 0 IF
5040 !   NO KEY WAS FOUND.  PARAMETERS REQUIRED ARE:
```

Listing 1 continued on page 172

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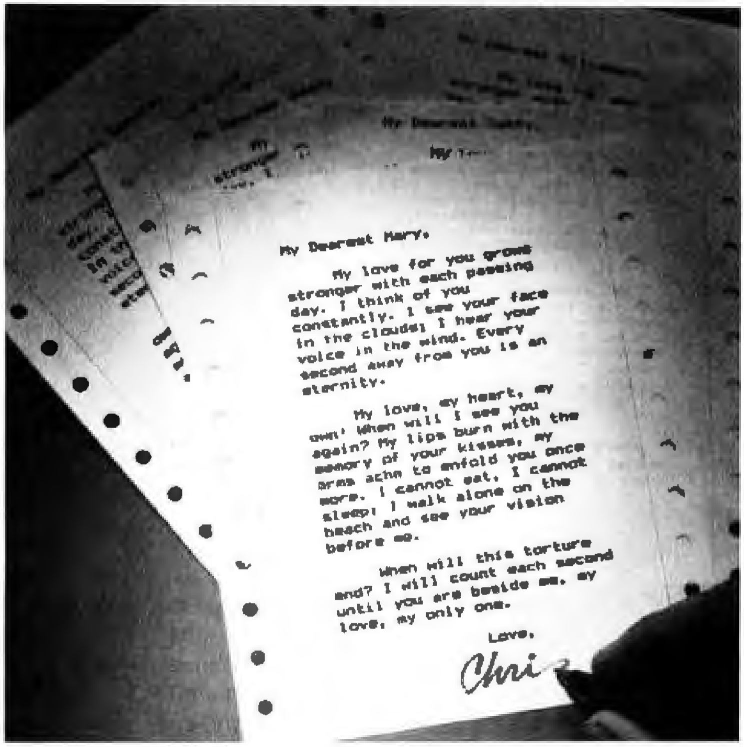

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Listing 1 continued:

```
5045 !    1)INDEX OF FIRST POSITION (INTEGER)
5050 !    2)INDEX OF LAST POSITION (INTEGER)
5055 !    3)KEY TO BE FOUND (STRING)
5060 !    4)STRING ARRAY IN WHICH THE SEARCH IS MADE
5065 !
5070 DEF FNS(INTEGER I,J,Q$,A$(*))
5075  INTEGER F,L,M
5080  F=I
5085  L=J
5090  M=(F+L) DIV 2                 !FIND CENTER OF ARRAY
5095  IF Q$=A$(M) THEN RETURN M    !IF KEY HAS BEEN FOUND, RETURN INDEX
5100  IF Q$>A$(M) THEN F=M+1
5105  IF Q$<A$(M) THEN L=M-1
5110  IF F<=L THEN 5090            !CONTINUE SEARCH THROUGH APPROPRIATE HALF
5115  M=0                          !RETURN 0 IF SEARCH FAILS
5120  RETURN M
5125 FNEND
5130 !
5135 ! *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
5140 ! ************ END OF BAR CODE GENERATION PROGRAM *****************
```

Text continued from page 150:

Since the HP-41C instructions are of varying length, they quite often straddle the border between two rows of bar code. If an instruction starts in the previous row and ends in the current row, the bytes of the instruction contained in the current row are the *leading partial-function bytes.* Alternately, if an instruction starts in the current row and ends in the next row, the bytes contained in the current row are the *trailing partial-function bytes.* The third byte of a bar-code row contains, in the 4 high-order bits, the number of leading partial-function bytes, and, in the 4 low-order bits, the number of trailing partial-function bytes.

A Bar-Code Generating Program

The program given in listing 1, which runs on a Hewlett-Packard HP-9845 minicomputer, allows the user to enter numbered HP-41C instructions and will insert the instructions into a text string for later use. Each instruction is associated with a value between 1 and 2240, which determines the order of execution of the HP-41C instructions. The number 2240 is given as a maximum since that is the largest number of bytes available to the user in program memory.

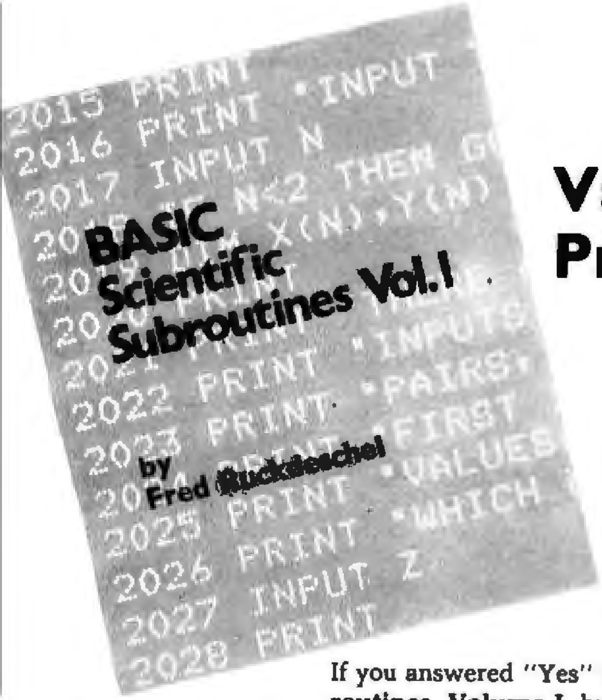
If the HP-41C program is extremely long, a renumbering command allows the user to create gaps in his numbering scheme to allow for later insertion of instructions. Using this program, the user is able to insert, delete, and replace instructions; the user can save the program in a file for later use.

In response to the prompt symbol, the user may give other single-word commands to compile and generate bar code for the HP-41C programs, save and retrieve the compiled HP-41C machine language, and list or delete the entire program. The syntax and action of each command are given in table 2 and will be printed out by the program if a "??" is typed in response to the prompt symbol.

The basic structure of the program is a main routine that generates the prompt symbol and decodes the input. A series of other routines perform the command functions and are called by a jump table in the main routine. The input to the main routine is decoded only to the extent of determining whether a command or an instruction has been given, and if an instruction has been decoded, the instruction number is calculated. The instruction is then appended to a text string, and a pointer to that instruction is entered into a pointer array at the position given by the instruction number. Consequently, the other routines will be able to retrieve the program by a linear inspection of the pointer array.

Replacement, deletion, and renumbering of instructions only involve manipulation of the pointer array, while insertion requires that the instruction number (an integer) must fall between two existing instruction numbers. The syntax of the HP-41C instructions recognized by this program follows that of the HP-82143A thermal printer and of the program listings distributed by the HP User's Library, with a few exceptions dictated by the difference between ASCII and the HP-41C character set. For example, characters representing the Greek letter Σ, the angle sign, and the ≠ sign are represented by the

Text continued on page 178



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Bar-Code Generator Commands

COMPILE	Compiles the current program and loads the compiled code into the array M.
DELETE *n*	Deletes the instruction given by *n* from the current program.
EXIT	Halts execution of the bar-code generator or of the line-number generator.
GETPROG	Retrieves compiled code from a file on cassette tape. (The routine prompts for a file name.)
GETTEXT	Retrieves program instructions from a file on cassette tape. (The routine prompts for a file name.)
LIST	Lists the entire current program.
NUMBER	Automatically generates instruction numbers for HP-41C program entry. The starting number and size of the increment are requested by the routine. This routine is halted by typing "EXIT".
RENUMBER	Renumbers the current program instructions. (The routine prompts for the old starting number, new starting number and size of the increment.)
RUN	Generates the bar code from the compiled code. (It may not be run unless compiled code has been generated.)
RUNPRIVATE	Generates bar code for a private program.
SAVEPROG	Stores compiled code for the current program on cassette tape. (The routine prompts for a file name.)
SAVETEXT	Stores instructions of the current program on cassette tape. (The routine prompts for a file name.)
SCRATCH	Erases the current program.
??	Displays a list of available commands and syntax rules.

Table 2: *A table of commands for the bar-code generating program given in listing 1.*

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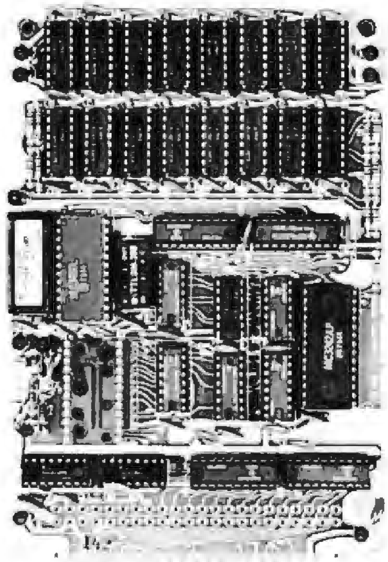

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Figure 2: *A demonstration program for the HP-41C. This bar-code program was created by an HP-9845 minicomputer connected to a Diablo 1650 printer using a Titan 10 metallic daisy-wheel. The program requires twenty registers within the HP-41C.*

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Text continued from page 172:
ASCII characters &, @, and #, respectively. Also, single quotes instead of double quotes are used for text and alphanumeric labels, and an alphanumeric append instruction is indicated by the character A preceding the single quotes and character string. The most important routines called by a command are the compile routine, which decodes the current program held in the text string, and the run routine, which takes the compiled machine code and generates the bit pattern representing the required bar code.

The program listed here was developed on an HP-9845A minicomputer and contains the functions and output statements required to generate bar code on the Diablo 1650 daisy-wheel printer. This is the system used by the HP User's Library to produce bar code at request for any program written either for the HP-41C or for the HP-67 and HP-97 series. The Diablo 1650 printer is used with a 96-character Titan 10 metallic daisy wheel and a Hytype II multistrike film ribbon.

The bars are printed by using the vertical bar (about 160 mils tall and 9 mils wide) on the Titan 10 with a horizontal increment of 1/120 inch. The narrow bars are two characters wide, the wide bars are four characters wide, and the spaces are three blanks wide. Three blanks are used instead of two because the ink generally spreads a slight amount, causing the spaces to shrink and the bars to grow larger. The paper used is the standard one-ply, 8½ by 11 inch, white computer paper. Figure 2 contains the bar code generated by the User Library's Diablo 1650 for a short demonstration program written for the HP-41C.

The subroutine at line 1605 prints a row of bar code and clears certain variables in preparation for the next row of bar code; this routine must be changed by the user if a different computer/printer combination is used. Copies of the resulting bar code may be made by an office copier if *careful attention* is paid to contrast, sharpness, and bar width. Many of the less expensive copy machines shrink the size of the bars, thus expanding the size of the spaces and rendering the bar code unreadable. Most of the commercial printing houses have the better copiers needed for this purpose. If many copies are needed, offset printing may also be used as a more expensive but very reliable method for bar-code reproduction.

For further assistance in generating bar code, you can obtain the Hewlett-Packard *Creating Your Own HP-41C Bar Code* manual (part number 82153-90019), which contains a listing of the program given here and a discussion of bar codes and bar-code generation. ■

Editor's Note:
The Hewlett-Packard bar-code format is partially compatible with the PAPERBYTE® format designed by BYTE Publications Inc in 1977. Fortunately, the compatibility is in the most important place, the representation of 1 and 0 bits within a line of bar code. Although Hewlett-Packard uses different header and trailer bytes to frame the actual bytes of data, the encoding scheme used to encode both the data and the header and trailer bytes is the same in both Hewlett-Packard bar codes and PAPERBYTE® . Hewlett-Packard's decision in this direction strenghtens the authority of the PAPERBYTE® format, and we feel that this is an important step toward the standardization of machine-readable bar code....GW

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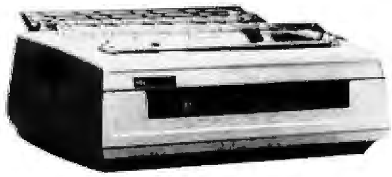

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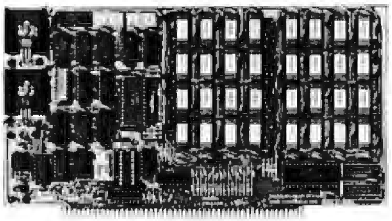

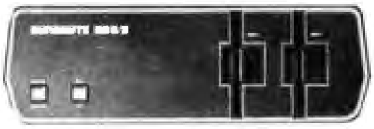

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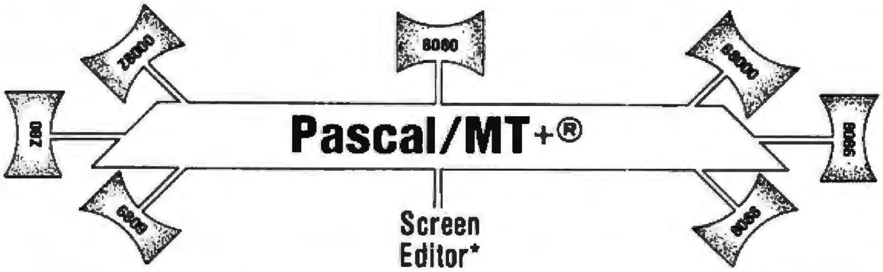

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Numerical Analysis for the TRS-80 Pocket Computer

Mike Salem, 26A Delancey St, London NW1 7NH, England

Complicated programs can often be easily modified to fit into the new pocket computers. I've taken three programs from the December 1979 issue of BYTE and modified them to run on the Radio Shack TRS-80 Pocket Computer (sold as the Sharp PC-1211 outside of the United States). The Pocket Computer has a 24-character LCD (liquid-crystal display), twenty-six fixed variables, and 1424 bytes of programmable memory.

One of the programs I modified was the discrete-Fourier-transform program that appeared in "Frequency Analysis of Data Using a Microcomputer" by F R Ruckdeschel (December 1979 BYTE, page 10). I also combined two programs that compute the time-domain response of a system with a given transfer function into a single program ("Noniterative Digital Solution of Linear Transfer Functions" by Brian Finlay, December 1979 BYTE, page 144). The modified programs have all of the features of the originals, with the obvious omissions of printing and plotting.

Incidentally, it is important to note that the TRS-80 Pocket Computer, in common with many machines, allows BASIC lines to contain multiple statements (saving 3 bytes of programmable memory for each line number omitted). Although this feature is useful in itself, the TRS-80 Pocket Computer also has an IF statement that can control all of the remaining statements in the

Listing 1: *A discrete-Fourier-transform program for the TRS-80 Pocket Computer. This program was modified from "Frequency Analysis of Data Using a Microcomputer" by F R Ruckdeschel (December 1979 BYTE, page 10). Statements entered on the same line are separated here for clarity.*

```
 10     :REM BYTE DEC 79
 11     :RADIAN
190     :INPUT "1ST X? ";Z,"LAST X? ";Y,"#OF POINTS? ";N
250     :I=1
        :INPUT "I/P SCALE FACTOR? ";I
        :IF I<1 GOTO 250
290     :D=(Y-Z)/(N-1)
        :Q=0
        :V=π/DI
        :U=V/(N-1)
340     :FOR I=1 TO N
        :PAUSE "NEXT # = ";I
        :BEEP 1
        :INPUT "NEXT F(T) VALUE? ";O
        :A(I+26)=O
        :NEXT I
370     :B=0
        :FOR I=27 TO N+26
        :IF B>A(I) LET B=A(I)
410     :NEXT I
420     :     FOR I= 27 TO N+26
        :     A(I)=A(I)-B
        :     NEXT I
        :B=ABS B
        :T=0
        :FOR I=27 TO N+26
        :IF T<A(I) LET T=A(I)
510     :NEXT I
710     :FOR I=1 TO N
        :W=(I-1)*U
        :C=0
        :P=0
        :     FOR M=1 TO N
        :     X=Z+(M-1)*D
        :     G=WX
770     :     C=C+A(M+26)*COS G
        :     P=P+A(M+26)*SIN G
        :     NEXT M
800     :F=√(PP+CC)*D
        :IF I=1 LET C=C-NB
        :          F=D*ABS C
810     :BEEP 1
        :PRINT U*(I-1);"RAD/S"
        :PRINT "AMPL. = ";F
815     :IF C<>0 LET O=ATN(P/C)*180/π
        :                PRINT "PHASE=";O
820     :NEXT I
        :BEEP 3
        :PRINT "END OF RUN"
        :END
```

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same line. Since this makes listings a bit difficult to read, I prepared listings 1 and 2 with a separate statement on each line. ■

Listing 2: *A program for the TRS-80 Pocket Computer that computes the time-domain response of a system with a given transfer function. The program shown was combined and modified from two programs contained in "Noniterative Digital Solution of Linear Transfer Functions" by Bryan Finlay (December 1979 BYTE, page 144).*

```
10    :REM "TF: TRANSFER FCN - BYTE DEC 79"
70    :RADIAN
      :INPUT "CONST.? ";K,"#TERMS NUM.? ";E,"#TERMS
      DEN.?";L
150   :IF E=0 GOTO 240
160   :    FOR G=27 TO E+26
      :    O=10+G
      :    INPUT "RL, NUM.? ";A(G),"IM, NUM.? ";A(O)
      :    NEXT G
240   :IF L=0 GOTO 330
250   :    FOR H=47 TO L+46
      :    O=10+H
      :    INPUT "RL, DEN.? ";A(H),"IM, DEN.? ";A(O)
      :    NEXT H
330   :FOR G=1 TO L
      :O=66+G
      :Q=76+G
      :A(O)=1
      :A(Q)=0
      :IF E=0 GOTO 450
370   :    FOR H=1 TO E
      :    D=A(26+H)-A(46+G)
      :    C=A(36+H)-A(56+G)
380   :    M=√(DD+CC)
      :    N=ATN(C/D)
      :    IF D<0 LET N=N-π
410   :    A(O)=MA(O)
      :    A(Q)=N+A(Q)
      :    NEXT H
450   :FOR R=1 TO L
      :IF R=G GOTO 501
465   :D=A(46+R)-A(46+G)
      :C=A(56+R)-A(56+G)
470   :M=√(DD+CC)
      :N=ATN(C/D)
      :IF D<0 LET N=N-π
500   :A(66+G)=A(66+G)/M
      :A(76+G)=A(76+G)-N
501   :NEXT R
      :NEXT G

520   :INPUT "T(0)? ";O,"DT? ";S,"# STEPS? ";N
      :T=O+NS
620   :U=-S
      :FOR Q=1 TO N
      :U=U+S
      :V=0
      :W=0
      :H=1+INT((U-O)/S)
650   :    FOR G=1 TO L
      :    X=A(66+G)*EXP(-UA(46+G))
      :    Y=A(76+G)-UA(56+G)
      :    V=V+X*COS Y
      :    W=W+X*SIN Y
      :    NEXT G
710   :Z=K*√(VV+WW)*SGN V
      :BEEP 1
      :PRINT "TIME=";U
      :PRINT "RESP.=";Z
730   :NEXT Q
```

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A Bug in BASIC

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The purpose of this article is to describe and analyze a particular bug that is common to a number of BASIC systems for microcomputers. Specifically, of fifteen microcomputers surveyed, four of them had this particular bug in their BASIC, nine of them did not, and the remaining two had the bug in one version of their BASIC but not in the other. The bug is illustrated by a simple BASIC program that runs properly on the systems that do not have the bug and encounters a run-time error on systems that do have it. By comparing the program inputs that cause erroneous behavior with those that do not, the cause of the bug is traced, and two possible corrections are suggested. One of these is quite elegant and results in almost no change in running time or space requirements. It is, of course, rather common for programmers to accuse either the hardware or the system software of being at fault when their programs have bugs. The analysis here may serve as an example of a valid isolation technique of a bug's source in system software.

The program illustrating the bug is shown in listing 1. It accepts some numbers from the keyboard, checks for the presence of the number 0, and checks for duplications. Sample inputs and outputs are shown in listing 2. Of the six test cases in listing 2 on page 190, only Test IV and Test VI cause problems; both correct and erroneous behavior are shown. Table 1 gives the names of the microcomputer systems and their respective behavior.

There are no easy explanations for the presence of this bug. As should be evident from table 1 on page 194, many of the lowest-priced systems are free from the bug,

Listing 1: *A BASIC program that sometimes causes a NEXT WITHOUT FOR error.*

```
10  DIM T(100)
20  PRINT "HOW MANY NUMBERS?"
30  INPUT N
40  PRINT "INPUT ";N;" NUMBERS"
50  FOR C=1 TO N
60  INPUT T(C)
70  NEXT C
80  FOR C=1 TO N
90  IF T(C)=0 THEN 130
100  NEXT C
110  PRINT "ZERO IS NOT PRESENT"
120  GOTO 140
130  PRINT "ZERO IS PRESENT"
140  FOR R=1 TO N-1
150  FOR C=R+1 TO N
160  IF T(R)=T(C) THEN 210
170  NEXT C
180  NEXT R
190  PRINT "NO DUPLICATIONS"
200  GOTO 220
210  PRINT "T(";R;")=T(";C;")"
220  END
```

as are many of the highest-priced systems. A large proportion of the BASIC systems surveyed, with and without the bug, were produced by a single software supplier; other systems, with and without the bug, were not. We draw no general conclusions about the general relative suitability of the various systems; many of the systems that exhibit the bug have numerous advantages when compared to systems that do not have it.

As we shall see, there are various ways to circumvent the bug. That is, we can rewrite the program so that it still does the same thing as before, without encountering the bug, and we can also do this in a variety of ways. This, however, does not change the fact that there is a bug. We have the incontrovertible evidence of a simple program that clearly *ought to run*, that *does run* on nine microcomputer systems, and *does not run* on another four systems.

The bug has to do with FOR...NEXT loops in which there are abnormal exits. Many programmers are still under the erroneous impression that this is illegal—that you are not supposed to jump out of a FOR loop. On the contrary, it is illegal to jump *into* such a loop. Abnormal exits from loops are absolutely necessary in programming for such tasks as searching (as illustrated here), error exits, and, in general, the treatment of special cases.

Let us now analyze the bug. It is clear from listing 2 that the problem arises at statement 180. The error message, NEXT WITHOUT FOR ERROR IN 180, means that there is a NEXT statement (180 NEXT R) that does not have a corresponding FOR statement. But this is clearly false; there is a corresponding FOR statement (140 FOR R=1 TO N−1).

Is the problem the expression N−1 in statement 140? If statement 140 is changed to 140 Z=N−1 and 145 FOR R=1 TO Z, the bug is still there. So this is not the problem.

Can we ever get to statement 180 without encountering the bug? If we look at Test I, we see the message NO DUPLICATIONS. Clearly this was printed at statement 190, and there are no jumps to 190 in the program, so the only way to get to 190 is through 180. Thus, in Test I, the computer got through statement 180 with no problems.

How did we get to statement 180? There are no jumps to 180 in the program either; so we must have gotten there from 170 NEXT C. Could this have caused the problem? Since the problem is that the system thought it was not in a loop when it got to statement 180, we now consider the possibility that the system thought it was coming out of an *outermost* loop at 170 NEXT C.

Could the system have thought it was coming out of one of the earlier loops? The FOR statement corresponding to 170 NEXT C is 150 FOR C=R+1 TO N. But there are two earlier FOR loops that use C, one starting at 50 and the other starting at 80. Could this be the source of the confusion?

If so, it was probably the loop starting at 80 that caused the problem. The loop starting at 50 is completely self-contained, but the loop starting at 80 has an abnormal exit: 90 IF T(C)=0 THEN 130. Here is our hypothe-

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Listing 2: *Test runs of the program in listing 1. Test IV and Test VI can each return two sets of behavior, one for versions of BASIC that correctly execute the program and one for versions of BASIC that do not.*

Test I
```
]RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?6
?7
?8
?10
?12
ZERO IS NOT PRESENT
NO DUPLICATIONS
```

Test II
```
]RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?4
?7
?2
?4
?10
ZERO IS NOT PRESENT
T(1)=T(4)
```

Test III
```
]RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?3
?7
?9
?23
?9
ZERO IS NOT PRESENT
T(3)=T(5)
```

Test IV (correct)
```
> RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?4
?0
?7
?12
?6
ZERO IS PRESENT
NO DUPLICATIONS
```

Test V
```
]RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?2
?6
?8
?2
?0
ZERO IS PRESENT
T(1)=T(4)
```

Test VI (correct)
```
> RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?7
?0
?24
?1
?24
ZERO IS PRESENT
T(3)=T(5)
```

Test IV (erroneous)
```
]RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?4
?0
?7
?12
?6
ZERO IS PRESENT
?NEXT WITHOUT FOR ERROR IN 180
```

Test VI (erroneous)
```
]RUN
HOW MANY NUMBERS?
?5
INPUT 5 NUMBERS
?7
?0
?24
?1
?24
ZERO IS PRESENT
?NEXT WITHOUT FOR ERROR IN 180
```

sis: when this abnormal exit was taken, the system did not realize that it was not in a loop any more. Then, when it came to 170, it thought that it was finally coming out of the loop that started at 80. Since this loop was an outermost loop, the system thought that it was no longer in any loops at all. Under these conditions (if they existed), a NEXT statement, such as the one at 180, would truly be an error.

This hypothesis is certainly plausible, but it has to be checked. Specifically, does it account for the fact that Tests I and III worked, while Tests IV and VI did not? In Tests I and III, we print ZERO IS NOT PRESENT. This was done at 110, and it is not too hard to see that in this case the abnormal exit is not taken; we never jump from 90 to 130. In Tests IV and VI, we print ZERO IS PRESENT, and under those conditions we do jump from 90 to 130. This behavior is consistent with our hypothesis.

Why did Test V work? The message T(1)=T(4) is printed by Test V. Looking at statement 210, we can see that we must have had R=1. Looking at statement 140, we can see that we must have been in the *first* iteration of that loop (since R=1) and that we made an abnormal exit from 160 to 210. Thus 180 was never executed. Again this behavior is consistent with our hypothesis.

What happens if we change C to D in the earlier loop? If we go back to statements 80, 90, and 100, and change C to D throughout these statements, the bug disappears. If we change C to D throughout the loop at statements 50, 60, and 70 (and leave 80, 90, and 100 without change), the bug does not disappear. This tells us two things. First, the bug has nothing to do with the loop at 50, 60, and 70 (again consistent with our hypothesis). Second, the bug definitely does have something to do with variable names. The confusion is between FOR C at 80 and FOR C at 150, and the confusion goes away if one of these is changed to FOR D and if other corresponding changes are made.

What happens if we change the earlier loop so that

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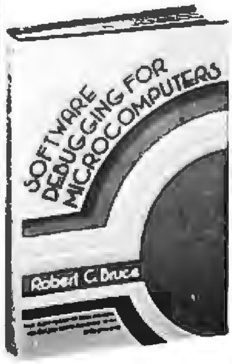

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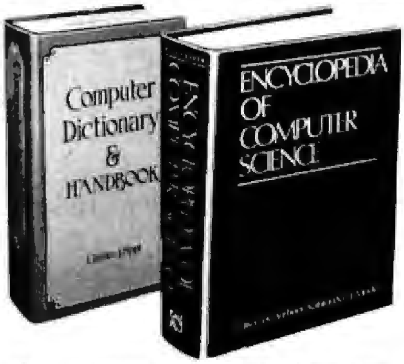

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Atari 800 and 400	yes
Commodore PET	yes
Cromemco	no
Heath H-11A	no
Hewlett-Packard HP-85	no
IMSAI VDP-80	no
North Star Horizon	no
Ohio Scientific Challenger 1P	yes
Radio Shack TRS-80 Model I (Level I BASIC)	no
Radio Shack TRS-80 Model I (Level II BASIC)	yes
Radio Shack Model II	no
Texas Instruments 99/4	no
Vector Graphics (MBASIC 5)	no

Table 1: *A list of computer systems' running versions of BASIC that do and do not run correctly due to a bug in their handling of the FOR...NEXT loop. The systems listed here were tested on November 12 and 13, 1980.*

there is no FOR statement? This can be done by simply changing 80 to C=1 and then replacing 100 by two statements: 100 C=C+1 and 105 IF C<=N THEN 90. If this is done, even though the same variable name C is still used in two places, the bug disappears. This is further evidence for our hypothesis, because now there is no confusion about which FOR statement corresponds to the NEXT statement where the bug appears.

The above changes illustrate ways of working around the bug. If you have a FOR loop with an abnormal exit, you will never find the bug if that particular FOR loop has a uniquely named loop-index variable. That is, if it ends with NEXT α, then nowhere else in the program should there be a statement NEXT α with the same α.

Now let us dig a little deeper. At statement 90, the exit goes to 130, while the loop involves only statements 80, 90, and 100. Why can't some of our BASIC systems tell that the exit at 90 is an abnormal exit? Presumably because they have *no information whatsoever* as to where loops start and end. Why would this be the case? There is a plausible explanation having to do with the relationship between the BASIC interpreter and its editor.

Many of the BASIC systems that exhibit the bug have a very close coupling between running and editing a BASIC program. The two activities, in fact, can be carried on alternately with very little internal data processing to accompany the switch-over from running to editing or from editing to running. Simple editing, however, may produce far-reaching changes in the loop structure of a program. Adding or deleting a single FOR or NEXT statement can cause the pairing of other FOR and NEXT statements to be changed, even though they are widely separated from the added or deleted statement. Therefore, the decision must have been made not to keep FOR...NEXT pairing information at run time, with the hope that it would never really be needed. As we can see, Murphy's law is applied in this case with a vengeance.

Let us now examine the bug technically in terms of stacking considerations. This will also suggest methods of fixing the bug.

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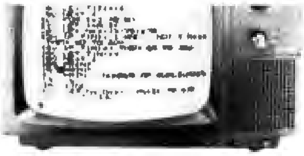

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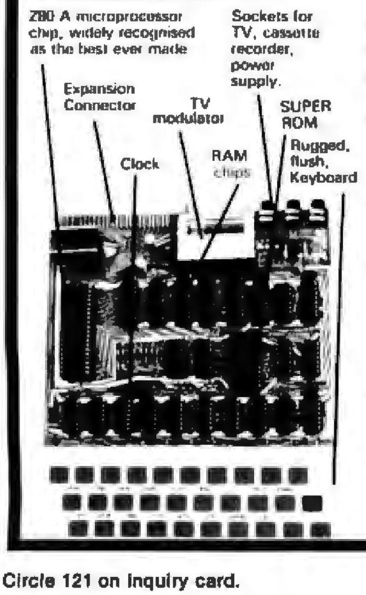

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Languages Forum

At the start of a FOR loop, certain information is stacked; upon normal exit from that loop, it is unstacked. Upon *abnormal* exit from a loop, the information is also supposed to be unstacked, but in most cases it does not matter whether the information is unstacked or not. In this case, however, it appears to matter. The sequence of events is as follows:

- At statement 50, we enter a loop, and C is stacked. Clearly, the loop-index-variable name must be stacked, along with other information that we shall ignore for the moment.
- At statement 70, we make a normal loop exit, and C is unstacked, leaving the stack empty.
- At statement 80, we enter another loop, and C is stacked again.
- At statement 90, if we make the abnormal exit from this loop, C is supposed to be unstacked; but let us assume for the moment that it is not.
- At statement 140, we enter another loop, and R is stacked.
- At statement 150, we enter a third loop, and C is again stacked. Note that we are now in two loops, although the system thinks that we are in three.
- At statement 170, we exit from a loop, and C is unstacked. But C is on the stack twice. Which version of C is unstacked? It must be the one at the *bottom* of the stack, because, according to our analysis, when we get to statement 180, the stack is empty. Then we try to unstack an entry, and, since it is empty, we signal an error.

This gives a clue to fixing the bug in an imaginative way. Of course, one way of fixing the bug is to simply keep the relevant FOR...NEXT pairing operation around at run time. But a simple change in the handling of NEXT statements would also fix the bug in this case. We must search the stack for the right information to unstack, and the trick is to search the stack *downwards* from the top, rather than upwards from the bottom. If we had done this, we would have unstacked the right version of C, and the bug would not have occurred.

Are there any other ill effects from leaving extra information on the stack that should be unstacked, as is done by those systems that have the bug? At the end of the execution of the program, the stack will not be empty. Since this could also happen if there were a FOR statement in the program without a corresponding NEXT, this indication might be given (erroneously) at the end of the run. (The Data General D2 microcomputer system appears to exhibit this behavior.) Another possible unwanted effect is unlimited stack growth, causing stack overflow. If an abnormal exit causing extraneous stack information is inside an outer loop, then unwanted stack information can continue to pile up—eventually resulting in overflow. This situation is more serious on a Z80-based system than on a 6502-based system, since the stack on the 6502 is confined to hexadecimal addresses 0100 thru 01FF, and it wraps around when it overflows.

In conclusion, let it be carefully noted—as is necessary in this fast-changing field—that all the information in this article is as of November 12 and 13, 1980.■

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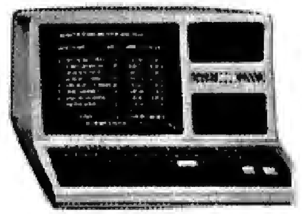

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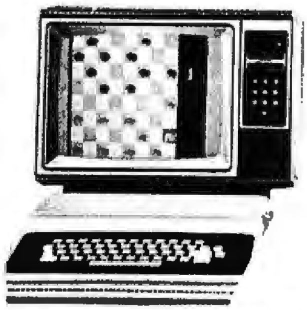

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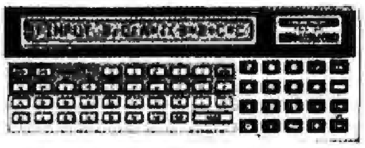

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Finally — one multi-purpose board combines all the most useful system support functions required by your computer. Extensive use of LSI technology not only packs the greatest number of features in the minimum amount of space, but also increases reliability and cuts costs compared to buying numerous single-function boards. Features include:

- — Sockets for 4K of extended address EPROM or RAM (2716 pinout)
- — Crystal controlled month/day/year/time clock
- — Optional high speed math processor (9511 or 9512)
- — Full RS-232 serial port
- — Three 16 bit interval timers (cascade or use independently)
- — 15 levels of vectored interrupts
- — Conforms fully to all IEEE 696/S-100 standards

Ready to add some extra performance to your S-100 system? Then this is the board for you. System Support 1 comes with a comprehensive owner's manual that includes numerous software examples; **add $195** to the above prices for the optional **9512** math processor.

COMPUPRO S-100 MOTHERBOARDS: DESIGNED FOR THE FUTURE, AVAILABLE NOW

Fully terminated and fully shielded, these advanced motherboards handle the coming generation of 5 to 10 MHz CPUs as well as present day 2 and 4 MHz systems. Mechanically compatible with most computer enclosures. **Unkits** have edge connectors and termination resistors pre-soldered in place for easy assembly.

20 slot motherboard with edge connectors — unkit $174, assm $214
12 slot motherboard with edge connectors — unkit $129, assm $169
6 slot motherboard with edge connectors — unkit $89, assm $129

CPU Z: 8 BITS OF Z80* POWER FOR THE S-100 BUS

Like many others, we claim full conformance to IEEE 696/S-100 specifications; unlike many others, we'll send you the timing specs to prove it. CPU Z includes all standard Z-80A* features along with power on jump, on-board fully maskable interrupts for interrupt-driven systems, selectable automatic wait state insertion, provision for adding up to 8K of on-board EPROM, and 16/24 bit extended addressing. Works with 6 MHz CPUs; supplied with 4 MHz CPU. **$225 unkit, $295 assm, $395 CSC.**

8088/8086 MONITOR-DEBUGGER: $35

Supplied on single sided, single density, soft-sector 8" disc. CP/M* compatible. Great development tool; mnemonics used in debug conform as closely as possible to current CP/M* DDT mnemonics.

COMPUPRO COMPUTER ENCLOSURE

$289 desktop, $329 rack mount

This enclosure does justice to the finest computer systems. Includes dual AC outlets and fuseholder on rear, heavy-duty line filter, quiet ventilation fan, and black anodized front panel (with textured vinyl painted cover for desktop version). Pre-drilled base accepts our high-performance S-100 motherboards or types by Vector, California Digital, and others. Rack mount version includes slides for easy pull-out from rack for maintenance or board changing.

PASCAL/M* FROM SORCIM: $175

PASCAL — easy to learn, easy to apply — can give a microcomputer with CP/M* more power than many minis. We supply a totally standard **Wirth PASCAL/M* 8" diskette** and comprehensive manual. Specify Z-80* or 8080/8085 version.

CompuPro products are available in **unkit** form, **assembled**, or qualified under the high-reliability Certified System Component (CSC) program (200 hour burn-in, extensive testing, extended 2 year warranty, more). Please note that **unkits** are not intended for novices, as de-bugging may be required due to problems such as IC infant mortality. Factory service is available for **unkits** at a flat service charge.

LOWEST PRICE EVER !! 16K DYNAMIC RAMS — 8/$37

Just what you would expect from the memory leader: the lowest price ever on 16K dynamic RAMs, backed up with a 1 year warranty. These are top quality, low power, high speed (200 ns) parts that expand memory in TRS-80* -I and -II computers as well as machines made by Apple, Exidy, Heath H89, newer PETs, etc. Add $3 for two dip shunts plus TRS-80* conversion instructions. **Hurry! 16K dynamic RAM prices may never be this low again, and quantities are limited.**

CPU 8085/88: 16 BIT DUAL PROCESSING POWER FOR THE S-100 BUS

When we shipped the first **CPU 8085/88** board back in June of 1980, we created a bridge between the 8 bit world of the present and the 16 bit world of the future. By using an 8088 CPU (for 16 bit power with a standard 8 bit bus) in conjunction with an 8 bit 8085, CPU 8085/88 is downward compatible with 8080/8085 software, upward compatible with 8086/88 software (as well as Intel's coming P-Series), designed for professional-level high speed applications, and capable of accessing 16 megabytes of memory . . . while conforming fully to all IEEE 696/S-100 standards (timing specs available on request).

Looking for a powerful 8 bit CPU board? Looking for a powerful 16 bit CPU board? Then look at **CPU 8085/88**, the best of both worlds.

Prices: **$295 unkit, $425 assm** (both operate at 5 MHz); **$525 CSC** (with 5 MHz 8085, 6 MHz 8088). Owner's manual available separately for $5.

Also available: **CPU 8085** (single 8 bit processor version of above) for **$235 unkit, $325 assm, $425 CSC.**

2102 MEMORY SPECIAL

While they last, 99 cents each, **10/$9.90**. Low power.

CLOSEOUT SPECIAL: 32K fully static memory for the SBC bus (RAM XI), now only $699 assembled. Limited quantities.

OTHER S-100 BUS PRODUCTS

Active Terminator Board	**$34.50 kit**
Memory Manager Board	**$59 unkit, $85 assm, $100 CSC**
Mullen Extender Board	**$59 kit**
Mullen Relay/Opto-Isolator Control Board	**$129 kit, $179 assm**
Spectrum color graphics board	**$299 unkit, $399 assm, $449 CSC**
2708 EPROM Board (2708s not included)	**$85 unkit, $135 assm, $195 CSC**
Interfacer 1 (dual RS-232 serial ports)	**$199 unkit, $249 assm, $324 CSC**
Interfacer 2 (3 parallel + 1 serial port)	**$199 unkit, $249 assm, $324 CSC**

COMING SOON: "MPX 1", a front end processor/system multiplexer for high speed multi-task/multiuser setups. Greatly enhances multiuser performance by taking over system I/O overhead from the main CPU. Included on board: 5 MHz 8085 microprocessor, 2K of ROM, 4K of RAM, interrupt controller, and much more. Finally . . . multi-processing is an affordable reality.

Also, if you've been waiting for someone to do a dual density disk controller board **right** . . . your patience has been rewarded. The **CompuPro** disk controller is on its way.

TERMS: Cal res add tax. Allow at least 5% shipping, excess refunded. Orders under $15 add $2 handling. VISA*/Mastercard* orders ($25 min) call (415) 562-0636, 24 hrs. Please include street address for UPS delivery. Prices are subject to change without notice.

FREE CATALOG: Find out more about the **CompuPro** product line, and how it can turn your computer into a powerful information processing tool. For 1st class delivery, add 41 cents in stamps; foreign orders add $2 (refundable with order).

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COMPUPRO PRODUCTS ARE AVAILABLE AT FINER COMPUTER STORES WORLD-WIDE OR DIRECT FROM THE FACTORY.

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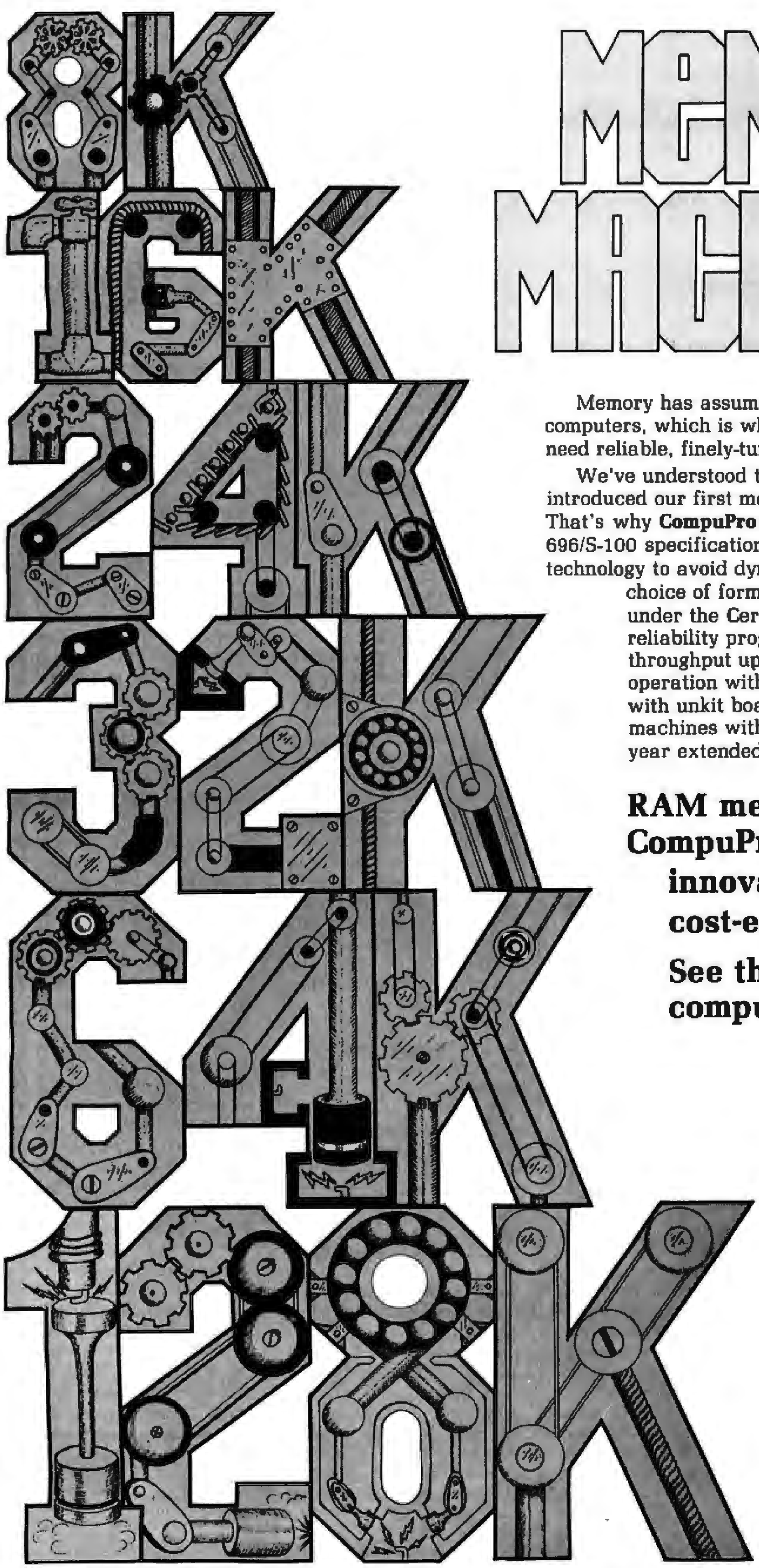

MEMORY MACHINES

Memory has assumed tremendous importance in today's computers, which is why you don't just need memory: you need reliable, finely-tuned, precision machines.

We've understood the importance of memory since we introduced our first memory board well over 5 years ago. That's why **CompuPro** memory conforms fully to all IEEE 696/S-100 specifications . . . uses low power static technology to avoid dynamic timing problems . . . comes in a choice of formats (**unkit, assembled**, or qualified under the Certified System Component high-reliability program) . . . and zips along to keep your throughput up where it should be (10 MHz operation with CSC and assembled boards, 5 MHz with unkit boards). We back these precision machines with a standard 1 year warranty, and 2 year extended warranty for CSC boards.

RAM memory machines from CompuPro couple experience, innovative engineering, and cost-effectiveness.

See them in person at finer computer stores world-wide.

CompuPro™

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Prices (assembled and tested units): **8K RAM 2A, $189; 16K RAM 14*, $349; 16K RAM 20-16**, $399; 24K RAM 20-24**, $539; 32K RAM 20-32**, $699.** Write for prices on **unkits** and CSC boards. **128K RAM 21-128*** (CSC only), **$2795.** Also available in 64K and 96K configurations. For 24 hour VISA® /Mastercard® orders, call **(415) 562-0636.**

*With IEEE extended addressing

**Use with IEEE extended addressing systems or bank select systems

BYTELINES

News and Speculation About Personal Computing

Conducted by Sol Libes

Superconductivity At Room Temperatures Reported: A breakthrough for the next generation of supercomputers may have been made. It was previously thought that superfast computers, using Josephson junctions, would require supercooling to a temperature near absolute zero. Now, Fred W Vahldiek of the Wright-Patterson Air Force Base, Dayton, Ohio reports that he has achieved superconductivity at room temperatures. Vahldiek has developed titanium borite crystals with zero resistance.

Further research will be required to determine whether or not this could lead to the development of computers with picosecond machine cycles and 100% power efficiency.

IBM Announces 370-On-A-Chip: IBM has disclosed what many already suspected: it has implemented the circuitry of a model 370 processor on a single integrated circuit. IBM has created a 370 model 138 processor that utilizes 5000 circuits and Schottky-clamped bipolar TTL (transistor-transistor logic) technology that can execute 2000 instructions per second. The device has a cycle time of only 100 ns and consumes 2.3 watts. It is part of a research project, and no specific plans for a product have been announced.

Fight For 16-Bit Microprocessor Market: It appears that the 16-bit microprocessor market is the scene of a three-way battle between the Motorola 68000, the Zilog Z8000, and the Intel 8086. Although the 68000 is ranked first in performance and the 8086 is ranked last, the volume of sales is greater for the 8086. Intel has a two-year lead in product availability. This means that there is already a substantial software base and peripheral device support. Furthermore, Intel has introduced 8086 enhancements such as a 10 MHz version, an arithmetic co-processor, and a new 32-bit microprocessor, the iAPX-432, that may undercut the 68000 and Z8000. Intel expects to start shipping samples of the iAPX-432 in two or three months.

UNIX-Like Operating Systems Increasing In Popularity: Several software suppliers are now offering UNIX-like operating systems that may rival CP/M. The first UNIX-like software package, called TYNIX, was released for LSI-11 and Heath H-11 systems in 1978 by the Boston Children's Museum. In 1979, Yourdon announced OMNIX for Z80 computers and advertised it as CP/M compatible and similar to UNIX. Yourdon then withdrew it because of software bugs, but it may be released again. Whitesmiths released its IDRIS system in early 1980. Also in 1980, ElectroLabs introduced its OS-1 UNIX-like system (now marketed by Software Labs), and late last year Microsoft and Morrow Designs announced packages for Z8000 and Z80 systems, respectively.

Copyright Decision Overturned: In Chicago, the US Court of Appeals has overturned an earlier ruling that ROM- (read-only memory) based software cannot be copyrighted. In the case of Datacash vs JS & A (as reported earlier in this column), the court had ruled that the marketing of a chess game by JS & A with a program identical to the one originally developed by Datacash was not copyright infringement because under the 1909 copyright law the program could not be read with the naked eye.

Ethernet Specifications Released: Xerox, Digital Equipment, and Intel have published specifications for the Ethernet system developed by Xerox. Ethernet provides a local networking system for word and data processing applications. Xerox has already released some Ethernet products.

Ethernet is a passive system and does not use switching logic or a central computer. Rather, coaxial cable and communications transceivers attach each machine to the network; each machine is assigned a 48-bit address. Data is transferred in serial groups which include the data and the addresses of both the sender and the addressee. Each transceiver monitors the cable for data with its address. It is expected that the IEEE (Institute of Electrical and Electronics Engineers) will integrate the Ethernet specifications into the networking standard currently in development.

Ada Language Finalized And The Rush Is On: Ada, the language that the DOD (Department of Defense) expects to eventually replace all other languages, has been finalized, according to Jean Ichbiah, president of Apsys, Washington DC. Over nine hundred revision proposals were submitted, and several major improvements have been incorporated into the proposed Ada language standard that was released in 1979. The most significant improvement is the addition of tasking. The *Ada Reference Manual* may be obtained from the DOD's DARPA office, 1400 Wilson Blvd, Arlington VA 22209.

At least twenty-five companies and universities are reported to be in the process of developing compilers for the Ada language. A few universities have already had their Ada compilers running. However, the first commercial release has yet to occur. Intel claims that its new 32-bit microprocessor, due for release shortly, will use Ada as its primary language. WD (Western Digital) is rumored to be working on a single-board Ada computer that is similar to its Pascal MicroEngine. WD has purchased a 20% interest in Telesoftware Inc of San Diego, which is developing an Ada compiler. (Dr Kenneth Bowles of UCSD Pascal fame owns an additional 40% interest in the company.) Reportedly, Telesoftware already has a preliminary version of its Ada compiler running.

CP/M For 8086/8088 Systems Released: Digital Research has released CP/M-86. This operating system is designed for 8086- and 8088-based systems and provides the same facilities and file format as CP/M, release 2. CP/M-86 can also function as a slave node in a CP/NET network. As with 8080-based versions of CP/M, the logic- and hardware-dependent portions of CP/M-86 are modularized for ease of customization. Digital Research also plans to release MP/M and PL/I for 8086/8088-based systems in the near future.

Montgomery Ward And Sears Expand Personal Computer Marketing: After test marketing Ohio Scientific computers in selected stores, Montgom-

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"Critical path" network analysis program for scheduling manpower, dollars and time to maximize productivity.

An interactive project management program that runs under CP/M and can relate together different skills, hourly pay rates and projects to maximize efficiency. MILESTONE could be used to track paper flow, build a computer, check a salesman's performance, or build a bridge. MILESTONE can be used by executives, engineers, managers, and small businessmen to:

- Find the critical tasks which can't be delayed.
- Discover which tasks are not time critical.
- See how manpower and expenses vary versus time.
- Investigate tradeoffs between manpower, dollars and time.
- Communicate plans to others using a printed project schedule.
- Change details of the project and immediately see the results on the screen.

Requires 48K RAM and CP/M. Also available for Apple UCSD Pascal or UCSD Pascal Operating Systems.
Formats: 8, NS, MP, CDOS, SB, TRS2, APPL
SPECIAL INTRODUCTORY PRICE: $295. until April 1, 1981
Manual alone - $30.

DATEBOOK™ - $295. Manual alone $25.

- Replaces your office appointment calendar
- Searches for openings that fit time of day, day of week & day of year constraints
- Appointments made, modified or cancelled by a few key strokes
- Copies of day's appointments can be quickly printed
- Schedule appointments 4 months in advance - plus.

Requires CP/M or UCSD Pascal and 48K RAM
Formats: 8, NS, MP, CDOS, SB, APPL, TRS2

TEXTWRITER III™ - $125. Manual alone - $25.

Require CP/M, NorthStar DOS, TRSDOS, or MDOS
Formats: 8, NS, MP, TRS, TRS2

REPORT WRITER™ - $150. Manual alone - $25.

Mini-word and arithmetic calculation processor designed to generate reports with ledger of figures and numeric calculations. Built-in calculator functions and calculator to paper errors. Saves data. Reports can be printed as often as desired. Changes in data can be easily entered and saved. "Cause and Effect" analysis easily computed using Recalculate function.
Requires CP/M, Microsoft Basic and 48K RAM
Formats: 8, NS, MP, SB, TRS2, CDOS

MAGIC WAND™ - $350. Manual alone - $35.

Word Processing System

- Full screen text editing
- Full text formatting commands
- Merging with external data files
- Variables
- Conditional commands
- True proportional printing
- Specify disk format, terminal and printer.

MAGIC MENU™

Turns Magic Wand into a turnkey system. Allows move from EDIT to PRINT, backup of files or disks, system status, etc. from menu without returning to CP/M 2.x
Requires 56K RAM, CP/M and Magic Wand.
Regular Price - $95
SPECIAL INTRODUCTORY PRICE: $45. when purchased with Magic Wand.
Formats: 8, NS, MP, SB, TRS2, APPL

PASCAL/M™ - $175. Manual Alone - $20.

CP/M™ compatible language for 8080/Z80 CPUs, supports full Jensen & Wirth plus 45 extensions to Standard Pascal including Random access files.

PASCAL/M BUSINESS - $225.

Manual alone - $20.
All features of Pascal/M plus 16 digit BCD real type and symbolic debugger which includes trapping on stores, examining and changing variables and tracing of program execution.

PASCAL/M for 8086/88 - $250.

Manual alone - $20.
All features of Pascal/M Business for the 8086 and 8088 processors running under the 8086/88 version of CP/M.
SPECIAL OFFER: Pascal/M Demo Disk & Manual - $20.
Requires CP/M & 54K RAM Formats: 8, NS, CDOS, APPL, TRS2, SB

TRANS 86™ - $125. Manual alone - $20.

8086/88 Translator for existing 8080/Z80 programs. The new source code can be easily edited and assembled using ACT II to produce hex code which can be executed by 8086/88. Emphasizes the extensions and features available in the 8086/88.
Requires CP/M and 32K RAM
Formats: 8, NS, CDOS, SB, APPL

ACT I™ - $125. Manual alone - $15.

CP/M compatible macro assembler for Z80, 8080/85, 6502 & 6800.
One assembler that supports all major 8 bit micros. ACT features include full macro capabilities, comprehensive pseudo-ops, link-file structures, cross reference map, and algebraic expression processor. Requires 24K RAM & CP/M.

ACT II - $175. Manual alone - $20.

CP/M 2.x compatible cross assembler for 8086/88

ACT I and ACT II together - $225.

Formats: 8, NS, CDOS, MP/M, TRS2, SB, APPL

PEARL™ The application software generator

Pearl asks questions that a programmer would have to answer to code the system. You answer the questions & Pearl uses built-in logic to construct both subroutines & mainline programs. The system then compiles & executes your program code.

- Level 1: For Personal Computing - $130.
- Level 2: The Business Assistant - $350.
- Level 3: Advanced Software Development - $650.

Manuals alone - $25. each
Requires CP/M and CBASIC2.
Formats: 8, NS, MP, SB, TRS2

ULTRASORT-II™ - $175.

The sort/merge/select utility for CBASIC2 written in assembly language. Can be loaded by CBASIC during run-time; also can be used as a stand-alone utility.
Requires CP/M and CBASIC2
Formats: 8, NS, MP, SB, TRS2, CDOS

CBASIC2™ - $120.

Industry standard intermediate code compiler with run-time interpreter. Features include chaining, integer & external precision arithmetic. CP/M, MP/M & relocated TRS-80 versions available.
Requires CP/M. Formats: 8, NS, MP, SB, TRS, TRS2, CDOS, MP/M.

COPYWRITER™

A powerful CP/M Word Processing System which includes a fast screen editor and is exceptionally easy to learn and use. Copywriter supports both vertical and horizontal scrolling for 132 column printers. File size is limited only by disk size. The print formatting program allows control over output word processing files, and permits the insertion of variable data into form letters. Full proportional printing is also supported.

COPYWRITER + includes an integrated mailing list system which can:

select any range of zip codes for printing
select which fields to fill into merge
select by title, position or department within a company
select by title, position or department within a company

Output can sort for bulk mailings by state and zip code.

COPYWRITER - $395.
COPYWRITER+ - $595.
COPYWRITER Screen Editor alone - $195.
Manual alone - $35.
Requires 54K RAM and CP/M
Formats: 8, NS

S-BASIC™ - $295. Manual alone $25.

Produces chainable, relocatable native code.

- ★ Fully defined user functions & procedures
- ★ Local & global variables
- ★ Single & double precision floating point
- ★ Fixed point packed BCD
- ★ Integer, string & character data types
- ★ Packed binary disk storage

Requires CP/M and 40K RAM
Formats: 8, NS, MP, SB

SELECTOR IV™ - $550. Manual alone - $25.

A totally self-contained CP/M Data Base System providing complete data, procedural, query, and report definition functions. Allows records to be managed on a one-for-one basis, as well as in 'batch' mode where several files can communicate with each other in a variety of ways. Includes multiple 'key fields'.
Requires 54K RAM, CP/M and CBASIC2
Formats: 8, NS, MP, SB

MICROSTAT™

Powerful statistical analysis package.
Includes data management sub-system for editing, sorting, ranking, lagging, data file transfers PLUS eleven data transformations (e.g. linear, reciprocal, exponential, etc.)

- Frequency distributions
- Multiple regression
- Time series
- Crosstabs/Chi-Square
- Factorials, permutations, combinations
- Scatterplots
- ANOVA (one and two-way)

Requires 48K RAM

CP/M - Microsoft Basic 80 version - $250.
NorthStar Basic version - $200.
Manual alone - $25.
Formats: 8, NS

FORMAT CODES 8 (8" single density IBM soft-sectored) NS (NorthStar DD) MP (Micropolis Mod II/Vector MZ) SB (Superbrain 3.0) CDOS (8" Cromemco CDOS) TRS (Radio Shack) TRS2 (TRS-80 Mod II) APPL (Apple II)

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For shipping add $5. in US; $10. outside US per package. California residents add appropriate state sales tax. Terms: Prepaid check, M/C or VISA or in US COD (UPS). Dealer inquiries invited. Prices effective until March 1, 1981 ery Ward has decided to expand its personal computer sales into one hundred stores. The stores will sell the OSI Challenger 1P and 4P cassette-based systems with accessories such as disk drives, video monitors, printers, security systems, and software. Sears is now carrying two full pages in its catalog promoting the Atari 400 and 800 computers, games software packs, and peripherals. Other retail chains and department stores are expected to follow in their footsteps.

System Puts Local Network On Cable TV: Sytek Inc, Sunnyvale, California has introduced a packet-network system to support up to 24,000 terminals and operate at up to 9600 bps (bits per second) over a cable TV system. This system, called "LocalNet," is expected to fill the gap that exists between such systems as Ethernet and ARPANET. Ethernet is limited to a 1 to 2 km distance while ARPANET is committed to long-distance distributed processing. LocalNet can cover up to 50 km distances on a single coaxial cable and can be piggybacked onto existing CATV cable systems, thus providing a very low-cost networking system.

NEC Claims Cure For Dual-Sided Floppy Problems: NEC, the Japanese manufacturer, claims to have developed a floppy disk system which eliminates the disk and head wear problems associated with dual-sided floppy disks. NEC uses an "air" shock absorber to cushion the force of the heads landing on the disk, and the company claims that its new FD1160 Soft Touch drive provides twice the media and head life of competitive drives.

Standard For 32-Bit Bus: The IEEE has formed a committee to draft a backplane bus standard, designated as P896, for 32-bit microcomputers. According to committee chairman Andrew Wilson, P896 is already well along in development, and a draft may be released soon. The bus will support 32-bit microprocessors under development by Intel and other companies. It will be processor-independent and will support up to sixty-four bus masters and clock rates of up to 20 MHz.

Z8000 Call Conventions Proposed: Microsoft, Bellevue, Washington (the largest supplier of microcomputer software) has proposed a standard for Z8000 calls that specify parameter-passing and register usage. Adoption of a standard would enable Z8000 languages, application programs, and operating systems to be more easily interfaced, and would facilitate the building of a Z8000 program library similar to the present CP/M User Group Library.

Do Computers Cause Unemployment? Calvin C Gotlieb, a professor of Computer Science at the University of Toronto, delivered a paper at the recent IFIPS (International Federation of Information Processing Societies, Inc) Congress-80 which claimed that computers are causing unemployment. Gotlieb cited dozens of studies to support his claim; for example, at one Western Electric facility, the number of employees was reduced by 50% (from 39,200 to 19,000) over a six-year period, while production doubled. A Japanese TV manufacturer increased production by 25% over a four-year period, while reducing the number of workers by 50%. Gotlieb contends that computers must be used more wisely, and cited a West German study that stated: "(C)omputers make things more formal, more routine, more bureaucratic and inevitably lead to less humane treatment of people." He also cited a law on the West German books that complains: "(O)nce a decision is made by a computer, no one is permitted to challenge it."

Amateur Robotics On The Rise: More and more hobbyists are building their own robots. The evidence is the fact that there are already several companies supplying robot parts to hobbyists and two magazines catering to their interests. Hobbyists seeking parts and kits should write to: Hobby Robotics Company, POB 997, Liburn GA 30247, and the Robot Mart, 19 W 34th St, New York NY 10001. Robot Mart also publishes the *Hobby Robot Newsletter*.

Flat-Panel Display Technology Improving: Although CRTs (cathode-ray tubes) still dominate the computer-terminal display field, it appears that several flat-screen systems will soon be ready to challenge that dominance. The new technologies include electrophoretic, electrochromic, LCD (liquid-crystal display) and LED (light-emitting diode) systems. LCD panels are already available in 1-and 2-line versions. Several firms will soon offer multiline panels. Dot-matrix displays are also under development by several firms, and prototypes are becoming available in LED, vacuum fluorescent, and electroluminescent technologies. There is no doubt that flat-screen terminals will compete with small CRTs within two or three years.

One manufacturer of flat screens is Optotek Ltd, of Ottawa, Canada, which will soon offer a display using LEDs that are 1/8000 inch in diameter. Each square inch of the display has 4000 diodes. A 3- by 4-inch display has 49,000 diodes. Control of the diodes is performed by special VLSI (very large-scale integration) integrated circuits provided for each square-inch block.

Random Bits: As of January 1, 1981, Radio Shack has stopped production of the TRS-80 Model I computer, in anticipation of increased sales of the TRS-80 Model III....The IEEE has established a committee to develop a standard for benchmark programs for microprocessor users.... Several hundred workers at the *Minneapolis Star and Tribune* newspaper recently went on strike to protest, among other things, the newspaper's experimental electronic newspaper project with CompuServe Inc.... Japan's NTT (Nippon Telegraph and Telephone Public Corporation) will soon inaugurate a public facimile network that may be the first step in developing an electronic mail system....Intel has released prices on its new 2764 64-K-bit (16K by 8 bits) 250ns EPROM: $163 each in lots of one hundred....Seventy to eighty percent of all TRS-80 Model II systems are running CP/M; this statement is based on the fact that Lifeboat Associates has already sold 4000 copies of CP/M for the Model II.

Random Rumors: Apple Computer Company may be setting up its own floppy-disk manufacturing operation to make double-sided double-density drives for its new Apple III Computer. Introduction of the drive is expected by mid-year.... Sources say that Radio Shack is close to releasing a hard-disk drive for the TRS-80 Model II and III computers. Further, Radio Shack will soon release version 1.3 of its DOS (disk-operating system) to replace version 1.2 which, reportedly, has many bugs. Unfortunately, the two versions will not be compatible....Altos Computers is said to have switched from the Z8000 to the 8086 for its new 16-bit system. This decision was probably due to the introduction of the CP/M-86 from Digital

Suddenly, RCA makes talking to your computer a lot cheaper.

New interactive data terminal with color graphics—only $369.*

RCA's new VP-3301 is a professional quality, ASCII encoded, interactive data terminal, suitable for a wide variety of industrial, educational, business and individual applications requiring interactive communication between computer and user. Connects directly to your computer or to a standard modem for over the phone access to time sharing networks and data bases. And it's compatible with networks such as those provided by CompuServe Information Services and Source Telecomputing Corp. Microprocessor intelligence and LSI video control integrated circuits bring performance, features and flexibility at a low price. Power supply included.

Unique color locking circuitry creates sharp, jitter free, true color graphics and rainbow free characters.

Displays the entire field of characters in any of 8 colors against any of 8 background colors (7 gray scales with monochrome monitors). Or to add special emphasis, you can display individual letters, words or lines in different colors or in reverse video.

The VP-3301 offers you a choice of two software-selectable display formats: Either 40 characters by 24 lines. Or 20 characters by 12 lines.

The terminal's resident character set consists of 52 upper and lower case alphabetics, 10 numerals, 32 punctuation/math symbols, and 31 control characters. You can also define a total of 128 of your own characters. Including: Greek letters and other foreign alphabets, graphic symbols, large graphics building blocks, playing card suits, unique character fonts, and "little green men."

The keyboard section features flexible-membrane key switches with contact life rated at greater than five million operations. A finger positioning overlay and positive keypress action give good operator "feel".

An on-board sound generator and speaker provides aural feedback for key presses and may also be activated with escape sequences to provide an audio output.

The sealed keyboard surface is spill proof and dust proof. This combined with high noise immunity CMOS circuitry makes the VP-3301 ideal for hostile environments.

Output is industry standard asynchronous RS232C or 20 mA current loop with six switch selectable baud rates and 8 selectable data formats.

The terminal can be connected directly to a 525 line color or monochrome monitor. Or to a standard TV set using an Rf modulator.

For more information, contact RCA MicroComputer Marketing, New Holland Avenue, Lancaster, PA 17604.

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RCA

Circle 127 on inquiry card.

Research....North Star Computers might be developing a single-board 8088-based system that will work with a hard disk and support CP/M ....Whitesmiths Ltd is rumored to be about to release an 8088/8086 version of its C compiler....A California firm may be readying an under $300 OEM (original equipment manufacturer) daisywheel printer that would be set for introduction by the end of the year.

Predictions, Predictions... In my December 1979 column I made eleven predictions for 1980. Several readers asked me to grade myself on how well I did, so here goes:

1. *The first Japanese personal computer system will become available in this country.* Score a "correct." In fact, several have been introduced and reported on in this column. Look for many more in 1981.
2. *Competitive pressures on small manufacturers will increase. This will cause several mergers, consolidations or acquisitions.* Score a "correct" on this one too. So many failures, mergers and acquisitions occurred that they are too numerous to be mentioned. More will be forthcoming in 1981.
3. *A sizable number of audio and office equipment retailers will enter the computer retailing business. This will create pressures on conventional computer stores. We may even see the appearance of stores that sell only software, much like audio record stores.* Score a "maybe." Although some steps have been taken in this direction (eg: Bell & Howell and several other audio/visual and office equipment suppliers), the real first step has yet to be taken...possible developments this year or next.
4. *16-bit microcomputer systems will be commonplace.* Score a "maybe" on this one too. Although several 16-bit systems were introduced, lack of 16-bit parts and software limited their adoption. We should see a significant increase in their acceptance in 1981 with the availability of CP/M, MP/M, UNIX and other powerful operating systems.
5. *IBM, DEC, Data General, H-P and other minicomputer makers will introduce low-cost microcomputer systems.* Score a "partial" on this one, as H-P (Hewlett-Packard) introduced the HP-85 and IBM showed its S-100 product in Europe but withheld it from the US market. These companies may jump in this year or next.
6. *Several personal computer manufacturers will introduce second-generation machines with significant increases in power.* Score a "no." Although Apple, Tandy and Commodore all introduced new machines, none were significantly different from their previous units. I look to 1981 for the introduction of a machine with significantly new performance versus price mark.
7. *The emphasis will shift from hardware to software. BASIC will continue as the dominant language.* Score another "correct." This year should see continued improvements in disk operating systems and applications packages.
8. *Business application software for microcomputer systems will finally come of age and provide the needed performance that suppliers have been promising but not delivering during the past two years.* Score a "correct."
9. *The first low-cost microcomputer-based robot kit will be introduced.* Score an "incorrect." Although a robotic arm kit was introduced, its price was beyond the means of most personal computerists. Maybe this prediction will come true in 1981.
10. *Typewriters will have built-in intelligence, and use microprocessors, built-in microdisks, and word processing features. The dumb typewriter will soon be a thing of the past.* Score an "incorrect." Although Smith-Corona and Triumph-Adler introduced electronic typewriters, their intelligence is still on a primitive level. I am now projecting 1982 or 1983 on this development.
11. *Personal computer time-sharing systems will proliferate.* Score a definite "correct" on this one.

All in all, I would rate my prediction ability as "fair": about sixty points out of a possible one hundred. Where I guessed wrong I was just ahead of the industry.

Predictions For The Future: Not allowing my previous performance to deter me, I will venture forth with some more predictions:

1. The S-100 will become the *de facto* standard for bus interfacing. There are already thirty-two manufacturers of S-100 systems, and I expect this number to increase to over forty in 1981 (and to include IBM). This trend should continue into the mid-1980s, when we may see the development of a new interface bus to accommodate new hardware and architectures.
2. Hardware will become more sophisticated and less expensive. This is not a difficult prediction to make, since Moore's law states that "the number of components per integrated circuit roughly doubles every year." Thus, personal computer systems will acquire the characteristics of their larger, more expensive predecessors. In other words, within three to five years we can expect personal computers with the characteristics of large IBM 370s. The likelihood is that by the mid-1980s we will see a single package device containing processor, floating-point arithmetic, main memory and read-only memory with the complete operating system and a compiler or interpreter.
3. The man-machine interface will improve to accommodate the many users who have little or no knowledge of computers. I therefore look for voice input/output to become commonplace by the end of the decade. Although voice input may be limited to short commands, output should be of a high quality with a large vocabulary.
4. Cheap mass storage will finally arrive via video cassette and optical disk memories. We will be able to store 100,000 pages of printed text on a single optical (video) disk...expect to see the *Encyclopaedia Britannica* on a single optical disk, with sophisticated cross-referencing software. Furthermore, expect optical disks that may be used with personal computers to provide high-quality video images for games, educational use, etc.
5. Higher-quality displays using either liquid crystal or semiconductor technology will replace CRTs (cathode-ray tubes).
6. Personal computers will include self-testing capabilities and redundant circuits to improve reliability.
7. Expect BASIC to continue as the dominant language. Assembler and Pascal will still be the most popular languages for systems-level programming, and C will increase in popularity. Natural programming languages and automatic programming still appear to be many years away. The number of menu-driven systems for the naive user will increase.
8. Operating systems such as UNIX, CP/M, MP/M and more sophisticated systems will increase in popularity, and many manufacturers will design special hardware to support these operating systems.

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a stamped, self-addressed envelope.

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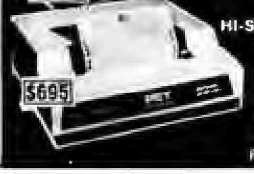

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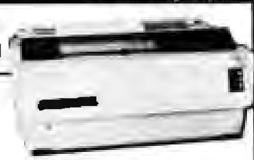

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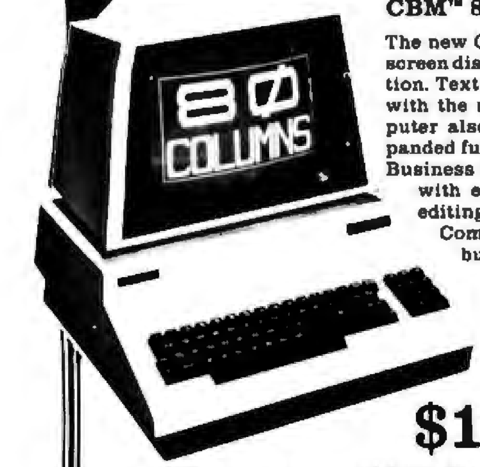

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Time travel is common now. You've decided to spend the afternoon in Vienna on a sunny spring day in 1770. There is talk that at the Royal Palace the Baron Wolfgang von Kempelen, counselor to the Royal Chamber, will be giving a demonstration of his amazing Automaton Chess Player. You wander over towards the Palace.

The murmur of the crowd grows as the Baron rolls a large wooden cabinet into the courtyard, the result of a solemn promise he made to the Queen 6 months ago to build a chess-playing machine. The Baron smiles graciously and invites anyone to come forward from the crowd to play the Automaton.

Meanwhile, the noblemen are about ready to accuse the Baron of a hoax. A machine that thinks? Rubbish. Sacrilege. And the spectators are no more convinced. Catcalls from the crowd dare the Baron to open the cabinet—obviously big enough to hold a small man—whereupon von Kempelen opens all the doors only to *reveal* a complex system of pulleys, gears, and levers, nothing else.

About this time, you decide to come forth from the crowd to play this wondrous machine. Unknown to everyone, you have Sargon 6, no bigger than a matchbook, hidden in your palm. With its aid, you win, but the Automaton plays a superb game. Afterwards, a crowd gathers around you, and the Baron congratulates you on your game. Everyone agrees that the machine played a creditable game of chess, clearly outplayed by a genius. A priest overhearing this remarks that this is proof of the superiority of the human mind. You shrug, put Sargon 6 in your pocket, and wander off into the crowd.

The Baron will go on to amaze the bewildered crowds in Europe and America for many years, and the machine will defeat many chess players. It will take 70 years for the *hidden* compartment and the hoax to be revealed. But the dream of a chess-playing machine is planted firmly in the minds of men. A dream which would take another 200 years to come true.

Introduction

Sargon 6 isn't available yet, but Sargon 2.5 is. It is a game module and holder slightly larger than a hardback book, but the real guts are no larger than a pocket calculator. This is the MGS (Modular Game System) from Chafitz; as of this writing, it is the strongest chess-playing microcomputer you can buy.

You may already be familiar with the Sargon 1 and Sargon 2.0 computer programs written by Dan and Kathe Spracklen. These are available on cassette or floppy disk (from Hayden Books) for the Apple II and TRS-80 computers. But now Chafitz is marketing Sargon 2.5 as a plug-in ROM (read-only memory) module that fits into the MGS. Presumably, when Sargon 3 and other versions are available, you can remove the old ROM and plug in the new one. Not only does this protect the firmware, but allows new games (such as checkers and backgammon) to be run on the same system.

The technical specifications of the MGS-Sargon 2.5 combination are many and impressive. The system is rather complete: a benefit of Chafitz's previous experience with its chess machine, Boris. A touchpad keyboard allows the user to:

- force selection of best move
- use the machine in its hint mode
- set playing level (from 0 to 6)
- set up a given position
- show elapsed time (either player, cumulative, or time per move)
- withdraw a move or moves (up to three moves)

At a Glance

Name
Chafitz Modular Game System with Sargon 2.5

Manufacturer
Chafitz Inc, 856 Rockville Pike, Rockville MD 20852, (301) 340-0200

Price
$375

Processor
6502, 8-bit

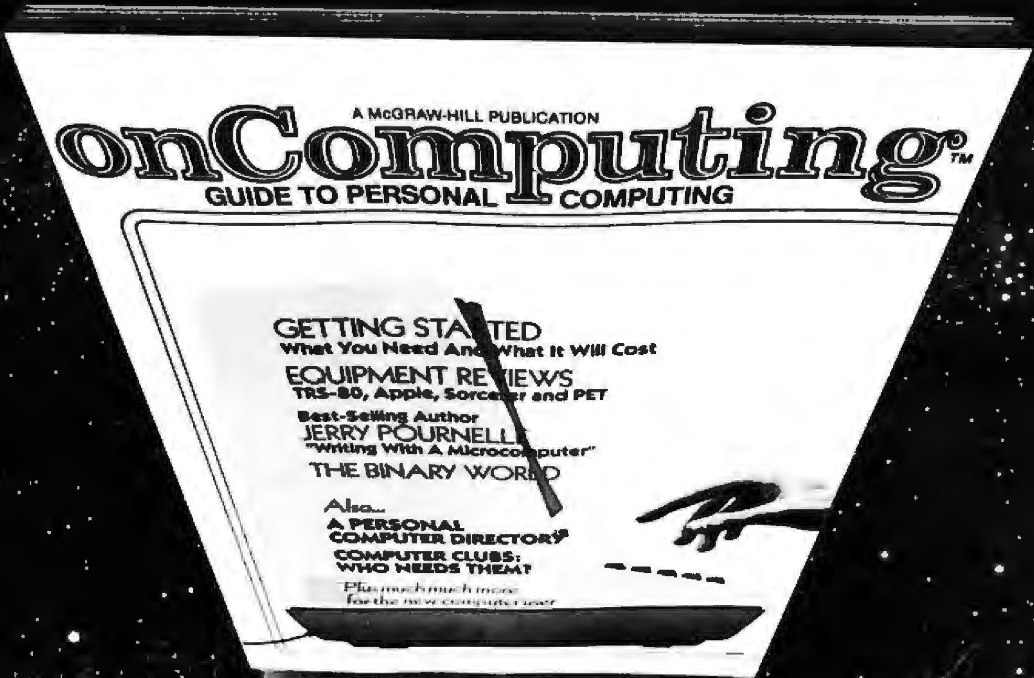
System-clock frequency
2 MHz

Memory
2 K bytes of programmable memory (for internal use only)

Additional features
Includes AC adapter, keyboard, chessboard, magnetized chess pieces; Sargon 2.5 is a removable module that can be replaced by other game modules (not yet released)

Software
Sargon 2.5 program, held in 8 K bytes of ROM

Options
Rechargeable battery option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Sicilian Defense

	White	Black
	Martellaro	Sargon 2.5 (level 4)
1.	e2-e4	c7-c5
2.	Ng1-f3	d7-d6
3.	Bf1-b5 ch	Bc8-d7
4.	Bb5-c4	Nb8-c6
5.	Nb1-c3	Ng8-f6
6.	d2-d4	c5xd4
7.	Nf3xd4	Qd8-b6
8.	Bc1-e3	Qb6xb2??
9.	Nd4-b5	Ra8-c8
10.	Ra1-b1	...and Black loses his Queen

Table 1: *Beginning of a chess game between the author and Sargon 2.5.*

The system is very nicely packaged. The quality of the plastic case and the display is outstanding. In the instruction manual there is a brief rule description of chess and information on the USCF (United States Chess Federation). This is an important and welcome addition. Overall, the instructions are clear and easy to understand. For once, we have complete documentation.

A conversation with Kathe Spracklen revealed that the decision algorithms of Sargon 2.5 are exactly the same as those of Sargon 2.0. The only modification is that the host 6502 microprocessor runs at 2.0 MHz as opposed to the Apple's effective 1.0 MHz, and Sargon 2.5 *thinks on its opponent's time*. The result of this is that Sargon 2.5 is often ready with a move as soon as the opponent enters his move. The program uses 8 K bytes of ROM and 2 K bytes of programmable memory.

Playing Strength

When chess programs were first written for microcomputers (Microchess 1.0 on the KIM and Sol), we all laughed and proceeded to demolish them. While we had respect for the programs on big computers, microcomputer chess programs had a poor reputation. Times have changed, and now the average player can no longer bully microcomputer-based chess programs. That is not to say that Sargon can't be beaten by a good player. (Some results are given here; see tables 1 and 2.) But now a player must use care and caution, and a single slip can mean disaster.

Sargon 2.5 in experimental form obtained a USCF rating of 1641 in a rated human tournament (the 1979 Paul Masson Championship). This is not bad at all for a machine that plays under tournament time controls and can be held in the palm of your hand. Reportedly, the Spracklens are working on major improvements that will boost its rating (Sargon 3) to 1800 in tournament time. Sargon 2.5 is probably the last microcomputer program that we amateur players will be able to consistently beat.

Playing Results

In a match of five games between Sargon 2.5 and Sargon 2.0 (which runs on my Apple II), the programs split—two wins, two losses each, and a declared draw. Sargon 2.5 started out slowly indeed. I didn't mind too much when I (rated about 1700) and a friend (rated 1850)

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Grunfeld-Indian Defense

White	Black
Sargon 2.5 (level 4)	Sargon 2.0 (level 3)
1. d2-d4	Ng8-f6
2. c2-c4	g7-g6
3. Nb1-c3	d7-d5
4. c4xd5	Nf6xd5
5. Nc3xd5	Qd8xd5
6. Ng1-f3	Bf8-g7
7. Bc1-f4	....

This gets the Bishop developed in preparation for 8. e2-e3.

...	Nb8-c6
8. e2-e3	Qd5-a5 ch
9. Qd1-d2	Nc6-b4 !

Not a bad move for a $30 program. But it will be fruitless.

10. Ra1-c1	Bc8-f5
11. Rc1-c5	Qa5-b6
12. Bf4xc7	Nb4-c2 ch

Sargon 2.0 has been wanting to do this badly. Now, however, it is in vain.

13. Rc5xc2	Qb6-e6
14. Bf1-b5 ch	Ke8-f8
15. Bb5-c4	Qe6-e4
16. Rc2-c3	Bf5-g4
17. Qd2-d1	....

Sargon 2.5 is finding all the right defensive moves and is a pawn and Knight to the good.

17.	Bg4xf3
18. g2xf3	Qe4-f5
19. O-O	....

Taunting Sargon 2.0 to do any harm...

19.	b7-b5
20. Bc4-b3	Qf5-g5 ch
21. Bc7-g3	Qg5-f6
22. Rc3-c5	a7-a6
23. Bb3-d5	Ra8-d8
24. Qd1-c2	....

Threatening, of course, 25. Rc5-c8.

24.	Qf6-f5
25. Qc2xf5	g6xf5
26. Bd5-b7	e7-e6
27. Bb7xa6	b5-b4
28. Rc5-c4	Rd8-a8?

Black was in serious trouble, but there was no reason to allow the following clincher.

29. Bg3-d6 ch	Kf8-e8
30. Ba6-b5 ch	....

The mating web starts...

30.	Ke8-d8
31. Rc4-c7	Ra8-a5
32. Rc7-b7	....

Threat: Rb7-b8 mate.

32.	Ra5-a8
33. Rb7-d7 ch	Kd8-e8
34. Rd7-a7 ch	Ke8-d8
35. Ra7xa8 mate	

Table 2: *Record of a complete chess game between Sargon 2.5 (running on the Chafitz Modular Game System) and Sargon 2.0 (running on an Apple II computer).*

Technical Notes on Sargon 2.5 and the Chafitz Modular Game System

The MGS is a plastic case with a slide-out tray. The top of the chessboard is brown and white soft grain with algebraic-notation markings. In the tray is the receptacle for the plug-in ROM, a keyboard (supplied with a chess overlay), and a compartment with chessmen—standard Staunton chess pieces, magnetized, with a 2¼-inch King. There is an AC (alternating current) adapter supplied. An optional battery pack is available for $39.95; on battery power, the unit can retain an adjourned position for about 24 hours. The total system price is $375.

Sargon 2.5 plays at six levels. Level 4 gives a reply in 2 to 4 minutes, plays in tournament time, and is rated 1641. If you want to wait 20 to 40 minutes per move at level 5, the claimed rating is 1800.

Opponent of Sargon 2.5	USCF Rating	Results
Martellaro	(1700+)	2 wins, 1 loss
J. Irwin	(1850)	1 win
Sargon 2.0	(1600?)	2 wins, 2 losses, 1 draw

Table 3: *An informal list of match results between Sargon 2.5 and other opponents.*

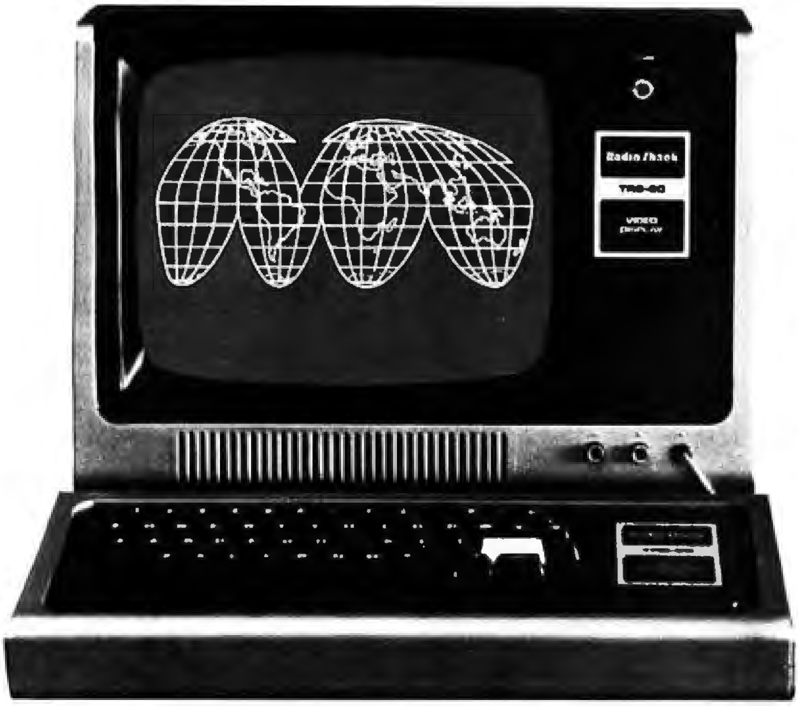
took three games from Sargon 2.5. But when Sargon 2.0 won its first two games, apprehension mounted. We wondered if there was a faulty ROM in Sargon 2.5, but we decided it was unlikely. Later, Sargon 2.5 came back to win two straight games against Sargon 2.0 and redeem itself (see match results, table 3).

The circumstances of the first two losses to Sargon 2.0 are peculiar. In the first game, everything was even down to pawns and King against pawns and King. But Sargon 2.0 gained a tempo (an advantage in time) and promoted a pawn to Queen before Sargon 2.5 could. In the second game, Sargon 2.5 played very speculatively on the attack and lost a Bishop for a pawn, then later another pawn. A whole Bishop down going into the end game with no compensation whatsoever caused me to declare a win for Sargon 2.0.

This is hard to quantify or justify, but it appears that Sargon 2.5 with its greater look-ahead capability plays more (what I would call) speculatively. Sargon 2.5 will play solid defense and sacrifice soundly, but it also appears to play a little more aggressively and loosely than Sargon 2.0. Sargon 2.0 is very solid and conservative and never risks too much. Because of this, Sargon 2.5 can get into trouble on the offensive.

It is also peculiar that in the games Sargon 2.5 won, it was on the defensive with White. (See the game score in table 2.) Sargon 2.0 huffed and puffed on the attack with Black for twenty moves, flailing away. When Sargon 2.5 was done fending off the attack, it was a Bishop and two pawns up and proceeded to mate. Astonishing.

The difference in strength between Sargon 2.5 and Sargon 2.0 seems small yet definite. My personal subjective experience is that Sargon 2.5 is more resilient on the defense, and I would prefer to play Sargon 2.0 as the weaker opponent. However, if you are running Sargon 2.0 on your microcomputer, the $300-plus investment for the "improved" version is hardly worth it. Wait for Sargon 3.■



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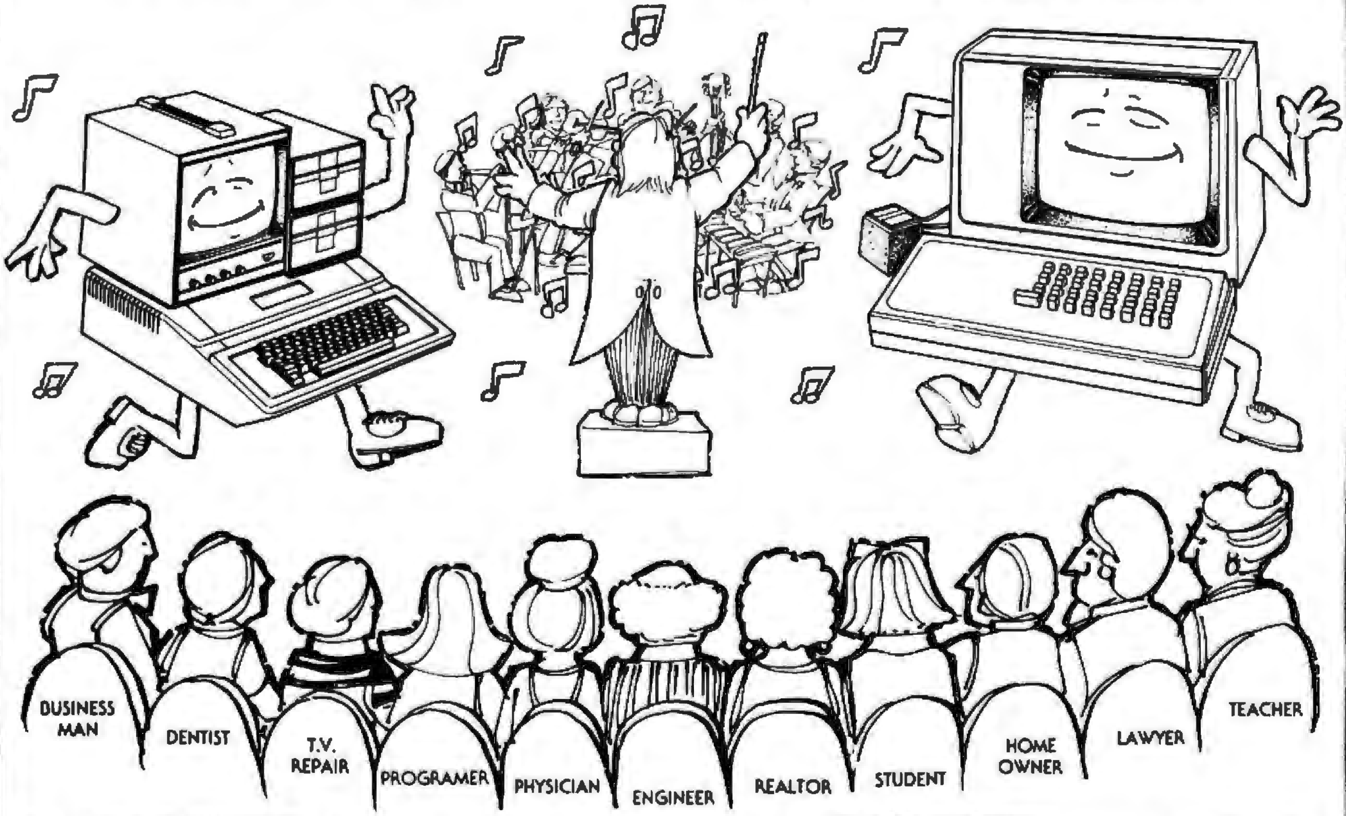

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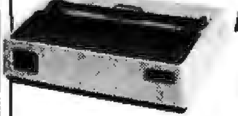

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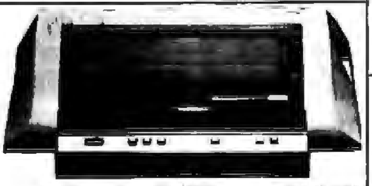

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Product Review

The SwTPC 6809 Microcomputer System

Tom Harmon, 1505 Magnolia Dr, Salisbury MD 21801

The SwTPC 6809 microcomputer system can be purchased in kit form (as the 69/K) for $495 or assembled and tested (the 69/A) for $595. Since I wanted to add sockets for all the integrated circuits, I chose the kit. (The assembled version doesn't use sockets.)

The 69/K and 69/A systems both include the MP-09 processor board, one MP-8M 8 K-byte programmable memory board, the MP-S2 RS-232C serial-interface card, and the MP-B3 motherboard with eight 50-pin slots and eight 30-pin slots. The case and power supply are also included.

The Processor Board

The MP-09 uses the Motorola 6809 microprocessor with a 1 MHz clock. The 6809 is the third-generation addition to the 8-bit 6800 family. It includes two 16-bit index registers, two 16-bit stack pointers, two 8-bit accumulators which can be treated as a single 16-bit register for some operations, and a direct-page register for direct-memory addressing. The 6809 includes all addressing modes of the 6800 with the addition of program-counter relative, extended indirect, indexed indirect, and program-relative indirect. Assembly language written with program-counter relative mode can be moved anywhere in memory without reassembly.

The 6809 is not object-code compatible with the 6800. Although 6800 source code can be reassembled with minor changes, the code should be rewritten to take full advantage of 6809 capabilities.

Sockets are provided on the board for three additional 2716 EPROMs (erasable programmable read-only memory devices). However, the documentation says the physical addresses of these may conflict with interface addresses and recommends they be switched off.

Included on the processor board is an integrated circuit that creates clock signals for various data-transfer rates. Because of the shortage of pins on the SS-50C bus, some of the clock signals share common bus lines and are jumper-selected.

A DAT (dynamic address translator) allows physical memory to be assigned as logical memory in any desired order. Because of this, you don't have to strap memory boards into consecutive memory locations. The principal use for the DAT will be for multiuser/multitasking software, which is still being developed.

A welcome feature is that the memory addresses used for input and output have been moved to a higher location to allow the 6809 to support 56 K bytes of programmable memory instead of the 32 K bytes supported on older SwTPC 6800 systems.

The MP-09 processor board is silk-screen masked and is of much higher quality than the memory board supplied with the kit. The MP-09 board is intended for use with the SS-50C bus and cannot be used with the older SS-50 bus unless modifications are made to the motherboard.

The SBUG-E Monitor

A 2 K-byte monitor (SBUG-E) is supplied in a ROM (read-only memory) that is pin compatible with a 2716 EPROM. The monitor contains disk bootstrap routines for both 5-inch and 8-inch floppy disks. A new DC-3 double-head single-density disk controller that is com-

At a Glance

Name
69/K (kit) or 69/A (assembled) computer

Use
6809-based personal computer

Manufacturer
Southwest Technical Products Corp, 219 W Rhapsody, San Antonio TX 78216 (512) 344-0241

Dimensions
length: 44 cm (17 inches)
width: 39 cm (15 inches)
height: 18 cm (7 inches)

Price
$495 (for 69/K), $595 (for 69/A)

Features
processor board containing 6809 microprocessor running at 1 MHz, RS-232C serial-interface card, 8 K bytes of programmable memory, fan

Hardware
RS-232C terminal (for input and output)

Software
SBUG-E monitor in ROM (included)

Hardware Options
extra memory boards, expansion kit for serial interface, MF-69 5-inch floppy-disk system (includes FLEX operating system)

Software Options
FLEX disk operating system, other software products from TSC (see text) that are supported by SwTPC

Documentation
looseleaf pages, 22 by 28 cm (8½ by 11 inches), in binder, with separate sections on kit construction (if applicable), schematics, parts layout, operation

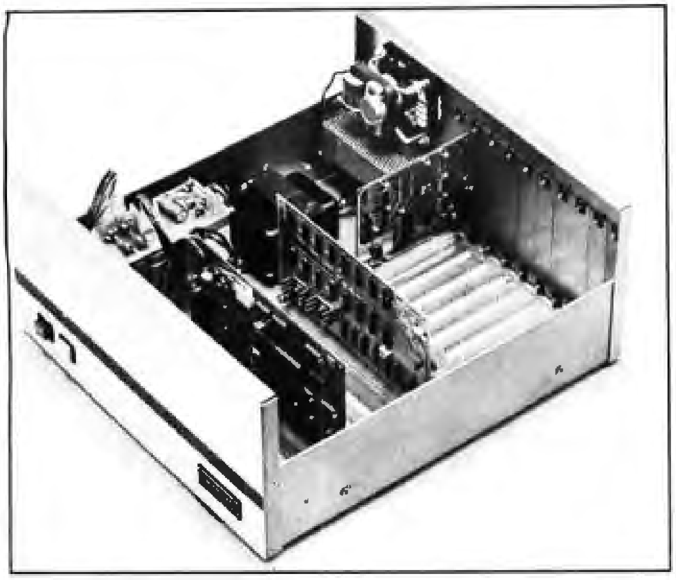

Photo 1: *The SwTPC 6809 microcomputer system. The factory-assembled 69/A sells for $595 and includes the three boards shown here. Front to back are the MP-09 processor board, the MP-8M memory board, and the MP-S2 RS-232C serial-interface board. The kit version 69/K is $495.*

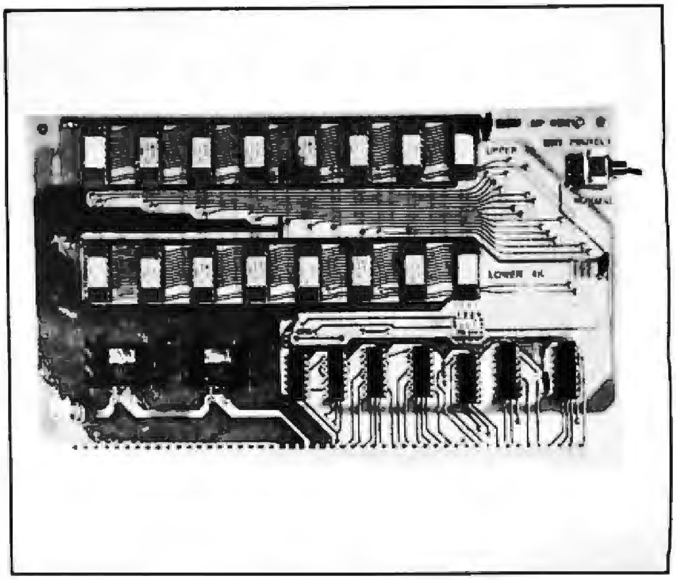

Photo 2: *The MP-8M programmable memory board for the SwTPC 6809 microcomputer system. Both the kit and assembled versions of the computer are shipped with one of these 8 K-byte boards. This board is addressable to any 8 K-byte boundry within the first 32 K bytes of memory.*

patible with the SS-50C bus is available from SwTPC for $150. The older MF-68 disk controller cannot be used with the SS-50C bus without modification. It has been rumored that SwTPC may soon discontinue the MF-68 floppy-disk drive and replace it with a DT-5 unit, which uses the Siemens double-head drive.

The SBUG-E monitor also includes a memory diagnostic. It allows you to set and release breakpoints, examine and alter memory, and examine and alter 6809 registers. Unfortunately, SwTPC does not provide source listings of SBUG-E. However, a disassembled source listing has been published in *68 Micro Journal* (June 1980).

Serial Interface

The MP-S2 serial-interface card is supplied set up for one serial port. It can be expanded to two ports by ordering the MP-SX expansion kit, which sells for $25. The card must be installed in bus-row 0, driving the system console with a standard RS-232C port. A nice feature is that you don't need extra cables or connectors since the DB-25 connector is mounted directly on the card.

Other Features

The MP-B3 motherboard uses the new SS-50C bus. Since I/O cards have decoding performed for sixteen addresses, the new cards are not downwards compatible with the SS-50 bus.

The power supply provides unregulated outputs of ±16 VDC and +8 VDC. Older SS-50 cards that obtained 12 VDC from the bus will now require on-board regulators.

The 6809 cabinet is constructed of heavy anodized aluminum and is a major improvement on the older SwTPC systems. I had no trouble getting the bolt holes to align perfectly.

The quality of the parts supplied with the 69/K kit is excellent. I did find several small components missing from the kit but had no trouble getting replacement parts from SwTPC.

DYNACOMP

Quality software for:

ATARI — **TRS-80 (Level II)***
PET — **NORTH STAR**
APPLE II Plus — **CP/M 8'' Disk**

Availability

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. All programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard 8'' CP/M floppy disks for systems running under MBASIC.

GAMES

BRIDGE 2.0 (Available for all computers) — Price: $17.95 Cassette, $21.95 Diskette

An all-inclusive version of this most popular of card games. This program both BIDS and PLAYS either contract or duplicate bridge. Depending on the contract, your computer opponents will either play the offense OR defense. If you bid too high, the computer will double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and is an excellent learning tool for the bridge novice.

HEARTS 1.5 (Available for all computers) — Price: $14.95 Cassette, $18.95 Diskette

An exciting and entertaining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to take any hearts or the queen of spades. Play against two computer opponents who are armed with hard-to-beat playing strategies.

***CRIBBAGE 2.0* (TRS-80 only)** — Price: $14.95 Cassette, $18.95 Diskette

This is a well-designed and nicely executed two-handed version of the classic card game, cribbage. It is an excellent program for the cribbage player in search of a worthy opponent as well as the beginner wishing to learn the game, in particular the scoring and jargon. The standard cribbage score board is continually shown at the top of the display (utilizing the TRS-80's graphics capabilities), with the cards shown underneath. The computer automatically scores and also announces the points using the traditional phrases.

CHESS MASTER (North Star and TRS-80 only) — Price: $19.95 Cassette, $23.95 Diskette

This complete and very powerful program provides five levels of play. It includes castling, en passant captures and the promotion of pawns. Additionally, the board may be preset before the start of play, permitting the examination of "book" plays. To maximize execution speed, the program is written in assembly language (by SOFTWARE SPECIALISTS of California). Full graphics are employed in the TRS-80 version, and two widths of alphanumeric display are provided to accommodate North Star users.

STARTREK 3.2 (Available for all computers) — Price: $ 9.95 Cassette, $13.95 Diskette

This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning while also attacking starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and move when shot at! The situation is hectic when the Enterprise is besieged by three heavy cruisers and a starbase S.O.S. is received! The Klingons get even!

SPACE TILT (Apple only) — Price: $10.95 Cassette, $14.95 Diskette

Use the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound simple? Not when the hole gets smaller and smaller! A built-in timer allows you to measure your skill against others in this habit-forming action game.

GAMES PACK I and GAMES PACK II — Price: $ 9.95 each, Cassette, $13.95 each, Diskette

GAMES PACK I contains BLACKJACK, LUNAR LANDER, CRAPS, HORSERACE, SWITCH and more. GAMES PACK II includes CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUMPUS and others. Available for all computers.

Why pay $5.95 or more per program when you can buy a DYNACOMP collection for just $9.95?

STUD POKER (ATARI only) — Price: $11.95 Cassette, $15.95 Diskette

This is the classic gambler's card game. The computer deals the cards one at a time and you (and the computer) bet on what you see. The computer does not cheat and *usually* bets the odds. However, it sometimes bluffs! Also included is a five card draw poker betting practice program. This package will run on a 16K ATARI.

STATISTICS and ENGINEERING

DATA SMOOTHER (Not available for ATARI) — Price: $14.95 Cassette, $18.95 Diskette

This special data smoothing program may be used to rapidly derive useful information from noisy business and engineering data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automatic plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — Price: $14.95 Cassette, $18.95 Diskette

Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) — Price: $19.95 Cassette, $23.95 Diskette

This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engineering-oriented decibel versus log-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educational and scientific use, TFA is an engineering tool. Available for all computers.

FOURIER ANALYZER and TFA may be purchased together for a combined price of $29.95 (Cassettes) and $37.95 (Diskettes).

REGRESSION I (Available for all computers) — Price: $19.95 Cassette, $23.95 Diskette

REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy; an automatic degree determination option; an extensive internal library of fitting functions; data editing; automatic data and curve plotting; a statistical analysis (e.g., standard deviation, correlation coefficient, etc.) and much more. In addition, new fits may be tried without reentering the data. REGRESSION I is certainly the cornerstone program in any data analysis software library.

REGRESSION II (PARAFIT) (Available for all computers) — Price: $19.95 Cassette, $23.95 Diskette

PARAFIT is designed to handle those cases in which the parameters are imbedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statement lines. Data and results may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions.

REGRESSION I and II may be purchased together for $36.95 (cassettes) and $44.95 (diskettes)

BUSINESS and UTILITIES

MAIL LIST II (North Star only) — Price: $21.95

This many-featured program now includes full alphabetic and zip code sorting as well as file merging. Entries can be retrieved by user-defined code, client name or Zip Code. The printout format allows the use of standard size address labels. Each diskette can store more than 1100 entries (single density; over 2200 with double density systems)!

TEXT EDITOR I (Letter Writer) — Price: $14.95 Cassette, $18.95 Diskette

An easy to use, line-oriented text editor which provides variable line widths and simple paragraph indexing. This text editor is ideally suited for composing letters and is quite capable of handling much larger jobs. Available for all computers.

PERSONAL FINANCE SYSTEM (ATARI only) — Price: $34.95 Diskette

PFS is a single disk menu oriented system composed of 10 programs designed to organize and simplify your personal finances. Features include a 300 transaction capacity; fast access; 26 optional user codes; data retrieval by month, code or payee; optional printing of reports; checkbook balancing; bar graph plotting and more. Also provided on the diskette is ATARI DOS 2.

FINDIT (North Star only) — Price: $19.95

This is a three-in-one program which maintains information accessible by keywords of three types: Personal (e.g., last name), Commercial (eg: plumbers) and Reference (eg: magazine articles, record albums, etc). In addition to keyword searches, there are birthday, anniversary and appointment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword or by cross-referencing two or three keywords.

DFILE (North Star only) — Price: $19.95

This handy program allows North Star users to maintain a specialized data base of all files and programs in the stack of disks which invariably accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

COMPARE (North Star only) — Price: $12.95

COMPARE is a single disk utility software package which compares two BASIC programs and displays the file sizes of the programs in bytes, the lengths in terms of the number of statement lines, and the line numbers at which various listed differences occur. COMPARE permits the user to examine versions of his software to verify which are the more current, and to clearly identify the changes made during development.

COMPRESS (North Star only) — Price: $12.95

COMPRESS is a single-disk utility program which removes all unnecessary spaces and (optionally) REMark statements from North Star BASIC programs. The source file is processed one line at a time, thus permitting very large programs to be compressed using only a small amount of computer memory. File compressions of 20-50% are commonly achieved.

GRAFIX (TRS-80 only) — Price: $12.95 Cassette, $16.95 Diskette

This unique program allows you to easily create graphics directly from the keyboard. You "draw" your figure using the program's extensive cursor controls. Once the figure is made, it is automatically appended to your BASIC program as a string variable. Draw a "happy face", call it H$ and then print it from your program using PRINT H$! This is a very easy way to create and save graphics.

TIDY (TRS-80 only) — Price: $10.95 Cassette, $14.95 Diskette

TIDY is an assembly language program which allows you to renumber the lines in your BASIC programs. TIDY also removes unnecessary spaces and REMark statements. The result is a compacted BASIC program which uses much less memory space and executes significantly faster. Once loaded, TIDY remains in memory; you may load any number of BASIC programs without having to reload TIDY!

SIMULATIONS and EDUCATION

BLACK HOLE (Apple only) — Price: $14.95 Cassette, $18.95 Diskette

This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to enter and maintain, for a prescribed time, an orbit close to a small black hole. This is to be achieved without coming so near the anomaly that the tidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

VALDEZ (Available for all computers) — Price: $14.95 Cassette, $18.95 Diskette

A simulation of supertanker navigation in the Prince William Sound and Valdez Narrows. The program uses an extensive 256X256 element radar map and employs physical models of ship response and tidal patterns. Chart your own course through ship and iceberg traffic. Any standard terminal may be used for display.

FLIGHT SIMULATOR (Available for all computers) — Price: $17.95 Cassette, $21.95 Diskette

A realistic and extensive mathematical simulation of take-off, flight and landing. The program utilizes aerodynamic equations and the characteristics of a real airfoil. You can practice instrument approaches and navigation using radials and compass headings. The more advanced flyer can also perform loops, half-rolls and similar aerobatic maneuvers.

TEACHER'S PET I (Available for all computers) — Price: $ 9.95 Cassette, $13.95 Diskette

This is the first of DYNACOMP's educational packages. Primarily intended for pre-school to grade 3, TEACHER'S PET provides the young student with counting practice, letter-word recognition and three levels of math skill exercises.

Ordering Information

All orders are processed and shipped postpaid within 48 hours. Please enclose payment with order along with computer information. If paying by VISA or Master Card, include all numbers on card. For orders outside North America add 10% for shipping and handling.

Add $2.50 to diskette price for 8'' floppy disk (soft sectored, CP/M, Microsoft BASIC)

*TRS-80 diskettes are not supplied with DOS or BASIC.

Deduct 10% when ordering 3 or more programs.

Ask for DYNACOMP programs at your local software dealer. Write for detailed descriptions of these and other programs from DYNACOMP.

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New York State residents please add 7% NYS sales tax.

The documentation supplied with the 69/K system is adequate, but the construction manuals are not as detailed as those of some other manufacturers. For example, you are told to install all resistors as a single step in construction, and you are expected to know the resistor color codes and be able to identify the polarity of all polarized capacitors. I would not recommend this kit for a beginning kit builder. However, an experienced builder should have no trouble.

Construction Hints

I selected low-profile tin soldier-tail sockets manufactured by Texas Instruments for use on the printed-circuit boards. These sockets may be purchased from a number of sources, including Digi-Key Corporation, POB 677, Highway 32 S, Thief River Falls MN 56701.

The straight pin-edge connectors on the motherboard seem to slope in one direction and the 10-pin male connectors should be installed with the slope in the same direction. This avoids problems when the printed-circuit boards are inserted later. You might also find it easier to remove the socket index pin before soldering the sockets to the board.

The Added Extras

In order to communicate with your microcomputer system, you'll need an RS-232C-compatible terminal. I selected the Heath H-19 video terminal over the SwTPC CT-82 because I prefer the larger 12-inch display size of the Heath. (The SwTPC CT-82 has a 9-inch display.) The normal format of the Heath H-19 is 24 lines by 80 characters, while the CT-82 format is 16 lines by 82 characters.

You'll probably want additional memory because only 4 K bytes of the supplied 8 K bytes of programmable memory are available for use. The SBUG-E monitor assigns a 4 K-byte area for a system stack and for internal tables and addresses. SwTPC sells additional MP-8Mb bare boards with edge connectors for $17. By buying your own integrated circuits and memory from independent suppliers, you can save a considerable amount of money over assembled units.

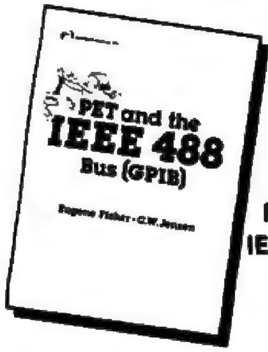
Digital Research Computers (POB 401565, Garland TX 75040) sells a 16 K-byte programmable memory board for the SS-50 bus ($26). The board uses type-2114 integrated circuits instead of the type-4044 programmable memory devices used by the MP-8M board. The quality is excellent and well worth adding to your 6809 system.

Of course you'll also need either a cassette-tape unit (like the SwTPC AC-30) or a floppy-disk system for loading and saving programs.

Software

The FLEX 09 version 2.6 disk operating system is available from SwTPC. The price ($35) includes a manual and object-code disk. FLEX 09 can be used with most of the 6809 software available from TSC (Technical Systems Consultants, POB 2574, West Lafayette IN 47906). TSC has a large amount of 6809 software, including a text editor, an assembler, several versions of BASIC, a debugging package, and others.

CSI (Control Systems Inc, 1317 Central, Kansas City KS 66102) has the UCSD Pascal compiler for $419 that

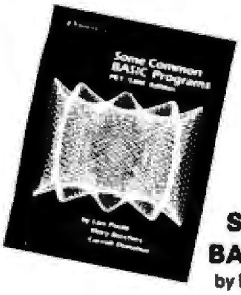


PET and the IEEE 488 Bus (GPIB)

by E. Fisher and C. W. Jensen

This is the only complete guide available on interfacing PET to GPIB. Learn how to program the PET interface to control power supplies, signal sources, signal analyzers and other instruments. It's full of practical information, as one of its authors assisted in the original design of the PET GPIB interface.

#31-4 $15.99



NEW PET/CBM edition

Some Common BASIC Programs

by L. Poole, M. Borchers, C. Donahue

76 Programs you can use even if you don't know BASIC. This book gives you a variety of math power including personal finance, taxes and statistics as well as other programs you'll want like Recipe Cost and Check Writer. All programs can be run on a PET or CBM with 8K or more.

#40-3 $14.99

PET owners can purchase the programs ready-to-run on cassette or disk. Use the book as a manual for operating instructions and programming options.

Disk #33-0 $22.50
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Practical BASIC Programs

ed. Lon Poole

These are 40 easy to use programs that each do something useful.

Income averaging, checkbook reconciliation, statistics, factorials, temperature conversion and musical transposition are just a few. It offers a wealth of practical computing power. Includes write-ups, program notes and instructional examples to help you realize the potential uses of each program.

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6502 Assembly Language Programming

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Increase the capabilities and performance of PET (and other 6502-based computers) by learning to program in assembly language.

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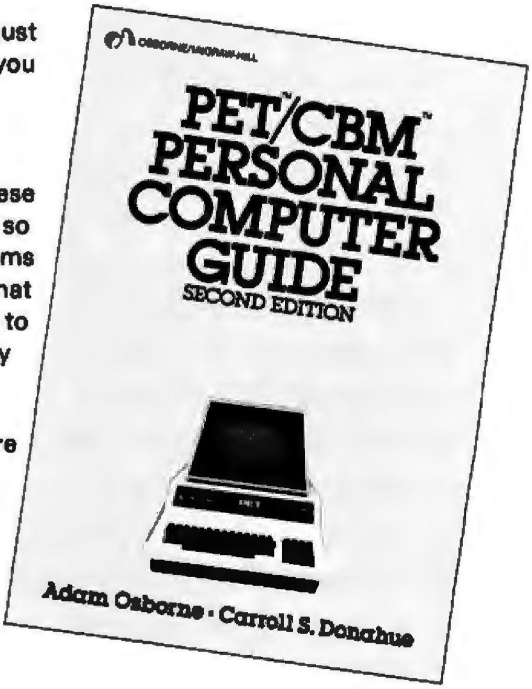
NEW Second Edition

PET™/CBM™ Personal Computer Guide Second Edition

by Adam Osborne and Carroll S. Donahue

The PET/CBM Personal Computer Guide is a step-by-step guide that assumes no prior knowledge of computers. If you can read English, you can use this book.

This book provides the important information and documentation that PET/CBM users have sought for so long. After reading this book you will have a good understanding of what a computer — especially the PET/CBM computer — can do for you. If you've just bought a PET or CBM this is the book you must have to really understand your computer. By using the examples found in this book, you will quickly get your PET/CBM up and running. These examples are thoroughly documented so you can learn how and why the programs work. It is the "how" and the "why" that are important if you want to learn how to make your PET or CBM work efficiently for you.



This second edition contains even more useful information than the first edition of this book. The guide contains a wealth of information on everything from keyboard variations to a detailed description of PET and CBM memory.

Included are:

Complete operating instructions for

- keyboard
- tape cassette
- disk

Description of all CBM BASIC statements

Optimal programming techniques including

- input/output programming
- file handling
- screen editing

Solutions to programming problems

CBM capabilities and limitations

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38-1 Practical BASIC Programs	$15.99		

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will run on a 6809 system with 56 K bytes of programmable memory. The software is available on both 5-inch and 8-inch floppy disks, and includes operating system, compiler and linker.

System Checkout

The power-supply cables and voltages are first checked without any other boards installed. Then the motherboard is installed, and finally the remaining printed-circuit boards. You will need an RS-232C-compatible terminal connected to the serial-interface card to test for the proper message, "S-BUG 1.5 - 8 K", followed a blinking cursor.

When I performed the checkout, everything appeared to be normal until I attached a terminal and noticed that the video display consisted of question marks being produced much faster than the current data-transfer rate, which was 300 bps (bits per second). The SwTPC documentation states that if *anything* is printed, especially question marks, the computer is probably working and that the problem is probably with the terminal parity, bit format, or data-transfer-rate setting.

I spent a considerable amount of time checking for problems and couldn't find anything wrong until I used my ohmmeter and observed that the resistance between the 300 and 4800 bps lines on the motherboard measured about 2 ohms. I immediately suspected a solder bridge but was unable to find one I then called in a friend with a very accurate ohmmeter. He detected a dip in the resistance at the closest pin on the motherboard. Using a projector lens, he found two extremely small copper bridges that were covered by the green coating on the motherboard and were virtually impossible to see with the naked eye. After I removed the copper bridges with a small knife, the system worked beautifully.

The moral of this story is that you should be careful to check adjacent bus lines on the motherboard both initially and after assembly. Doing this will eliminate a lot of frustration and wasted time.

Conclusions

I'm pleased with the overall quality of the SwTPC 69/K, and I recommend it to any experienced kit builder. One big headache-saver is to check out individual finished boards on a working SS-50 or SS-50C system. I used a friend's SS-50 computer to test the 8 K-byte programmable memory board supplied with the kit.

If you don't have a means of testing individual boards, I strongly suggest the purchase of the 69/A assembled and tested system. When you consider the amount of time spent assembling and testing the unit, the extra $100 seems like a bargain.

SwTPC does have technical services available, but the entire computer must be repacked and sent to San Antonio, Texas.Without the proper test equipment, it is difficult, if not impossible, to track down specific problems.

If you purchase factory-assembled boards, SwTPC does offer a factory exchange program. Boards can be exchanged for a fixed fee ($40 for the MP-09 processor board). All factory-assembled products are included in the plan for 6 months, and SwTPC will arrange a service contract after the 6-month period. If you're using your computer for business, this service is ideal.■

CALL FOR PAPERS

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PARIS, SEPT. 7-10, 1981

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EUROMICRO 1981 is the seventh annual symposium organized by EUROMICRO, the European Association for Microprocessing and Microprogramming. Previous annual conferences have been held in Nice, Venice, Amsterdam, Munich, Goteborg and London. The purpose of this conference is to bring together practitioners and theoreticians from industry, government and academia who are interested in all problems relating to the underlying concepts and the use of microprocessing and microprogramming.

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Authors should submit six complete copies of their papers to the program chairman not later than by March 15, 1981.

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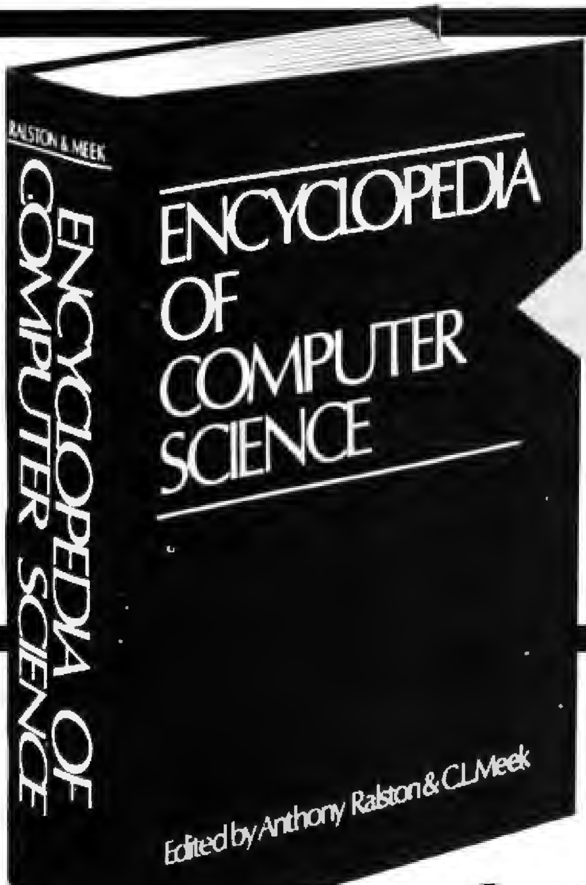

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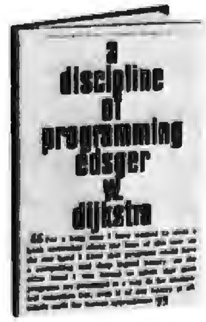

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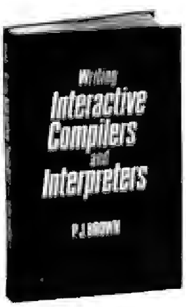

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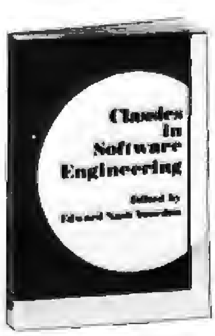

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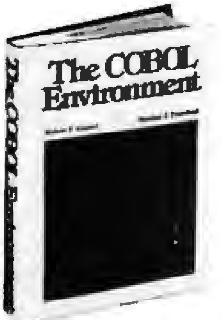

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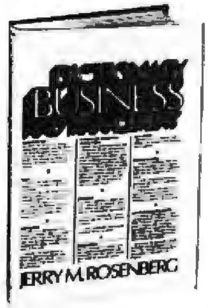

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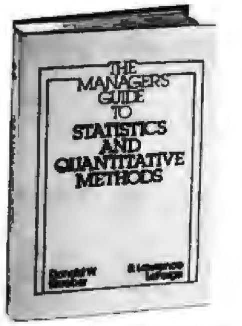

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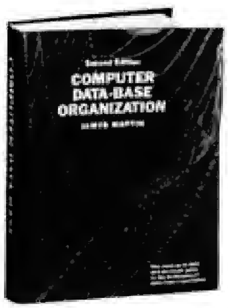

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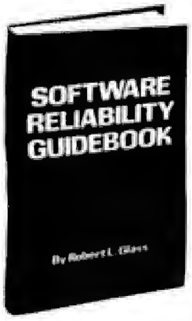

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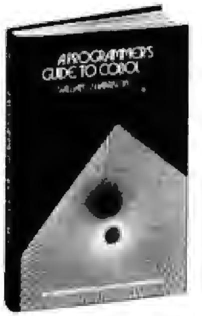

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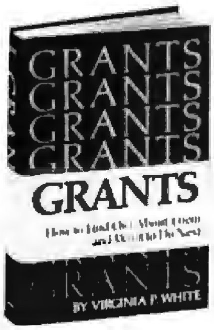

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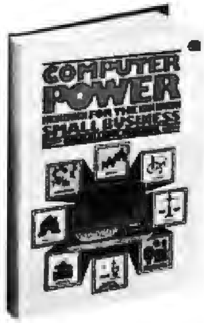

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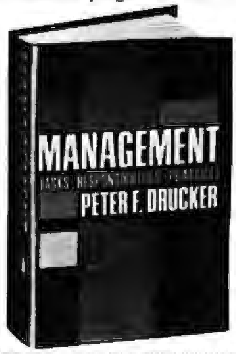

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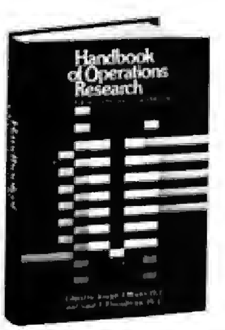

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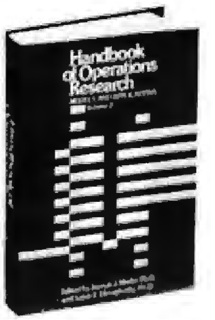

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The Picture-Perfect Apple

Phil Roybal
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A picture is worth a thousand words. And it was the capability of representing information in pictures that initially attracted me to the Apple II computer.

But images on a screen can be *too* personal an experience. Often no one else sees them. It would be great if there were a way to transcribe these images so that others could also appreciate them. There is a way to do it, and this article tells how.

The program discussed here was written in Apple (6502) assembly language for the Qume Sprint Micro 3, a daisy-wheel printer with a 16-bit parallel interface. The approach is quite general in nature; therefore, you will find it easy to adapt it to other hardware.

The high-resolution screen of the Apple II is actually a window into the memory between decimal addresses 8192 and 16,383. Anything you see there can be printed on paper. This means that if you have a graphics printer, you needn't go to a lot of trouble writing plotting routines for it. Those already available in the Apple languages and utility programs will suffice quite handily.

This capability can be put to good use the next time you need to produce a high-quality chart for a presentation, or an attention-getting cover for a report. You can do the job on the same letter-quality printer you used to produce the report itself.

Even if you don't have one of these elegant but expensive printers, this routine is still useful. Very little depends upon either the printer or the interface. In fact, the bulk of the routine is concerned with decoding the high-resolution screen addresses. Therefore, you can quickly tailor the printer routine to your hardware.

The High-Resolution Graphics Screen

The Apple graphics screen is a tricky beast. If you calculate how much memory it should consume, it comes out:

280 dots × 192 lines = 53,760 pixels

Then consider that there are eight colors that can be displayed. This means you throw in 3 bits per pixel to wind up with:

53,760 × 3 = 20,160 bytes of memory

Despite this, the screen takes up only 8192 bytes. How is this done?

The screen doesn't show every color in every location. Only black-and-white images take advantage of the full resolution of the screen. Colors show up in alternate columns (green alternates with violet, orange with blue, etc). Apple's video circuitry and the television set's response characteristics combine to make the rows of colored dots appear to fuse together. Thus, you can draw a "solid" horizontal line across the screen, regardless of the color you plot it in.

While this bit of trickery does save memory, it makes analyzing screen images rather complex since you have to figure out what the color is at any given location. Fortunately, since most printers produce only black and white, the color issue is academic. If a dot is there, the printer prints it. The end result is that colors appear as less dense clusters of dots than solid white, providing a shading effect to images produced on the printer.

What causes the most difficulty is that the designer of the Apple saved himself a logic gate or two through the use of rather unorthodox screen addressing. As a result, adjacent screen rows do not occupy consecutive memory locations. It is the decoding of this high-resolution screen addressing which accounts for a good deal of the complexity of this program. The software has to use a series of counters to keep track of where it is on the screen. (Figure 2 shows how it works.)

The high-resolution screen of the Apple II is actually a window into the memory.

High-resolution screen addressing is easy to understand if it is considered as a series of hexadecimal rather than decimal numbers.

As shown in figure 1, the screen is divided into three major sets of horizontal lines which I call *triads*. Each triad is divided into eight groups of horizontal lines called *octets*. And finally, each octet consists of eight horizontal lines called *fillers*. A line consists of 280 dots, which are derived from 40 bytes of memory by using the lower 7 bits of each byte. This is how it works.

The *triads* begin with lines whose first bytes (leftmost characters) have hexadecimal addresses:

2000
2028
2050

If you poke 1s into these addresses while the high-resolution screen is black, dots will appear along the left margin, evenly dividing the screen vertically into thirds.

Within a triad are octets. The octets begin with lines whose first bytes are incremented by hexadecimal 80 from the starting address of the triad. For example, the first triad, which starts at hexadecimal 2000, has octets beginning with lines whose first bytes have hexadecimal addresses:

2000
2080
2100
2180
2200
2280
2300
2380

Each *octet* has eight lines within it.

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These lines start with bytes whose addresses go up in increments of hexadecimal 400 from the octet starting address. Thus, the first octet of the first triad has eight lines in it that start with the hexadecimal addresses:

2000
2400
2800
2C00
3000
3400
3800
3C00

This is a bit complex. It helps if you work out a table and verify it by poking information into the high-resolution screen area. Adapting the program to handle a different printer is relatively trivial compared to understanding the address scheme. Thus, this algorithm is a good base to build on, no matter what hardware you use.

A Tour of the Driver

The driver routine (see figure 2) knows that the screen is contained in the memory area between hexadecimal 2000 and 3FFF. Therefore, it moves the print head to the left margin and then starts with hexadecimal address 2000, in the first

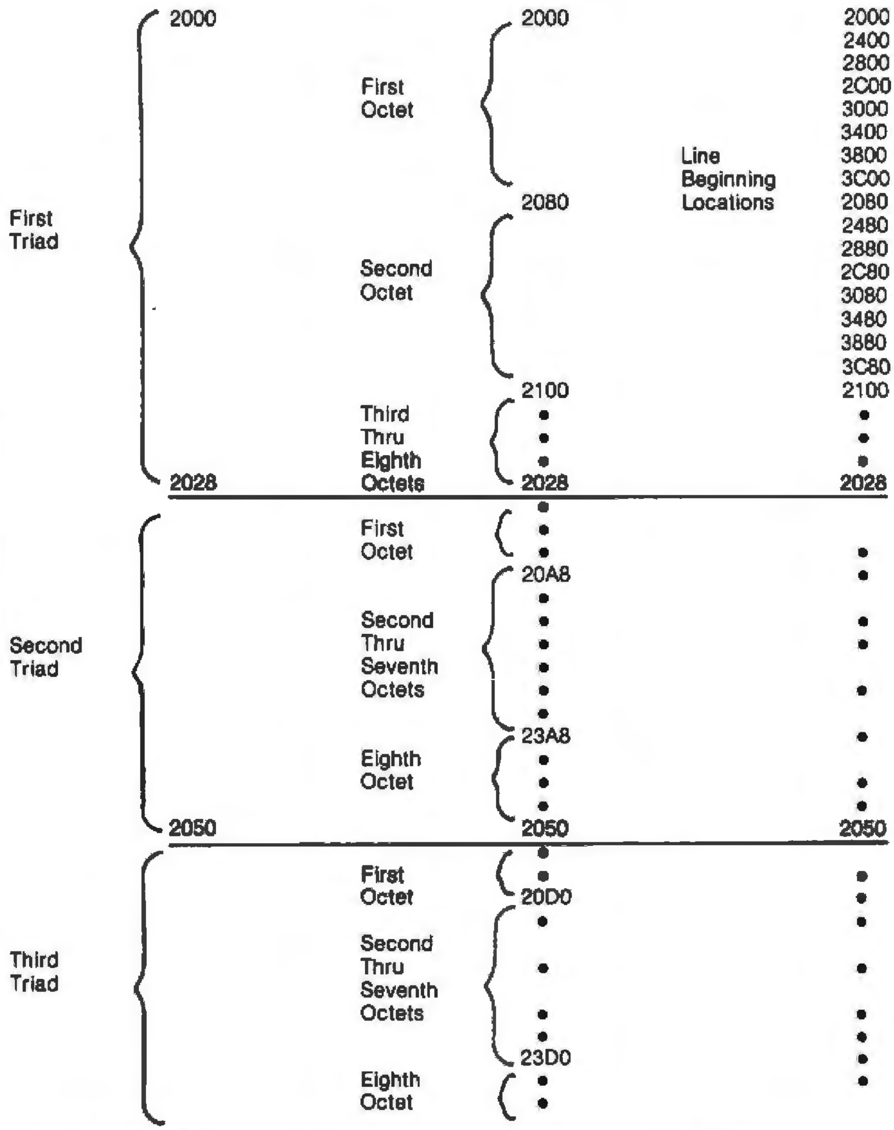

Figure 1: *Apple II high-resolution screen-memory addressing. All addresses shown are in hexadecimal radix. The screen is divided into three major sets of horizontal lines called* triads. *Each triad is divided into eight groups of horizontal lines called* octets. *Each octet is divided into eight horizontal lines called* fillers. *Each line uses 40 bytes of programmable memory and consists of 280 dots.*

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triad, first octet, and first filler line. Beginning at one end of the first line, it looks at the lower 7 bits of each byte until it has scanned (decimal) 40 bytes without finding a dot, or until it has found a dot.

In the first case, the complete line is blank (all zeroes), so the driver issues a line feed. It then picks the next line (in this case, the second filler line in

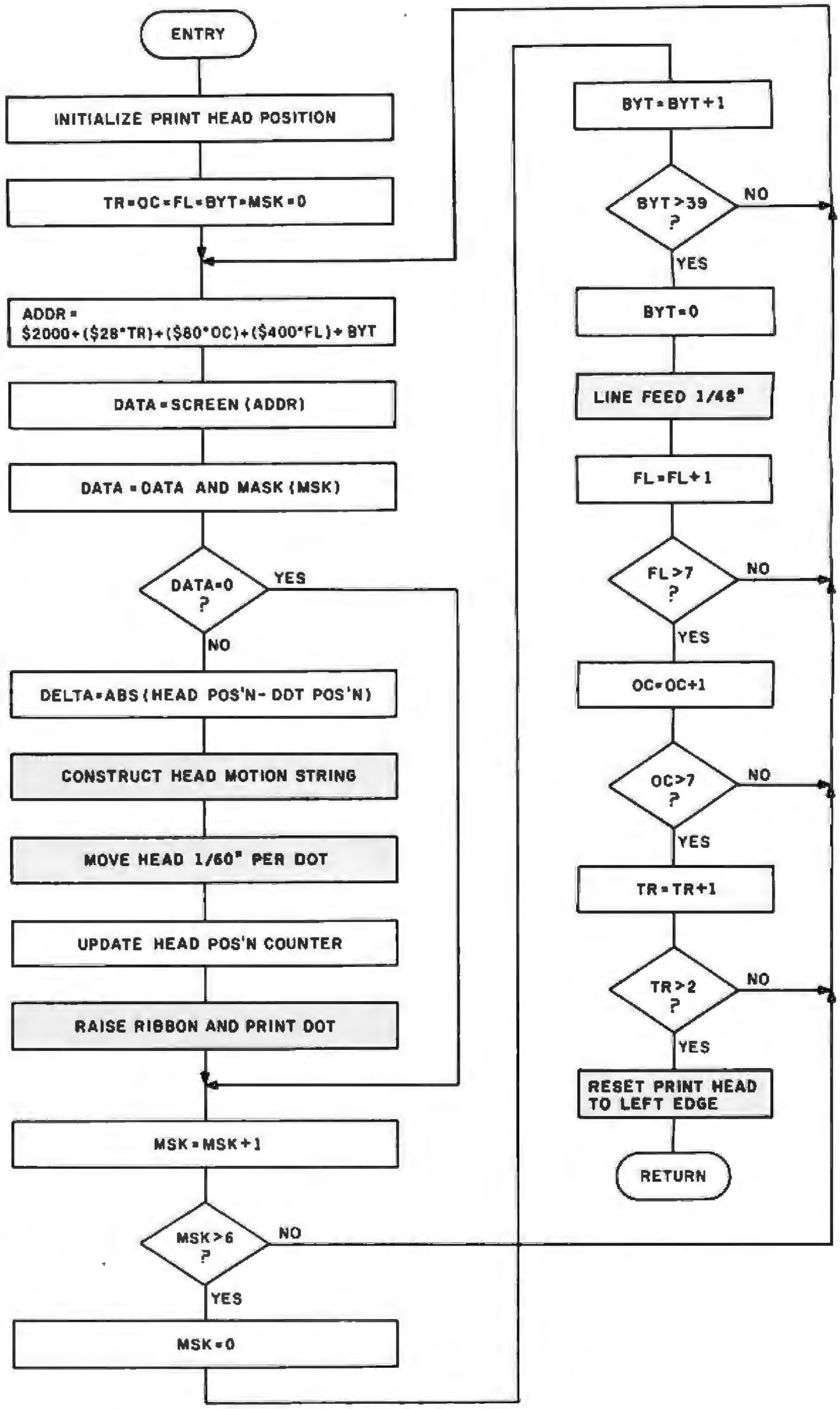

Figure 2: *Flowchart for a program to drive the Qume Sprint Micro 3 plotter to print Apple II screen graphics. The shaded boxes indicate hardware-dependent code, although the code is very similar for all 16-bit parallel printers. Abbreviations are as follows: TR=triad counter; OC=octet counter; FL=filler counter; BYT=filler-line-byte counter; and MSK=seven-dot byte mask.*

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the first octet) and again scans it from end to end. This pattern continues (if the whole screen is blank) through the eight filler lines of each octet, the eight octets of each triad, and all three triads, until the end of the screen is reached. Then the driver jumps back to the routine that called it.

When a nonzero bit (a dot on the screen) is found, the driver calculates the distance from the present print head location (normally over the last dot printed) to the new dot position. It then moves the print head into place in a single step (instead of ratcheting along over every dot position). When the print head is in place, the dot is printed.

In the driver written here, if at least one dot has been printed on a line, the next line will be scanned and printed from the opposite direction. This provides the fastest printing with minimum wear and noise under average conditions. While this scheme is not 100% optimized, it does yield very acceptable performance. The determination of scan- and head-motion direction adds complexity to the algorithm without contributing to the basic capability, so this feature is omitted from the flowchart in the interests of clarity.

The bulk of this program is dedicated to screen-address decoding. The only section tightly woven about the hardware is the output routines. These come last in the source code to facilitate changing them without reassembling the entire driver. They assume that you are using a Qume printer receiving 16-bit parallel code in the format shown in figure 3. If you are using another printer and interface, just write code to send the correct control characters to your printer hardware.

Using the Plotter

The driver was written for a printer that provides horizontal resolution of 120 steps per inch and vertical resolution of 48 steps per inch. Two horizontal increments are used for each screen dot, and one vertical increment is used for each line. As a result, the printer will reproduce the high-resolution graphics screen in a space about 11.3 by 9.8 cm (4.7 by 4 inches). This area will be centered on a 20.8 cm- (8½-inch) wide page, and will start printing at wherever the paper is located at the time the driver is called.

Once you have loaded the driver and produced an image in high-

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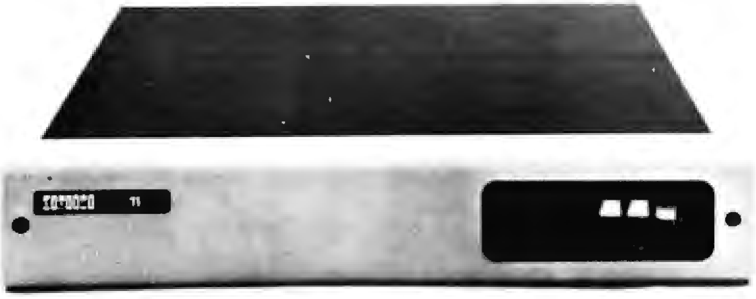

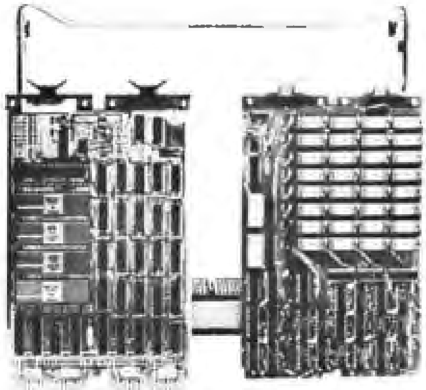

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resolution page 1, just turn on your printer and enter the routine with a CALL from BASIC or a G command from the monitor.

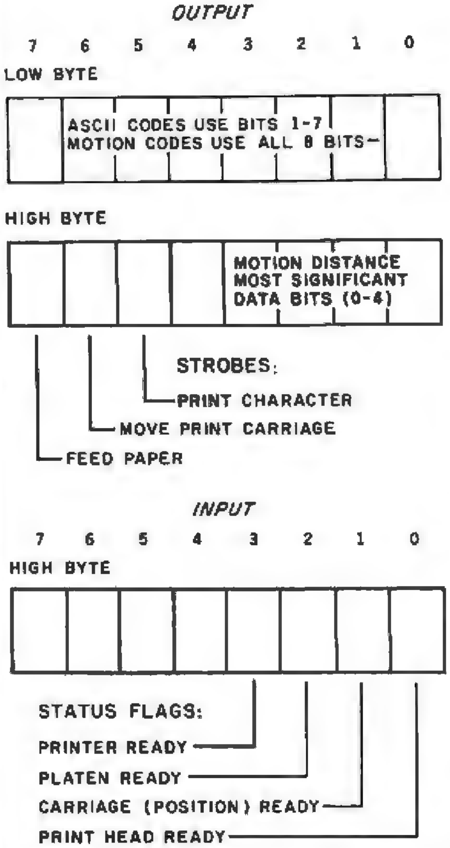


Figure 3: *The form in which the driver described in the text communicates with the Qume Sprint Micro 3 plotter. A strobe consists of a "1" bit in the appropriate position, with all other bits "0." If all strobes are raised simultaneously, the printer is reset and the print carriage moves to the left margin.*

Getting a Copy of the Driver

A driver code is rather long for publication. In any case, typing it in is a masochistic form of entertainment. To alleviate these problems, I have made this code available on 5-inch floppy disk. The disk includes:

- object code assembled at hexadecimal location 9000 (for 48 K-byte systems), and hexadecimal location 5000 (for 32 K-byte systems)
- source code in a text file

Also included is a version of this code adapted for use with Sprint 5 printers interfaced through Apple's Serial Interface Card.

To obtain your copy of this floppy disk, send a check for $14.95 (California residents add 6% sales tax) plus $1.00 shipping and handling to Contech, 1111 Pippin Creek Ct, San Jose CA 95120. Ask for the "Picture-Perfect Apple" software.■

Figures 4a, 4b, and 4c: *Three examples of Apple II high-resolution graphics transcribed by the Qume Sprint Micro 3 plotter, using the driver described in this article.*

Poking Data Into the High-Resolution Screen Area

Direct interaction with the Apple II high-resolution screen memory is an excellent way to test addressing schemes and explore the structure of Apple graphics images. To experiment on your own, get into the monitor mode (type CALL −155) and display the high-resolution screen by typing:

```
C050 C054 C057
```

and hit the Return *key. You are looking at page 1 of the high-resolution screen. To clear it of garbage, fill it with 0s by typing:*

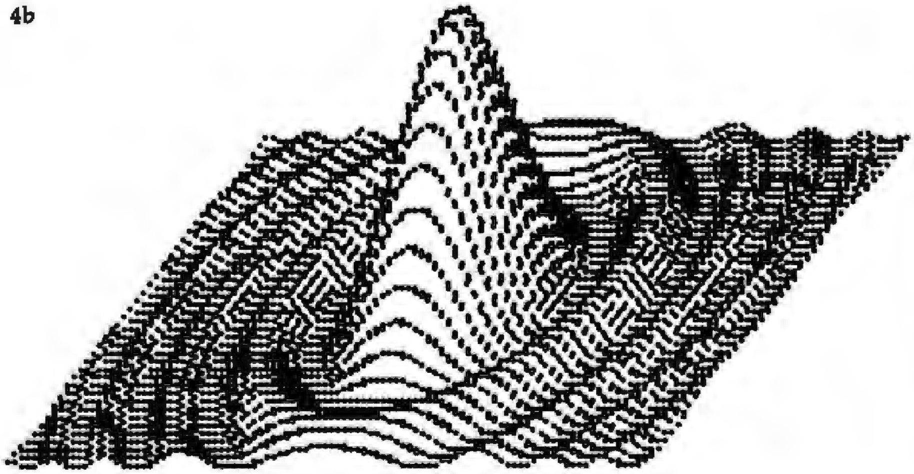
```
2000:0 2001<2000.3FFEM
```

followed by a return. *Once you have a clean screen, type a hexadecimal address followed by a colon and FF. For example:*

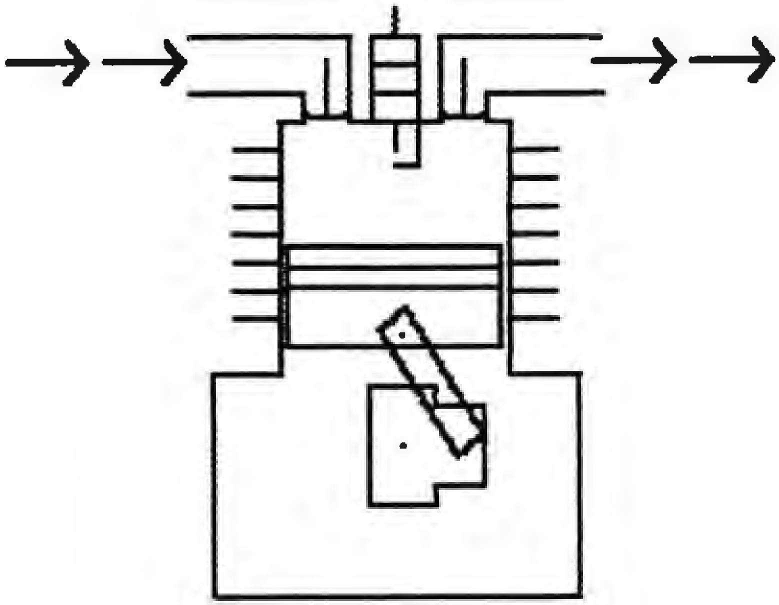
```
2000:FF
```

followed by a return. *This will set the byte to all 1s and will produce a 7-dot-wide line segment at the appropriate place on the screen.*

4b



4c



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The PMC-80 will operate with any of the many peripherals Radio Shack and other independent vendors have invented to plug into the TRS-80.* Most importantly, the Interface Adapter permits Expansion Interfaces with memory expansion to 48K to be added. An Expansion Interface will also permit the addition of Radio Shack compatible 5¼" disks and disk operating systems, RS 232, printers, etc.

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Micrograph

Part 3: Software and Operation

E Grady Booch
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Some background on interactive computer-graphics systems was presented in Part 1. In Part 2, a description was given of the hardware for a low-cost color-graphics display processor, called Micrograph, which interfaces to a microcomputer as an intelligent peripheral device. In this, the third and final part, you will become familiar with the software for Micrograph, which implements the display-processor instruction set introduced in Part 1, and be given instructions for operating the system.

Software Perspective

Two packages of software are required to support Micrograph, as we have observed in the generalized graphics system in Part 1. The first package is the applications software, which executes in the host computer. This software creates and manipulates abstractions of images. The elements of these images are described to the display processor through the instructions in a display list. Within the display processor itself, there must reside a second software package that converts these instructions into a visible image.

In Part 1, we described one such instruction set for controlling a color raster-scan display processor, and it is summarized in table 1, here, in Part 3. Since emphasis has been on the display processor, and since the applications software is system specific, the remainder of this article will concentrate upon the other package: the software internal to the display processor. However, the protocol software in the host computer that is needed to carry out communication with Micrograph will be described.

Mnemonic	Name
CALL	Call subroutine
LCRAM	Load color memory
LPIX	Load pixel
LREG	Load register
LSUB	Load subroutine
LSYM	Load symbol
MOV	Move
RCRAM	Read color memory
RET	Return
RPIX	Read pixel
RREG	Read register
RSUB	Read subroutine
RSYM	Read symbol
SYM	Display symbol
VEC	Draw a vector
WAIT	Wait

Diagnostics are available under XERR.

Table 1: *Summary of graphics primitives. These instructions control the graphics-display processor in Micrograph.*

Software Description

The source software for Micrograph consists of approximately 2400 lines of Z80 assembly-language code plus internal comments. (See listing 2 in Part 1, BYTE, November 1980, page 280; listing 1 in Part 2, BYTE, December 1980, page 327; and listing 1, in this issue, page 240.) This code assembles to approximately 2.6 K bytes of object code and resides in the three system EPROMs (erasable programmable read-only memories) in the address space decimal 0 to 3071.

The Micrograph software was written on a Zilog Development System and conforms to the Zilog Z80 assembly-language standards. Structured programming and stepwise refinement were used to develop the software. By virtue of these techniques, once I had cleared out the typos in the source, I required only four assemblies to complete the final working package.

Software Structure

Figure 1 (on page 264) indicates that, as a result of stepwise refinement, the Micrograph software is highly structured. The software consists of one main routine, three driving modules, seventeen routines that implement the instruction set, twelve shared utility routines, and five interrupt-service routines. These routines appear grouped together by their class, then alphabetically in the software source listing.

The routine MAIN drives the entire Micrograph software and handles a call to the power-up INIT (initialization). MAIN then enters an infinite loop of instruction fetches (via FETCH) and executes (via EXEC). In this sequence, Micrograph requests an instruction from the host computer and executes it. PRIMAT is then called by EXEC to calculate which instruction has been commanded and, in turn, calls the appropriate routine that processes the various options of the instruction.

These sixteen routines (CALLS through WAIT) correspond directly to the instruction set in table 1. Since the routines execute similar code, they may call any of several utility routines. These routines include null subroutine calls (GUSER and USER), routines for communicating with the host computer (GETBLK, SENDBK, and SENDBY), and some primitive

Text continued on page 260

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Listing 1: *The final third of the firmware for Micrograph control, written for the Z80 microprocessor used in the prototype. The first and second portions of the firmware appeared with Part 1 and Part 2 of this series.*

```
07EA   E1                       POP   HL                     ;RESTORE H AND L
07EB   FDE1                     POP   IY                     ;RESTORE IY
07ED   F1                       POP   AF                     ;RESTORE STACK
07EE   C9                       RET

                ; CLIP ***********************************************
                ;
                ; CLIP DETERMINES IF A POINT SHOULD BE CLIPPED OR NOT.
                ; CLIP FIRST DETERMINES THE POINT REFERENCED, THEN
                ; COMPARES IT WITH THE CASE. SUCCESS IS SET IN THE
                ; POINT IS NOT CLIPPED.
                ;
                ; CALLS          NONE
                ;
                ; CALLED BY
                ;                PUT
                ;                RPIX
                ;                LPIX
                ;
                ; REGISTERS      A       (TEMPORARY)
                ;                B       (CASE)
                ;                C       (SUCCESS)
                ;                D       (TEMPORARY)
                ;                E       (TEMPORARY)
                ;                H       (TEMPORARY)
                ;                L       (TEMPORARY)
                ;                IX      (INDEX)
                ;                IY      (INDEX)
                ;
                ; I/O            NONE
                ;
                ; STRUCTURES     GDR0    (X)
                ;                GDR1    (Y)
                ;                GDR6-13 (VIEWPORTS)
                ;                REF     (REFERENCE)
                ;
07EF   0E01     CLIP:   LD    C,1                    ;ASSUME SUCCESS
07F1   DDCB434E         BIT   1,(IX+REF)             ;POINT TO REFERENCE
07F5   C0               RET   NZ                     ;RETURN IF SET
07F6   F5               PUSH  AF                     ;SAVE A AND F
07F7   FDE5             PUSH  IY                     ;SAVE IY
07F9   E5               PUSH  HL                     ;SAVE H AND L
07FA   D5               PUSH  DE                     ;SAVE D AND E
07FB   0E00             LD    C,0                    ;CLEAR SUCCESS
07FD   FD21861D         LD    IY,STRUCT+GDR6         ;LOAD REFERENCE START
0801   DDCB4346         BIT   0,(IX+REF)             ;TEST REFERENCE
0805   2804             JR    Z,CLIP0                ;JUMP IF NOT SET
0807   FD218A1D         LD    IY,STRUCT+GDR10        ;LOAD REFERENCE START
080B   FD6E00   CLIP0:  LD    L,(IY+0)               ;LOAD LEFT X
080E   2600             LD    H,0                    ;CLEAR H
0810   CBD9             SET   3,C                    ;SET BIT 3
0812   DD5E00           LD    E,(IX+GDR0)            ;GET X
0815   1600             LD    D,0                    ;CLEAR D
0817   AF               XOR   A                      ;CLEAR CARRY
0818   ED52             SBC   HL,DE                  ;SUBTRACT
081A   FA2108           JP    M,CLIP1                ;JUMP IF MINUS
081D   2802             JR    Z,CLIP1                ;JUMP IF ZERO
081F   CB99             RES   3,C                    ;SET BIT 3
0821   FD6E02   CLIP1:  LD    L,(IY+2)               ;LOAD RIGHT X
0824   2600             LD    H,0                    ;CLEAR H
0826   CBD1             SET   2,C                    ;SET BIT 2
0828   DD5E00           LD    E,(IX+GDR0)            ;GET X
082B   1600             LD    D,0                    ;CLEAR D
082D   AF               XOR   A                      ;CLEAR CARRY
082E   ED52             SBC   HL,DE                  ;SUBTRACT
0830   FA3508           JP    M,CLIP2                ;JUMP IF MINUS
0833   CB91             RES   2,C                    ;RESET BIT 2
0835   FD6E01   CLIP2:  LD    L,(IY+1)               ;LOAD LEFT Y
0838   2600             LD    H,0                    ;CLEAR H
083A   CBC9             SET   1,C                    ;SET BIT 1
083C   DD5E01           LD    E,(IX+GDR1)            ;GET Y
083F   1600             LD    D,0                    ;CLEAR D
0841   AF               XOR   A                      ;CLEAR CARRY
0842   ED52             SBC   HL,DE                  ;SUBTRACT
0844   FA4B08           JP    M,CLIP3                ;JUMP IF MINUS
0847   2802             JR    Z,CLIP3                ;JUMP IF ZERO
0849   CB89             RES   1,C                    ;SET BIT 1
084B   FD6E03   CLIP3:  LD    L,(IY+3)               ;LOAD RIGHT Y
084E   2600             LD    H,0                    ;CLEAR H
0850   CBC1             SET   0,C                    ;SET BIT 0
0852   DD5E01           LD    E,(IX+GDR1)            ;GET Y
0855   1600             LD    D,0                    ;CLEAR D
0857   AF               XOR   A                      ;CLEAR CARRY
0858   ED52             SBC   HL,DE                  ;SUBTRACT
085A   FA5F08           JP    M,CLIP4                ;JUMP IF MINUS
085D   CB81             RES   0,C                    ;CLEAR BIT 0
085F   79       CLIP4:  LD    A,C                    ;GET C
0860   0E00             LD    C,0                    ;CLEAR SUCCESS
0862   CB48             BIT   1,B                    ;TEST CASE
0864   2014             JR    NZ,CLIP6               ;JUMP IF SET
0866   CB40             BIT   0,B                    ;TEST CASE
0868   2006             JR    NZ,CLIP5               ;JUMP IF NOT SET
```

Listing 1 continued on page 242

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Listing 1 continued:

```
086A   FE0A              CP    10             ;TEST IF 10
086C   2820              JR    Z,CLIP8        ;JUMP IF EQUAL
086E   1822              JR    CLIP9          ;JUMP AROUND
0870   FE08      CLIP5:  CP    8              ;TEST IF 8
0872   281A              JR    Z,CLIP8        ;JUMP IF SO
0874   FE0B              CP    11             ;TEST IF 11
0876   2816              JR    Z,CLIP8        ;JUMP IF SO
0878   1818              JR    CLIP9          ;JUMP AROUND
087A   CB40      CLIP6:  BIT   0,B            ;TEST BIT 0
087C   200A              JR    NZ,CLIP7       ;JUMP IF SET
087E   FE02              CP    2              ;TEST IF 2
0880   280C              JR    Z,CLIP8        ;JUMP IF SO
0882   FE0E              CP    14             ;TEST IF 14
0884   2808              JR    Z,CLIP8        ;JUMP IF SO
0886   180A              JR    CLIP9          ;JUMP AROUND
0888   FE05      CLIP7:  CP    5              ;TEST IF 5
088A   2002              JR    NZ,CLIP8       ;JUMP IF NOT SO
088C   1804              JR    CLIP9          ;JUMP AROUND
088E   0E01      CLIP8:  LD    C,1            ;SET SUCCESS
0890   1802              JR    CLIP10         ;JUMP AROUND
0892   0E00      CLIP9:  LD    C,0            ;CLEAR SUCCESS
0894   D1        CLIP10: POP   DE             ;RESTORE D AND E
0895   E1                POP   HL             ;RESTORE H AND L
0896   FDE1              POP   IY             ;RESTORE IY
0898   F1                POP   AF             ;RESTORE AF
0899   C9                RET                  ;RETURN
                 ;
                 ; GETBLK *********************************************
                 ;
                 ; GETBLK READS B BYTES OF DATA AND PLACES THE DATA
                 ; STARTING AT HL.
                 ;
                 ; CALLS          FETCH
                 ;
                 ; CALLED BY      LCRAM
                 ;                LSUB
                 ;                LSYM
                 ;
                 ; REGISTERS      A        (DATA)
                 ;                B        (COUNT)
                 ;                H        (POINTER)
                 ;                L        (POINTER)
                 ;
                 ; I/O            NONE
                 ;
                 ; STRUCTURES     NONE
                 ;
089A   CDED01    GETBLK: CALL  FETCH          ;CALL FETCH
089D   77                LD    (HL),A         ;SAVE THE DATA
089E   23                INC   HL             ;INCREMENT THE POINTER
089F   05                DEC   B              ;DECREMENT THE COUNT
08A0   20F8              JR    NZ,GETBLK      ;JUMP IF NOT DONE
08A2   C9                RET                  ;RETURN
                 ;
                 ; GUSER **********************************************
                 ;
                 ; GUSER IS THE DEFAULT GRAPHICS SUBROUTINE WHICH IS
                 ; THE DUMMY CALL FORM THE PRIMITIVE CALL. GUSER SIMPL.
                 ; RETURNS.
                 ;
                 ; CALLS          NONE
                 ;
                 ; CALLED BY      CALLS
                 ;
                 ; REGISTERS      NONE
                 ;
                 ; I/O            NONE
                 ;
                 ; STRUCTURES     NONE
                 ;
08A3   80        GUSER:  DEFB  128            ;RETURN FROM GRAPHICS
                 ;
                 ; PEEK ***********************************************
                 ;
                 ; PEEK READS DATA FROM A PIXEL. PEEK FIRST SETS A READ
                 ; FLAG, CALLS PIXEL, THEN RETURNS. PEEK EXPECTS THE
                 ; PIXEL TO BE AT XY. THE COLOR IS RETURNED IN A.
                 ;
                 ; CALLS          PIXEL
                 ;
                 ; CALLED BY      RPIX
                 ;
                 ; REGISTERS      A        (COLOR RETURN)
                 ;                C        (READ FLAG)
                 ;
                 ; I/O            NONE
                 ;
                 ; STRUCTURES     NONE
                 ;
08A4   0E01      PEEK:   LD    C,1            ;SET READ FLAG
08A6   CDAA08            CALL  PIXEL          ;GET THE DATA
08A9   C9                RET                  ;RETURN
                 ;
                 ; PIXEL **********************************************
                 ;
                 ; PIXEL MAPS THE USER COORDINATE DATA TO THE PHYSICAL
                 ; SYSTEM. THIS IS PERHAPS THE MOST COMPLEX ROUTINE IN
                 ; THE FIRMWARE, AND IS THE ONLY ROUTINE THAT MUST
```

Listing 1 continued on page 244

DEALERS: By now you know that it takes . . . . .

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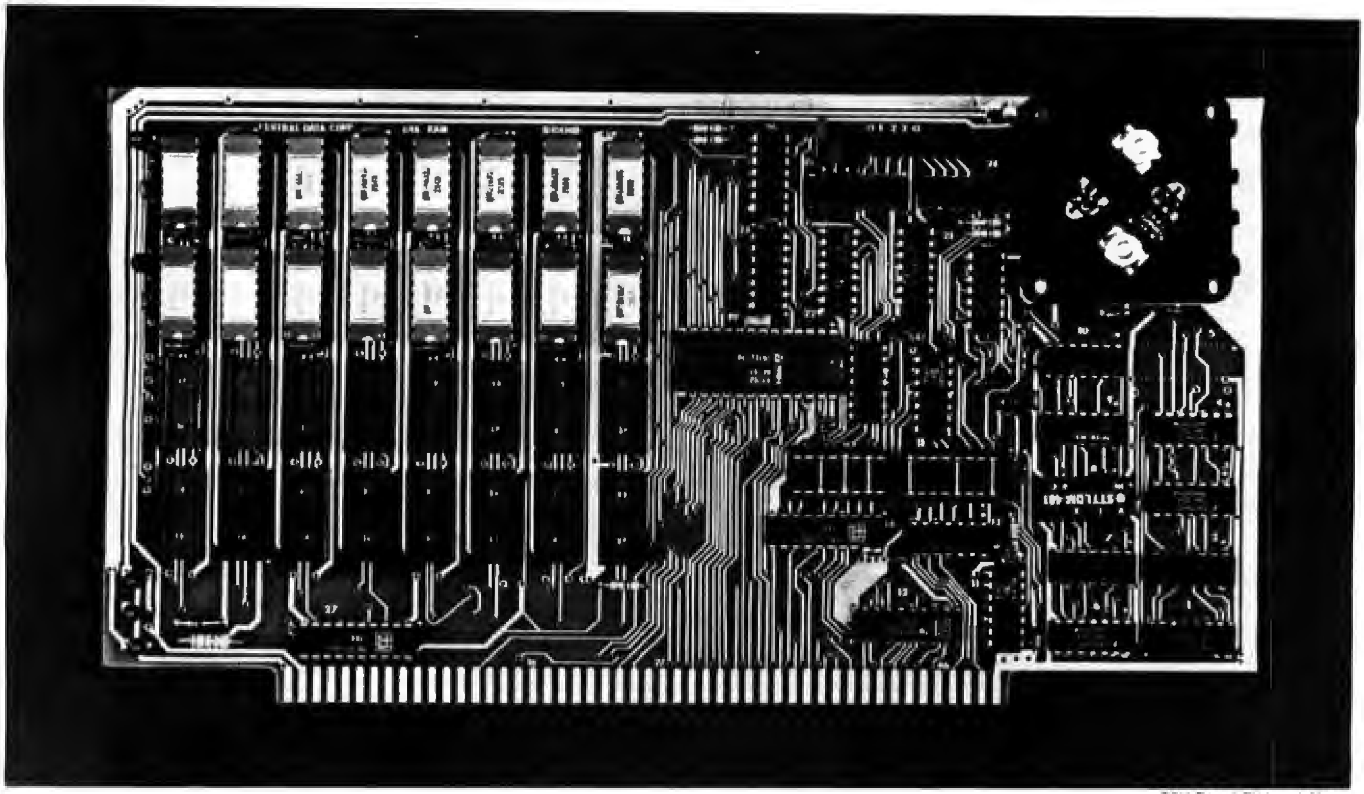
Circle 156 on inquiry card.

Listing 1 continued:

```
                 ; BE MODIFIED IF SYSTEM II IS USED. PIXEL FIRST
                 ; DETERMINES WHAT DISPLAY DENSITY IF USED, AND IF THE
                 ; OPERATION IS READ OR WRITE. THE PHYSICAL ADDRESS
                 ; OF THE PIXEL IS DETERMINED, THEN THE BIT ADDRESS IS
                 ; MAPPED OUT. PIXEL DEALS WITH THE PIXEL AT XY, THE
                 ; READ FLAG IN REGISTER C, AND EXPECTS/RETURNS THE
                 ; COLOR IN REGISTER A.
                 ;
                 ; CALLS          NONE
                 ;
                 ; CALLED BY      POKE
                 ;                PEEK
                 ;
                 ; REGISTERS      A       (COLOR,FLAGS)
                 ;                C       (FLAGS, TEMPORARY)
                 ;                D       (TEMPORARY)
                 ;                E       (TEMPORARY)
                 ;                H       (POINTER)
                 ;                L       (POINTER)
                 ;                IX      (INDEX)
                 ;                IY      (INDEX)
                 ;
                 ; I/O            NONE
                 ;
                 ; STRUCTURES     GDR0    (X)
                 ;                GDR1    (Y)
                 ;                GDR14   (DISPLAY FORMAT)
                 ;                REFRESH RAM
                 ;
08AA  FDE5       PIXEL:  PUSH IY                 ;SAVE IY
08AC  E5                 PUSH HL                 ;SAVE HL
08AD  D5                 PUSH DE                 ;SAVE DE
08AE  F5                 PUSH AF                 ;SAVE AF
08AF  DD7E0E             LD   A,(IX+GDR14)       ;GET DISPLAY FORMAT
08B2  E6E0               AND  11100000B          ;MASK ALL BUT TYPE
08B4  FE00               CP   0                  ;64 X 64 ?
08B6  280D               JR   Z,PIXEL0           ;JUMP IF SO
08B8  FEC0               CP   11000000B          ;128 X 128 ?
08BA  CA4209             JP   Z,PIXELA           ;JUMP IF SO
08BD  FEE0               CP   11100000B          ;256 X 192 ?
08BF  CA8709             JP   Z,PIXELC           ;JUMP Ts SO
08C2  C39C00             JP   XERR               ;ERROR OTHLRWISL
08C5  DD7E01     PIXEL0: LD   A,(IX+GDR1)        ;GET Y
08C8  2F                 CPI                     ;COMPLEMENT
08C9  67                 LD   H,A                ;LOAD H
08CA  CB3C               SRL  H                  ;SHIFT
08CC  CB3C               SRL  H                  ;SHIFT
08CE  DD6E00             LD   L,(IX+GDR0)        ;LOAD X
08D1  CB3C               SRL  H                  ;SHIFT
08D3  CB1D               RR   L                  ;SHIFT
08D5  CB3C               SRL  H                  ;SHIFT
08D7  CB1D               RR   L                  ;SHIFT
08D9  CB3C               SRL  H                  ;SHIFT
08DB  CB1D               RR   L                  ;SHIFT
08DD  CB3C               SRL  H                  ;SHIFT
08DF  CB1D               RR   L                  ;SHIFT
08E1  110020             LD   DE,RBOTTOM         ;LOAD BASE ADDRESS
08E4  19                 ADD  HL,DE              ;ADD OFFSET
08E5  DD7E00             LD   A,(IX+GDR0)        ;GET X
08E8  E60C               AND  00001100B          ;MASK ALL BUT 2 BITS
08EA  CB3F               SRL  A                  ;SHIFT
08EC  CB3F               SRL  A                  ;SHIFT
08EE  CB41               BIT  0,C                ;CHECK READ FLAG
08F0  281E               JR   Z,PIXEL3           ;JUMP IF NOT SET
08F2  4F                 LD   C,A                ;LOAD C
08F3  F1                 POP  AF                 ;RESTORE A
08F4  7E                 LD   A,(HL)             ;GET PIXEL
08F5  CB41               BIT  0,C                ;CHECK LSB
08F7  2804               JR   Z,PIXEL1           ;JUMP IF ZERO
08F9  CB27               SLA  A                  ;SHIFT A
08FB  CB27               SLA  A                  ;SHIFT A
08FD  CB49       PIXEL1: BIT  1,C                ;TEST NEXT BIT
08FF  2808               JR   Z,PIXEL2           ;JUMP IF ZERO
0901  CB27               SLA  A                  ;SHIFT
0903  CB27               SLA  A                  ;SHIFT
0905  CB27               SLA  A                  ;SHIFT
0907  CB27               SLA  A                  ;SHIFT
0909  E6C0       PIXEL2: AND  11000000B          ;MASK ALL ELSE
090B  D1                 POP  DE                 ;RESTORE DE
090C  E1                 POP  HL                 ;RESTORE HL
0900  FDE1               POP  IY                 ;RESTORE IY
090F  C9                 RET                     ;RETURN
0910  4F         PIXEL3: LD   C,A                ;SAVE DATA
0911  F1                 POP  AF                 ;RESTORE COLOR
0912  163F               LD   D,00111111B        ;LOAD A MASK
0914  E6C0               AND  11000000B          ;MASK COLOR
0916  CB41               BIT  0,C                ;TEST READ FLAG
0918  280A               JR   Z,PIXEL4           ;JUMP IF NOT SET
091A  CB3F               SRL  A                  ;SHIFT
091C  CB3F               SRL  A                  ;SHIFT
091E  F5                 PUSH AF                 ;SAVE AF
091F  7A                 LD   A,D                ;GET THE MASK
0920  0F                 RRCA                    ;ROTATE RIGHT
0921  0F                 RRCA                    ;ROTATE RIGHT
0922  57                 LD   D,A                ;RESTORE THE MASK
0923  F1                 POP  AF                 ;RESTONL AF
0924  CB49       PIXEL4: BIT  1,C                ;TEST LSB
```

Listing 1 continued on page 246



32K Board Pictured Above

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Central Data

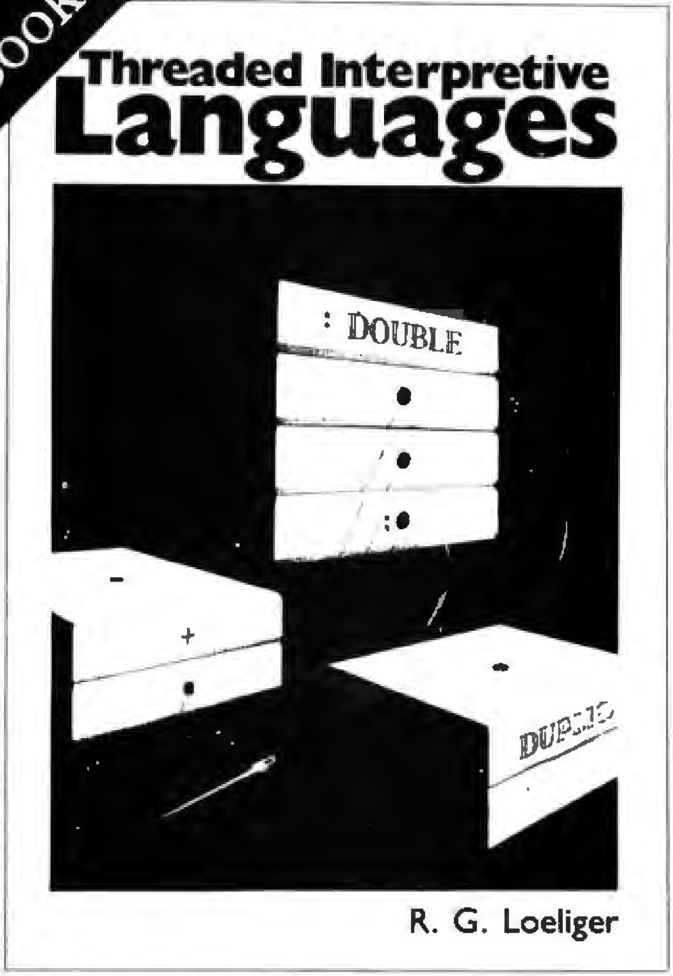
Circle 158 on inquiry card.

Listing 1 continued:

```
0926  2D10             JR    Z,PIXEL5         ;JUMP IF ZERO
0928  CB3F             SRL   A                ;SHIFT
092A  CB3F             SRL   A                ;SHIFT
092C  CB3F             SRL   A                ;SHIFT
092E  CB3F             SRL   A                ;SHIFT
0930  F5               PUSH  AF               ;SAVE AF
0931  7A               LD    A,D              ;GET THE MASK
0932  0F               RRCA                   ;ROTATE RIGHT
0933  0F               RRCA                   ;ROTATE RIGHT
0934  0F               RRCA                   ;ROTATE RIGHT
0935  0F               RRCA                   ;ROTATE RIGHT
0936  57               LD    D,A              ;GET THE MASK
0937  F1               POP   AF               ;RESTORE AF
0938  4F      PIXEL5:  LD    C,A              ;SAVE MASK
0939  7E               LD    A,(HL)           ;GET DATA
093A  A2               AND   D                ;MASK THE OLD
093B  B1               OR    C                ;AND DATA
093C  77               LD    (HL),A           ;SAVE PIXEL
093D  D1               POP   DE               ;RESTORE DE
093E  E1               POP   HL               ;RESTORE HL
093F  FDE1             POP   IY               ;RESTORE IY
0941  C9               RET                    ;RETURN
0942  DD7E01  PIXEL6:  LD    A,(IX+GDR1)      ;LOAD Y
0945  2F               CPL                    ;COMPLEMENT
0946  67               LD    H,A              ;LOAD H
0947  CB3C             SRL   H                ;SHIFT
0949  DD6E00           LD    L,(IX+GDR0)      ;LOAD X
094C  CB3C             SRL   H                ;SHIFT
094E  CB1D             RR    L                ;SHIFT
0950  CB3C             SRL   H                ;SHIFT
0952  CB1D             RR    L                ;SHIFT
0954  CB3C             SRL   H                ;SHIFT
0956  CB1D             RR    L                ;SHIFT
0958  110028           LD    DE,RBOTTOM+2048  ;LOAD BASE ADDRESS
095B  19               ADD   HL,DE            ;ADD OFFSET
095C  DD7E00           LD    A,(IX+GDR0)      ;GET X
095F  E606             AND   00000110B        ;MASK ALL BUT 2 BITS
0961  CB3F             SRL   A                ;SHIFT
0963  CB41             BIT   0,C              ;TEST LSB
0965  281E             JR    Z,PIXEL9         ;JUMP IF NOT SET
0967  4F               LD    C,A              ;SAVE A
0968  F1               POP   AF               ;RESTORE A
0969  7E               LD    A,(HL)           ;GET PIXEL DATA
096A  CB41             BIT   0,C              ;TEST NEXT BIT
096C  2804             JR    Z,PIXEL7         ;JUMP IF NOT SET
096E  CB27             SLA   A                ;SHIFT
0970  CB27             SLA   A                ;SHIFT
0972  CB49    PIXEL7:  BIT   1,C              ;TEST NEXT BIT
0974  2808             JR    Z,PIXEL8         ;JUMP IF NOT SET
0976  CB27             SLA   A                ;SHIFT
0978  CB27             SLA   A                ;SHIFT
097A  CB27             SLA   A                ;SHIFT
097C  CB27             SLA   A                ;SHIFT
097E  E6C0    PIXEL8:  AND   11000000B        ;AND ALL ELSE
0980  D1               POP   DE               ;RESTORE DE
0981  E1               POP   HL               ;RESTORE HL
0982  FDE1             POP   IY               ;RESTORE IY
0984  C9               RET                    ;RETURN
0985  4F      PIXEL9:  LD    C,A              ;RESTORE A
0986  F1               POP   AF               ;RESTORE STACK
0987  163F             LD    D,00111111B      ;GET THE MASK
0989  E6C0             AND   11000000B        ;MASK ALL ELSE
098B  CB41             BIT   0,C              ;CHECK LSB
098D  280A             JR    Z,PIXELA         ;JUMP IF ZERO
098F  CB3F             SRL   A                ;SHIFT
0991  CB3F             SRL   A                ;SHIFT
0993  F5               PUSH  AF               ;SAVE AF
0994  7A               LD    A,D              ;GET THE MASK
0995  0F               RRCA                   ;ROTATE RIGHT
0996  0F               RRCA                   ;ROTATE RIGHT
0997  57               LD    D,A              ;RESTORE THE MASK
0998  F1               POP   AF               ;RESTORE THE MASK
0999  CB49    PIXELA:  BIT   1,C              ;CHECK NEXT BIT
099B  2810             JR    Z,PIXELB         ;JUMP IF ZERO
099D  CB3F             SRL   A                ;SHIFT
099F  CB3F             SRL   A                ;SHIFT
09A1  CB3F             SRL   A                ;SHIFT
09A3  CB3F             SRL   A                ;SHIFT
09A5  F5               PUSH  AF               ;SAVE AF
09A6  7A               LD    A,D              ;GET THE MASK
09A7  0F               RRCA                   ;ROTATE RIGHT
09A8  0F               RRCA                   ;ROTATE RIGHT
09A9  0F               RRCA                   ;ROTATE RIGHT
09AA  0F               RRCA                   ;ROTATE RIGHT
09AB  57               LD    D,A              ;GET THE MASK
09AC  F1               POP   AF               ;RESTORE AF
09AD  4F      PIXELB:  LD    C,A              ;SAVE A
09AE  7E               LD    A,(HL)           ;GET PIXEL DATA
09AF  A2               AND   D                ;MASK THE OLD
09B0  B1               OR    C                ;OR WITH C
09B1  77               LD    (HL),A           ;SAVE PIXEL
09B2  D1               POP   DE               ;RESTORE DE
09B3  E1               POP   HL               ;RESTORE HL
09B4  FDE1             POP   IY               ;RESTORE IY
09B6  C9               RET                    ;RETURN
09B7  DD7E01  PIXELC:  LD    A,(IX+GDR1)      ;MOVE Y TO A
09BA  2F               CPL                    ;COMPLEMENT
```

Listing 1 continued on page 248

A New Book From BYTE Books



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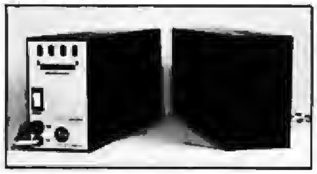
Listing 1 continued:

```
09BB   67                    LD    H,A              ;SAVE IN H
09BC   DD6E00                LD    L,(IX+BDRO)      ;GET X
09BF   CB3C                  SRL   H                ;SHIFT H
09C1   CB1D                  RR    L                ;SHIFT L
09C3   CB3C                  SRL   H                ;SHIFT H
09C5   CB1D                  RR    L                ;SHIFT L
09C7   CB3C                  SRL   H                ;SHIFT H
09C9   CB1D                  RR    L                ;SHIFT L
09CB   110018                LD    DE,RBOTTOM-2048  ;POINT TO BOTTOM
09CE   19                    ADD   HL,DE            ;ADD OFFSET
09CF   DD7E00                LD    A,(IX+BDRO)      ;GET X
09D2   E607                  AND   00000111B        ;MASK A
09D4   CB41                  BIT   0,C              ;TEST LSB
09D6   2824                  JR    Z,PIXELG         ;TEST FOR READ
09D8   4F                    LD    C,A              ;LOAD C
09D9   F1                    POP   AF               ;RESTORE A
09DA   7E                    LD    A,(HL)           ;GET PIXEL
09DB   CB41                  BIT   0,C              ;TEST LSB
09DD   2802                  JR    Z,PIXELD         ;JUMP AROUND SHIFT
09DF   CB27                  SLA   A                ;SHIFT A
09E1   CB49          PIXELD: BIT   1,C              ;TEST NEXT BIT
09E3   2804                  JR    Z,PIXELE         ;JUMP AROUND SHIFT
09E5   CB27                  SLA   A                ;SHIFT A
09E7   CB27                  SLA   A                ;SHIFT A
09E9   CB51          PIXELE: BIT   2,C              ;TEST NEXT BIT
09EB   2808                  JR    Z,PIXELF         ;JUMP AROUND SHIFT
09ED   CB27                  SLA   A                ;SHIFT A
09EF   CB27                  SLA   A                ;SHIFT A
09F1   CB27                  SLA   A                ;SHIFT A
09F3   CB27                  SLA   A                ;SHIFT A
09F5   E680          PIXELF: AND   10000000B        ;MASK ALL OTHERS
09F7   D1                    POP   DE               ;RESTORE DE
09F8   E1                    POP   HL               ;RESTORE HL
09F9   FDE1                  POP   IY               ;RESTORE IY
09FB   C9                    RET                    ;RETURN
09FC   4F            PIXELG: LD    C,A              ;SAVE DATA
09FD   F1                    POP   AF               ;GET COLOR
09FE   167F                  LD    D,01111111B      ;LOAD THE MASK
0A00   E680                  AND   10000000B        ;MASK ALL ELSE
0A02   CB41                  BIT   0,C              ;TEST LSB
0A04   2807                  JR    Z,PIXELH         ;JUMP AROUND SHIFT
0A06   CB3F                  SRL   A                ;SHIFT
0A08   F5                    PUSH  AF               ;SAVE AF
0A09   7A                    LD    A,D              ;GET THE MASK
0A0A   0F                    RRCA                   ;ROTATE RIGHT
0A0B   57                    LD    D,A              ;GET THE MASK
0A0C   F1                    POP   AF               ;RESTORE AF
0A0D   CB49          PIXELH: BIT   1,C              ;TEST NEXT BIT
0A0F   280A                  JR    Z,PIXELI         ;JUMP AROUND SHIFT
0A11   CB3F                  SRL   A                ;SHIFT
0A13   CB3F                  SRL   A                ;SHIFT
0A15   F5                    PUSH  AF               ;SAVE AF
0A16   7A                    LD    A,D              ;GET THE MASK
0A17   0F                    RRCA                   ;ROTATE RIGHT
0A18   0F                    RRCA                   ;ROTATE RIGHT
0A19   57                    LD    D,A              ;GET THE MASK
0A1A   F1                    POP   AF               ;RESTORE AF
0A1B   CB51          PIXELI: BIT   2,C              ;TEST NEXT BIT
0A1D   2810                  JR    Z,PIXELJ         ;JUMP AROUND SHIFT
0A1F   CB3F                  SRL   A                ;SHIFT
0A21   CB3F                  SRL   A                ;SHIFT
0A23   CB3F                  SRL   A                ;SHIFT
0A25   CB3F                  SRL   A                ;SHIFT
0A27   F5                    PUSH  AF               ;SAVE AF
0A28   7A                    LD    A,D              ;GET THE MASK
0A29   0F                    RRCA                   ;ROTATE RIGHT
0A2A   0F                    RRCA                   ;ROTATE RIGHT
0A2B   0F                    RRCA                   ;ROTATE RIGHT
0A2C   0F                    RRCA                   ;ROTATE RIGHT
0A2D   57                    LD    D,A              ;GET THE MASK
0A2E   F1                    POP   AF               ;RESTORE AF
0A2F   4F            PIXELJ: LD    C,A              ;SAVE A
0A30   7E                    LD    A,(HL)           ;GET PIXEL
0A31   A2                    AND   D                ;MASK THE OLD PART
0A32   B1                    OR    C                ;OR DATA
0A33   77                    LD    (HL),A           ;SAVE PIXEL
0A34   D1                    POP   DE               ;RESTORE DE
0A35   E1                    POP   HL               ;RESTORE HL
0A36   FDE1                  POP   IY               ;RESTORE IY
0A38   C9                    RET                    ;RETURN
                     ;
                     ; POKE ************************************************
                     ;
                     ; POKE WRITES DATA TO THE PIXEL AT XY. POKE SETS A
                     ; WRITE FLAG THEN CALLS PIXEL. THE COLOR DATA IS
                     ; EXPECTED IN REGISTER A.
                     ;
                     ; CALLS          PIXEL
                     ;
                     ; CALLED BY      LPIX
                     ;                PUT
                     ;
                     ;
                     ; REGISTERS      C        (WRITE FLAG)
                     ;
                     ; I/O            NONE
                     ;
```

Listing 1 continued on page 250

SIRIUS 80+

High Performance Low Cost Floppy Add-Ons!



The SIRIUS SYSTEMS 80+ Series of Floppy Disk add-ons are designed to provide unmatched versatility and performance for your TRS-80*. Consisting of four different add-ons, there is a 80+ Series Floppy Disk Drive to meet your needs.

COMMON CHARACTERISTICS

- *5ms track-to-track access time*
- *Auto-Eject*
- *180 day WARRANTY*
- *Exceptional speed stability - 11/2%*
- *Single/Double Density operation*
- *Mix any or all 80+ Series on the SS Standard cable*

SPECIFIC CHARACTERISTICS

The **SIRIUS 80+1** -a single sided, 40 track Drive. Offering 5 more tracks than the Radio Shack model, it cost $120 less. Formatted data storage is 102K/204K Bytes Single/Double Density.

SIRIUS 80+1 .... **$379.95**

The **SIRIUS 80+2** is a dual sided, 80 track (40 per side) Disk Drive. It appears to the TRS-80* as TWO 40 track drives yet **COST LESS THAN HALF THE PRICE!** Even greater savings result since data is recorded on both sides of the media instead of only a single side. This unit may require the SS Standard cable. Formatted data storage is 204K/408K Bytes Single/Double Density.

SIRIUS 80+2 .... **$449.95**

The **SIRIUS 80+3** - a single sided, 80 track Drive. Offering 2½ times the storage of a standard Radio Shack Disk Drive, the 80+3 greatly reduces the need for diskettes correspondingly. Additionally, because of the increased storage and faster track-to-track access time, the 80+3 allows tremendously increased throughput for disk based programs! The 80+3 includes SIRIUS's TRAKS-PATCH on diskette (for use with 96 tpi drives). Formatted data storage is 204K/408K Bytes Single/Double Density.

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The **SIRIUS 80+4** -a dual sided, 160 track (80 per side) 5¼" monster! The ultimate in state-of-the-art 5¼" Floppy Disk Technology, the 80+4 is seen by the TRS-80* as two single sided disk drives. Thus, in terms of capacity, one 80+4 is equivalent to 4⅓ standard Radio Shack drives — at a savings of over 73% (not to mention diskettes!!!). (With a double density converter the available memory is huge!) The 80+4 (a 96 tpi drive) includes TRAKS-PATCH on diskette and may require the SS Standard cable. Formatted storage is 408K/816K Bytes Single/Double Density.

SIRIUS 80+4 .... **$649.95**

All 80+ Series Floppy Disk add-ons operate at 5ms track-to-track but are Expansion Interface limited to 12ms for the TRS-80*

**TRS-80© of Tandy Corp.*

ACCESSORIES

SS Standard 2 Drive Cable **$29.95**
NEWDOS/80-Sophisticated Operating System for the TRS-80* from Apparat **$149.95**

Save up to 10% *with these SIRIUS Packages!*

NEWDOS/80, SIRIUS 80+3, and Two Drive Cable **$624.95**
NEWDOS/80, SIRIUS 80+4, and Two Drive Cable **$749.95**
NEWDOS/80, Two (2) SIRIUS 80+3's, Two Drive Cable **$1080.95**
NEWDOS/80, Two (2) SIRIUS 80+4's, Two Drive Cable **$1349.95**

Introducing the Versatile, Low-Cost OMEGA Series Controller

As new technological advances bring down the cost of fast, reliable mass data storage, the need for an inexpensive, versatile controller have become greater and greater. To meet this need, SIRIUS SYSTEMS' OMEGA Series Controller was designed.

The SIRIUS OMEGA Series Controller Module utilizes an **on-board microprocessor** to mediate data transfer to a wide variety of peripherals from an equally wide variety of host computer systems. Up to four Winchester Hard Disks (8" or 14"), four 5¼" Floppy Disks Drives and/or up to eight 8" Floppy Disk Drives may be **in use at one time.** Host systems interfacing is accomplished via a parallel or a serial interface. With the additon of a Personality module, the OMEGA Series Controller Module is directly **compatible with many popular computer systems** (among them the TRS-80*, Apple, Heath, and others). Provision is made for the addition of a streaming tape drive, also.

SPECIFIC HARDWARE FEATURES INCLUDE:

- *Control of up to twelve Floppy Disk Drives (eight 8" and/or four 5¼")*
  - *8" and/or 5¼" Disk Drive Utilization*
  - *Single (FM) or Double (MFM) density data storage*
  - *Hard or Soft sectored diskette usage*
  - *Utilization of "Quad" density (96 tpi) 8" or 5¼" Disk Drives*
- *Control of up to four WINCHESTER type PRIAM DISKOS Disk Drives*
  - *8" or 14" may intermix on the same cable*
  - *Accommodates 8" and/or 14" drives of 5.3Mbytes to 154Mbytes*
  - *Ultra-Fast data transfers*
- *Extremely flexible host-controller interfacing*

SPECIFIC SOFTWARE FEATURES INCLUDE:

- Dynamic format modifications via command words
- Extremely flexible format acceptance for unusual data storage formats
- Easily interfaces to standard operating systems (TRS-DOS*, CP/M®, etc)
- Operates in either get/put sector mode or data string mode
- Performance parameters may be changed by EPROM replacement or Dynaminic Reprogramming

CP/M® of Digital Research

Dedicated systems cards are also available on a limited basis for the STD-BUS and the S 100. These cards feature shared memory also (again, software selectable) in addition to the regular OMEGA Series Controller Module features. Consult SIRIUS SYTEMS for current price and availability for the entire line of OMEGA Series Memory Units and Controllers. **Dealer inquiries are invited.**

What TFORTH is - and what it has to offer YOU!

TFORTH is a unique growth programming language for the TRS-80® that combines the best features of an interpreter and a compiler all in one functional easy-to-use package. TFORTH cannot be simply compared with Fortran, BASIC or PASCAL. This high speed, high level modular code offers the speed found in many FORTRAN compliers yet retains the on-line conviences found in BASIC INTERPRETERS by flagging input errors as they occur line-by-line. Unlike PASCAL, TFORTH needs no "run-time" package for support. Serving as an operating system, compiler, assembler, interpreter, virtual memory manager, all in one: TFORTH makes easy, efficient- structured re-entrant programs a natural consequence.

The key to TFORTH's flexibility and ease of use lies in its use of a stack for parameters and a unique dictionary for WORDS. These WORDS are stated in terms of other WORDS already defined in the dictionary. It is this rich set of WORDS that provides DO LOOPS, IF-THEN-ELSE statements, BEGIN-END statements, virtual memory, any number base (to base 32) for input or output, a macro assembler, re-entrant code, multithread dictionary, line editor, excellent math package (16 bit integers, double precision floating point, SIN, COS, TAN, EXP and LOG) and it runs under either TRSDOS* or NEWDOS. Assembler inherently nests with high level in an easy fashion. Complicated drivers for new devices take only a few lines of TFORTH which saves both memory and disk space!

TFORTH is a procedural language specifing a process rather than a desired result. The ability to have the language grow in the direction the user desires is excellent for novel applications. New data types and new processes can become part of the language. Due to the modular constructions, a very compact code is produced which executes at exceptionally high speeds between machine code and machine code plus 20% typical overhead speeds. Memory requirements can be "less" than assembler coding or other high level languages.

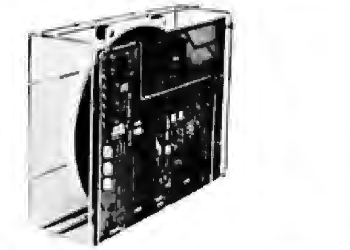
TFORTH comes complete for the TRS-80® with as little as 16K of memory and a single Disk Drive using either TRS-DOS® or NEWDOS. It provided on diskettes and an optional Math and Utilities package is available.

Through TFORTH an excellent way to develop new languages, provide simple control of device (including video monitors, A/D and D/A converters and burglar alarms) and to implement tasks requiring monitoring and decision is offered. Many WORDS to handle peripherals are part of basic TFORTH and others may be added easily. Often, substantial hardware development can be eliminated by using TFORTH to do the major digital or reduction of data.

For many applications a minimal task may be written in high level (or mixture of assembler and high level) code: loaded, assembled and prior to execution may be written to the disk as a ready to execute machine code/EXE module with the DOS.

TFORTH (on diskette - specify for Standard or 96 tpi Disk Drives) **$129.95**
TFORTH with the addition of TRAKS-PATCH (a powerful combination!) **$136.95**

PRIAM Hard Disks Now Available from SIRIUS SYSTEMS!



PRIAM's high-performance, low-cost Winchester disc drives speed up throughput and expand data storage from 20 megabytes to 154 megabytes. And a single controller can be used to operate 14-inch-disc drives with capacities of 33, 66, or 154 megabytes or floppy-disc-size drives holding 20 and 34 megabytes. So it's easy to move up in capacity, or reduce package size, without changing important system elements or performance.

- *Fast, Linear Voice Coil Positioning*
- *10 ms track-to-track positioning*
- *Fully servoed head positioning*
- *Dedicated servo tracks*
- *DC Power required only!*
- *Simple, parallel Interface*
- *Optional SMD Interface*
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- *90 ms Maximum Positioning Time*
- *6.4 ms Average Latency*

THE PRIAM LINEUP

Model/Disc Size	Capacity	Size	Weight	Price
DISKOS 3350 (14")	33Mbytes	7" × 17" × 20"	33 lbs	$2995
DISKOS 6650 (14")	66 Mbytes	7" × 17" × 20"	33 lbs.	$3749
DISKOS 15450 (14")	154 Mbytes	7" × 17" × 20"	33 lbs.	$4695
DISKOS 2050 (8")	20 Mbytes	4.62" × 8.55" × 14.25"	20 lbs	$2995
DISKOS 3450 (8")	34 Mbytes	4.62" × 8.55" × 14.25"	20 lbs.	$3745
DISKOS 1070	10.6 Mbytes	floppy-size	(low)	$2195

All PRIAM DISKOS Drives have a Transfer Rate of 1.03 Mbytes/Sec.
Optional SMD interface available for $150.

SIRIUS SYTEMS offer cases and enclosures for all PRIAM Hard Disk Drives. All 14" Winchester Drives will mount in our 14" Standard Case. The 8" Winchesters have two alternatives: a single drive case and a dual drive case. All SIRIUS SYSTEMS Winchester drive cases include Power Supply, internal cabling, switches, fan, extra AC outlet (not switched, but fused) and possess very adequate ventilation. Drive addressing is done on the rear of the Case and not on the drive itself to provide ease of use during operation. All WINCHESTER DRIVE Cases are Warranted for a full year and come in our standard blue-black color scheme. Consult us for current availability and pricing.

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8" Disk Drive
DOUBLE SIDED!
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High performance Double Sided Disk 8" Disk Drive ■ Single or Double Density ■ Door Lock and Write Protect INCLUDED! ■ Negative DC Voltage not required ■ Low Power Operation

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QUME DataTrak 8 .... **$574.95** (2/$549 ea)
QUME Technical Manual **$6.95**
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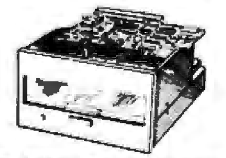
MPI 51/52 & 91/92 5¼" Disk Drives



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MPI 91 (Single Head/80 tracks)
250K/500K Bytes Single/Double Density** **$399.95**

MPI 92 (Dual Head/160 tracks (80/side))
500K/1000K Bytes Single/Double Density** **$524.95**

MPI Technical Manual **$6.95**
**Unformatted data storage

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We accept **MC, VISA, AE, COD** (requires Certified Check, Cashier's Check or Cash) and **Checks** (personal checks require 14 days to clear). **SHIPPING AND HANDLING:** $7.00 per Floppy Disk Drive or 80+ Module ■ 5% for other items (any excess will be refunded) ■ **Foreign Orders** add 10% for Shipping & Handling. Payment in U.S. currency ■ Tennessee residents add 6% Sales Tax ■ **VOLUME DISCOUNTS AVAILABLE**

SIRIUS SYSTEMS
7528 Oak Ridge Highway
Knoxville, Tennessee 37921

Circle 161 on inquiry card.

Circle 162 on inquiry card.

Announcing the most important utility ever introduced for the TRS-80* Model I and Model II—

ENHBAS™

ENHBAS is an Enhanced Basic extension module, which loads at the top of BASIC, adding many commands and background tasks—

☐Over **30** new commands added to your BASIC:

- •**SORT**-Multi-keying, multi-tagging array sort. Sorts thousands of items in mere seconds, all with *one* command!
- •**JNAME**-Use line *labels* along with line numbers in branching statements, as in assembly language, using the ENHBAS commands **GTO** and **CSUB** (special GOTO and GOSUB). How many times have you wanted to use variables to reference line numbers? Now you can! GTO and CSUB allow variable expressions as operands, such as in **GTO X+40**.
- •**WHILE / WEND**-New, structured programming loop construct. Makes for more logical program flow (less GOTO's).
- •**EXEC / EVAL**-Two new, extremely powerful functions! **EVAL** evaluates an algebraic expression in string form. With EVAL you can manipulate complex functions in string form, and then evaluate them. **EXEC** executes a string expression *as if it were a BASIC program line!* With EXEC, your computer can actually write its own programs and execute them!
- •**CALL**-Pass control to machine language subroutines at *any* address, passing parameters *both* ways.
- •**CLM / PAGE**-Set up automatic page roll-over and other line printer functions from BASIC.
- ***•All these and many more!***

☐In addition to the above commands, Model I ENHBAS contains *vector graphics* and drawing commands. Model II ENHBAS has many functions suited to business programming—ISAM file handling commands, RS-232 access, and many more; along with several Model I BASIC commands left out of Model II (PEEK, POKE, OUT, etc.).

☐ENHBAS includes many background utilities (Model I version):

- ***•User-definable cursor***
- ***•Key click***
- ***•Two-tone beep on error***
- ***•Automatic lower-case***
- ***•Automatic debounce***
- ***•Short-entry commands (Shift-letter prints command)***
- ***•Real Control keys***
- ***•One letter commands***
- ***•Formatted LISTings***

ENHBAS is available for:

16K Model I—Level-II Tape	$39.95
32K Model I Disk	$39.95
32K Model III *(avail. 11/1/80)*	$39.95
32K Model II (on TRSDOS disk)	$99.95

**TRS-80* is a reg. trademark of Radio Shack, a Tandy Co.

Other software:

CSG PILOT-Disk-based, high level language.
32K Model I Disk **$59.95**

Z-EMULATOR-Executes assem. lang. lines.
16K Model I—Level-II Tape **$29.95**
32K Model I Disk **$29.95**

ENHCOMP-Integer subset BASIC compiler. Full graphics. Requires RS Editor/Assembler.
32K Model I Disk **$24.95**

ABBREV-Level-I abbrev. in Level-II/Disk.
16K Model I—Level-II Tape **$24.95**
32K Model I Disk **$24.95**

Dealer and OEM inquiries invited.

The Cornsoft Group

6008 N. Keystone Ave., Dept. B
Indianapolis, IN 46220
(317) 257-3227

Listing 1 continued:

```
                ; STRUCTURES    NONE
                ;
0A39    0E00    POKE:   LD   C,0                  ;SET WRITE FLAG
0A3B    CDAA08          CALL PIXEL                ;WRITE THE PIXEL
0A3E    C9              RET                       ;RETURN
                ;
                ; PLOT *********************************************
                ;
                ; PLOT PLOTS A POINT AT XY AND AT A LARGER WIDTH IF
                ; NECESSARY. PLOT FIRST PUTS THE BASIC POINT AT XY
                ; AND IF A LARGER WIDTH IS SPECIFIED, AROUND THE POINT.
                ;
                ; CALLS         PUT
                ;
                ; CALLED BY     VEC
                ;
                ; REGISTERS     IX      (INDEX REGISTER)
                ;
                ; I/O           NONE
                ;
                ; STRUCTURES    GDR0    (X)
                ;               GDR1    (Y)
                ;               GDR5    (VECTOR MODE)
                ;
0A3F    CD7E0A    PLOT:   CALL PUT                ;PUT TO BASIC POINT
0A42    DDCB057E          BIT  7,(IX+GDR5)        ;TEST WIDTH
0A46    C8                RET  Z                  ;RETURN IF NOT SET
0A47    DD3400            INC  (IX+GDR0)          ;INCREMENT X
0A4A    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A4D    DD3401            INC  (IX+GDR1)          ;INCREMENT Y
0A50    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A53    DD3500            DEC  (IX+GDR0)          ;DECREMENT X
0A56    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A59    DD3500            DEC  (IX+GDR0)          ;DECREMENT X
0A5C    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A5F    DD3501            DEC  (IX+GDR1)          ;DECREMENT Y
0A62    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A65    DD3501            DEC  (IX+GDR1)          ;DECREMENT Y
0A68    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A6B    DD3400            INC  (IX+GDR0)          ;INCREMENT X
0A6E    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A71    DD3400            INC  (IX+GDR0)          ;INCREMENT Y
0A74    CD7E0A            CALL PUT                ;PUT THE NEXT POINT
0A77    DD3500            DEC  (IX+GDR0)          ;RESTORE X
0A7A    DD3401            INC  (IX+GDR1)          ;RESTORE Y
0A7D    C9                RET                     ;RETURN
                ;
                ; PUT **********************************************
                ;
                ; PUT PUTS A POINT AT XY IF IT IS NOT CLIPPED. PUT
                ; FIRST CALLS CLIP THEN PLOTS THE POINT IF IS NOT
                ; CLIPPED.
                ;
                ; CALLS         CLIP
                ;               POKE
                ;
                ; CALLED BY     PLOT, MOV, SYM
                ;
                ; REGISTERS     NONE
                ;
                ; I/O           NONE
                ;
                ; STRUCTURES    NONE
                ;
0A7E    CDEF07    PUT:    CALL CLIP               ;TEST FOR CLIP
0A81    CB41              BIT  0,C                ;CHECK SUCCESS
0A83    C8                RET  Z                  ;RETURN IF CLIPPED
0A84    CD390A            CALL POKE               ;PUT POINT
0A87    C9                RET                     ;RETURN
                ;
                ; SENDBK *******************************************
                ;
                ; SENDBK OUTPUTS B BYTES OF DATA STARTING AT HL.
                ; SENDBK FIRST GETS THE DATA, INCREMENTS THE POINTER,
                ; THEN CONTINUES THE LOOP UNTIL B IS ZERO.
                ;
                ; CALLS         SENDBY
                ;
                ; CALLED BY     RCRAM
                ;               RSUB
                ;               RSYM
                ;
                ; REGISTERS     A       (DATA)
                ;               B       (BYTE COUNT)
                ;               H       (POINTER)
                ;               L       (POINTER)
                ;
                ; I/O           NONE
                ;
                ; STRUCTURES    NONE
                ;
0A88    7E        SENDBK: LD   A,(HL)             ;GET THE DATA
0A89    23                INC  HL                 ;INCREMENT THE POINTER
0A8A    CD910A            CALL SENDBY             ;SEND THE DATA
0A8D    05                DEC  B                  ;DECREMENT COUNT
0A8E    20F8              JR   NZ,SENDBK          ;CONTINUE IF NON ZERO
0A90    C9                RET                     ;RETURN
```

Listing 1 continued on page 252

Circle 163 on inquiry card. ⟶

ANALOG INTERFACES

Industrial, Scientific, Laboratory, or Commercial Microcomputer Users-

Industrial quality data conversion boards for APPLE, S-100, PET, TRS-80, AIM, and KIM systems. Tecmar can provide individual boards, data conversion subsystems, or complete Data Conversion Systems. Tecmar's growing product line offers outstanding features, meticulous engineering, exceptional documentation, and a seven year record of proven reliability.

TRS-80 **TRS-80**

Tecmar's new Analog to Digital converter Board (AD200) is designed to meet sophisticated data acquisition needs. The board accommodates various precision A/D modules by Analogic and Data Translation. These modules are easily interchanged to provide options such as 12, 14, or 16 bit accuracy; 125 KHz throughput; variable ranges and gains.

AD200XX	S-100 A/D and Timer Board	$695
AD200AP	Apple A/D Board	$495

AD-200 Features

- 12 bit accuracy and resolution standard
- 30 KHz conversion rate standard
- Jumper selectable for 16 single-ended or 8 differential inputs
- External trigger of A/D
- Output formats: Two's complement, binary, offset binary
- Auto channel incrementing from any channel to any channel
- Data is latched providing pipelining for higher throughputs
- Provision for synchronizing A/Ds
- Utilizes interrupt for status test
- Jumper selectable input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V

In addition the S-100 version:

- Complies with IEEE S-100 specifications
- Transfers data in 8 or 16 bit words
- Provides for expansion to 256 channels
- Is switch selectable I/0 or memory mapped

Timer Features on S-100 Board

In addition to the A/D features, the S-100 Board contains a powerful timer circuit which can start A/D conversion and can also be used independently for time of day, event counting, frequency shift keying and many other applications.

- 5 independent 16 bit counters (cascadable)
- 15 lines available for external use
- Time of day
- Event counter
- Alarm comparators on 2 counters
- One shot or continuous frequency outputs
- Complex duty cycle and frequency shift keying outputs
- Programmable gating and count source selection
- Utilizes vectored interrupt

Options for AD-200

• Programmable gain up to 500	$ 175
• 14 bit accuracy	645
• 16 bit accuracy	1,045
• 100 KHz conversion rate	445
• 125 KHz conversion rate	545
• Screw Terminal and Signal Conditioning panel	250
• Thermocouple cold junction compensation	125
• Rack mounting assembly with plexiglass cover	125
• Low level, wide range permitting low level sensors such as thermocouples, pressure sensors and strain gauges to be directly connected to the module input	65

Apple D/A Features $295

- 12 bit accuracy and resolution
- 2 independent digital to analog converters
- 8 parallel latched output lines
- Jumper selectable output ranges: ±10V, ±5V, ±2.5V, 0 to +10V, 0 to +5V
- 3 microsecond conversion time
- Minimal software required

S-100 PET TRS-80 AIM KIM

The original Tecmar data conversion boards (AD-100 and DA-100) continue to solve less sophisticated conversion problems. These S-100 boards interface to the PET, TRS-80, AIM, and KIM through standard S-100 expansion interfaces.

AD-100 Features

- 12 bit accuracy and resolution
- 30 KHz conversion rate
- 16 single-ended or 8 differential inputs (specify AD100S or AD100D)
- Jumper selectable I/0 or memory mapped operation for S-100 systems
- Jumper selectable input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V
- Minimal software required
- Complies with IEEE S-100 specifications.

DA-100 Features

- 12 bit accuracy and resolution
- 4 independent digital to analog converters
- 3 microsecond settling time
- Jumper selectable output ranges: ±10V, ±5V, ±2.5V, 0 to +10V, 0 to 5V
- Jumper selectable I/O or memory mapped operation for S-100 systems
- Minimal software required
- Complies with IEEE S-100 specifications

Expansion board, power supply, and enclosure for PET	$250
Expansion board and power supply for TRS-80, KIM, or AIM	150

S-100 Real Time Video Digitizer

- Digitizes and Displays in 1/60 sec. flicker-free
- 16 Gray Levels
- Switch Selectable to display Black and White Graphics (8 pixels/byte)
- Maximum Resolution: 512 pixels/line x 240 lines
- Minimal software requirements $850

S-100 BOARDS

8086 CPU W/vectored interrupts	$450
RAM 8Kx16/16Kx8	$395
8086 PROM-I/O	$495
Serial and Parallel I/O	$350
Parallel I/O & Timer	$350

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[2]Reg. Trademark of Commodore

TECMAR INC.

Data Acquisition Systems and Video Microcomputer Systems Available

23414 Greenlawn • Cleveland, OH 44122

TECMAR, INC.
(216) 382-7599

Listing 1 continued:

```
                       2439  ;
                       2440  ; SENDBY ****************************************************
                       2441  ;
                       2442  ; SENDBY OUTPUTS ONE BYTE OF DATA. SENDBY WAITS UNTIL
                       2443  ; THE OUTPUT IS CLEAR TO SEND, THEN OUTPUTS THE DATA
                       2444  ; CURRENTLY IN A. THE OUTPUT INTERRUPT STATUS IS
                       2445  ; SET AGAIN.
                       2446  ;
                       2447  ; CALLS          NONE
                       2448  ;
                       2449  ; CALLED BY      RREG
                       2450  ;                SENDBK
                       2451  ;                XERR, RPIX, RCRAM
                       2452  ;
                       2453  ; REGISTERS      A        (DATA)
                       2454  ;
                       2455  ; I/O            PORT 2   (STATUS)
                       2456  ;                PORT 6   (OUTPUT)
                       2457  ;
                       2458  ; STRUCTURES     NONE
                       2459  ;
0A91    DDCB0F5E       2460  SENDBY: BIT  3,(IX+GDR15)       ;TEST OUTPUT INTERRUPT
0A95    20FA           2461          JR   NZ,SENDBY          ;JUMP IF STILL SET
0A97    D306           2462          OUT   (6),A             ;SEND THE DATA
0A99    F3             2463          DI                      ;DISABLE INTERRUPTS
0A9A    DDCB0FDE       2464          SET  3,(IX+GDR15)       ;SET THE OUTPUT FLAG
0A9E    DD7E0F         2465          LD   A,(IX+GDR15)       ;GET THE STATUS
0AA1    D302           2466          OUT  (2),A              ;SEND THE STATUS
0AA3    FB             2467          EI                      ;ENABLE INTERRUPTS
0AA4    C9             2468          RET                     ;RETURN
                       2469  ;
                       2470  ; USER *******************************************************
                       2471  ;
                       2472  ; USER IS A DUMMY ROUTINE WHICH IS THE DEFAULT CALL
                       2473  ; FROM CALLS. USER SIMPLY RETURNS FROM A
                       2474  ; SUBROUTINE.
                       2475  ;
                       2476  ; CALLS          NONE
                       2477  ;
                       2478  ; CALLED BY      CALLS
                       2479  ;
                       2480  ; REGISTERS      NONE
                       2481  ;
                       2482  ; I/O            NONE
                       2483  ;
                       2484  ; STRUCTURES     NONE
                       2485  ;
0AA5    C9             2486  USER:   RET                          ;RETURN
                       2487  ;
                       2488  ; END OF MICROGRAPH *****************************************
                       2489  ;
                       2490          END
```

```
CROSS REFERENCE
SYMBOL   VAL  M DEFN REFS
CALLS    026F    718  123
CALLS1   0287    729  719
CASE     07A0   1826  872 1084 1324 1497 1 '09
CASE0    07B3   1838 1832
CASE1    07C1   1842 1840
CASE2    07D5   1851 1849
CASE3    07E9   1860 1858
CLIP     07EF   1897  908 1329 2406
CLIP0    0808   1909 1907
CLIP1    0821   1919 1916 1917
CLIP10   0894   1974 1972
CLIP2    0835   1928 1926
CLIP3    0848   1938 1935 1936
CLIP4    085F   1947 1945
CLIP5    0870   1956 1952
CLIP6    087A   1961 1950
CLIP7    0888   1968 1962
CLIP8    088E   1971 1954 1957 1959 1964 1966 1969
CLIP9    0892   1973 1955 1960 1967 1970
COLOR    0049    212 1660 1710
CONST    0068    117
CR0      1C00    218  779  788  798  821 1188 1197 1207 1230
CR1      1C10    219
CR2      1C20    220
DEFIN    008E    145
ECOLOR   004D     99  212
EGDR     0004     39  152
EGDR0    0004     40  153
EGDR1    0005     41  154
EGDR10   000E     50  163
EGDR11   000F     51  164
EGDR12   0010     52  165
EGDR13   0011     53  166
EGDR14   0012     54  167
EGDR15   0013     55  168
EGDR2    0006     42  155
EGDR3    0007     43  156
EGDR4    0008     44  157
EGDR5    0009     45  158
EGDR6    000A     46  159
EGDR7    000B     47  160
EGDR8    000C     48  161
```

Listing 1 continued on page 254

ALL THESE FEATURES... IN THIS SMALL SPACE... AT THIS LOW PRICE!

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Listing 1 continued:

```
EGDR9  000D      49  162
EGPC   0046      92  205
EL00   0014      57  170
EL01   0016      58  171
EL02   0018      59  172
EL03   001A      60  173
EL04   001C      61  174
EL05   001E      62  175
EL06   0020      63  176
EL07   0022      64  177
EL10   0024      65  178
EL11   0026      66  179
EL12   0028      67  180
EL13   002A      68  181
EL14   002C      69  182
EL15   002E      70  183
EL16   0030      71  184
EL17   0032      72  185
EM     0048      94  207
EMM    0049      95  208
EMN    004A      96  209
ENULL  0050     101  214  512
ENEF   0047      93  206
ES00   0034      74  187
ES01   0035      75  188
ES02   0036      76  189
ES03   0037      77  190
ES04   0038      78  191
ES05   0039      79  192
ES06   003A      80  193
ES07   003B      81  194
ES10   003C      82  195
ES11   003D      83  196
ES12   003E      84  197
ES13   003F      85  198
ES14   0040      86  199
ES15   0041      87  200
ES16   0042      88  201
ES17   0043      89  202
ESLINK 0014      56  169
ESLONG 0034      73  186
ESOFF  0045      91  204
ESPTR  0044      90  203
ESTRUC 0004      38  151  510  512
ESX    004B      97  210
ESY    004C      98  211
EXEC   023D     631  249
EXERRT 004E     100  213
FETCH  01E0     574  248  794  804  806  808  817  887  905  946  983
                     989  992 1031 1087 1130 1139 1203 1226 1435 1514
                    1601 1644 1653 1784 2000
FETCH0 01FC     579  580
FETCH1 020B     585  578
FETCH2 0230     603  584
FRAME  0146     386  119
FREE   10CD     215  508
GDR    0000     152  944 1363
GDR0   0000     153  893  912 1085 1141 1325 1334 1500 1502 1504 1506
                    1527 1531 1540 1542 1555 1599 1666 1753 1755 1912
                    1922 2098 2109 2174 2183 2246 2255 2369 2373 2375
                    2381 2383 2385
GDR1   0001     154  894  914 1086 1142 1326 1336 1499 1503 1511 1513
                    1543 1600 1680 1756 1758 1931 1941 2093 2170 2243
                    2371 2377 2379 2386
GDR10  000A     163 1841 1908
GDR11  000B     164
GDR12  000C     165
GDR13  000D     166
GDR14  000E     167  393  526  948 2084
GDR15  000F     168  285  286  287  289  292  294  340  344  345  347
                     351  352  388  389  395  396  421  422  448  449
                     519  520  574  575  579  583  604  605  632  633
                     637  638 2460 2464 2465
GDR2   0002     155  885  902 1146 1553 1657
GDR3   0003     156  883  900 1149 1550 1659
GDR4   0004     157  391 1788 1789
GDR5   0005     158 1082 1495 1597 2367
GDR6   0006     159 1838 1905
GDR7   0007     160
GDR9   0009     162
GETBLK 089A    2000  780  790  823  995 1027 1044 2004
GPC    0042     205  730  742  743 1262 1263 1273
GR08   0008     161
GSTACK 107F     149  150  729 1265
GUSER  0BA3    2023   65   66   67   68   69   70   71   72
INIT   0184     484  247
INPUT  0168     419  120
INT0   0068     119  490
INT1   006A     120  492
INT2   006C     121  494
IVECT  0068     118
L00    0010     170
L01    0012     171
L02    0014     172
L03    0016     173
L04    0018     174
L05    001A     175
L06    001C     176
```

Listing 1 continued on page 258

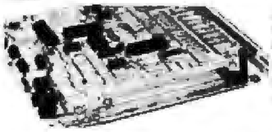
Start learning and computing for only $129.95 with a Netronics 8085-based computer kit. Then expand it in low-cost steps to a business/development system with 64k or more RAM, 8" floppy disk drives, hard disks and multi-terminal I/O.

THE NEW EXPLORER/85 SYSTEM

Special! *Full 8" floppy, 64k system for less than the price of a mini! Only* $1499.95!

(Also available wired & tested, $1799.95)

Imagine — for only $129.95 you can own the starting level of Explorer/85, a computer that's expandable into full business/development capabilities — a computer that can be your beginner system, an OEM controller, or an IBM-formatted 8" disk small business system. From the first day you own Explorer/85, you begin computing on a significant level, and applying principles discussed in leading computer magazines. Explorer/85 features the advanced Intel 8085 cpu, which is 100% compatible with the older 8080A. It offers onboard S-100 bus expansion, Microsoft BASIC in ROM, plus instant conversion to mass storage disk memory with standard IBM-formatted 8" disks. All for only $129.95, plus the cost of power supply, keyboard/terminal and RF modulator if you don't have them (see our remarkable prices below for these and other accessories). With a Hex Keypad/display front panel, Level "A" can be programmed with no need for a terminal, ideal for a controller, OEM, or a real low-cost start.



Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use. $129.95

LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O ... all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • **I/O:** Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ... cassette tape recorder input and output ... cassette tape control output ... LED output indicator on SOD (serial output) line ... printer interface (less drivers) ... total of four 8-bit plus one 6-bit I/O ports. • **Crystal Frequency:** 6.144 MHz. • **Control Switches:** Reset and user (RST 7.5) interrupt ... additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • **Counter/Timer:** Programmable, 14-bit binary. • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems ... RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000, leaving 0000 free for user RAM/ROM. Features include tape load with labeling ... examine/change contents of memory ... insert data ... warm start ... examine and change all registers ... single step with register display at each break point, a debugging/training feature ... go to execution address ... move blocks of memory from one location to another ... fill blocks of memory with a constant ... display blocks of memory ... automatic baud rate selection to 9600 baud ... variable display line length control (1-255 characters/line) ... channelized I/O monitor routine with 8-bit parallel output for high-speed printer ... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling ... tape dump with labeling ... examine/change contents of memory ... insert data ... warm start ... examine and change all registers ...

Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)

Level "A" With Hex Keypad/Display.

single step with register display at each break point ... go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

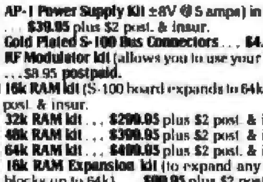
Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4k RAM expansion selectable in 4k blocks ... address decoding for onboard 8k EPROM expansion selectable in 8k blocks ... address and data bus drivers for onboard expansion ... wait state generator (jumper selectable), to allow the use of slower memories ... two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP. professional drive.
- LSI controller.
- Write protect.
- Single or double density.
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track)

DISK CONTROLLER/ I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives.
- 1771A LSI (SD) floppy disk controller.
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports.
- Autoboot to disk system when system reset.
- 2716 PROM socket included for use in custom applications.
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- Onboard I/O baud rate generators to 9600 baud.
- Double-sided PC board (glass epoxy.)

DISK DRIVE CABINET/POWER SUPPLY

- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

ORDER A COORDINATED EXPLORER/85 APPLICATIONS PAK!

Beginner's Pak (Save $26.00!) — Buy Level "A" (Terminal Version) with Monitor Source Listing and AP-1 5-amp Power Supply: (regular price $199.85), now at SPECIAL PRICE: **$169.95** plus post. & insur.

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Special 8" Disk Edition Explorer/85 (Save over $104!) — Includes disk-version Level "A", Level "B", two S-100 connectors and brackets, disk controller, 64k RAM, AP-1 5-amp power supply, Explorer/85 deluxe steel cabinet, cabinet fan, 8" SD/DD disk drive from famous CONTROL DATA CORP. (not a hobby brand!), drive cabinet with power supply, and drive cable set-up for two drives. This package includes everything but terminal and printers (see coupon for them). Regular price $1630.30, all yours in kit at SPECIAL PRICE: **$1499.95** plus post. & insur. Wired and tested, only **$1799.95.**

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Please send the items checked below:

- ☐ **Explorer/85 Level "A" kit** (Terminal Version) ... **$129.95** plus $3 post. & insur.
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- ☐ **8k Microsoft BASIC** on cassette tape **$64.95** postpaid
- ☐ **8k Microsoft BASIC in ROM kit** (requires Levels "B", "D" and "E") ... **$99.95** plus $2 post. & insur.
- ☐ **Level "B" (S-100) kit** ... **$49.95** plus $2 post. & insur.
- ☐ **Level "C" (S-100 6-card expander) kit** ... **$39.95** plus $2 post. & insur.
- ☐ **Level "D" (4k RAM) kit** ... **$69.95** plus $2 post. & insur.
- ☐ **Level "E" (EPROM/ROM) kit** ... **$5.95** plus 50¢ p&h.
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- ☐ **64k RAM kit** ... **$499.95** plus $2 post. & insur.
- ☐ **16k RAM Expansion kit** (to expand any of the above in 16k blocks up to 64k) ... **$99.95** plus $2 post. & insur. each.
- ☐ **Intel 8085 cpu Users' Manual** ... **$7.50** postpaid
- ☐ **12" Video Monitor** (10MHz bandwidth) ... **$139.95** plus $5 post. & insur.
- ☐ **Beginner's Pak** (see above) **$169.95** plus $4 post. & insur.
- ☐ **Experimenter's Pak** (see above) ... **$219.95** plus $6 post. & insur.
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- ☐ **Special: Complete Business Software Pak** (see above) ... **$899.95** postpaid.
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  - ☐ **CP/M 1.4** ... **$100** postpaid
  - ☐ **CP/M 2.0** ... **$150** postpaid
  - ☐ **Microsoft BASIC** ... **$325** postpaid
- ☐ **Intel 8085 cpu User Manual** ... $7.50 **postpaid.**
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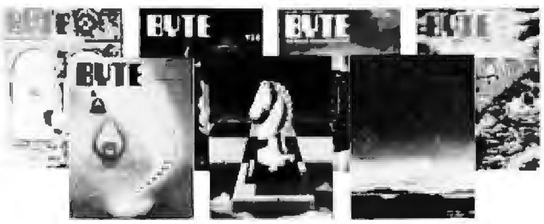

May 1978

GRAPHICS IN DEPTH: 3-D Adds a New Dimension to Your Display; CONVERT YOUR TV SET TO A VIDEO MONITOR; HIDDEN LINE SUBROUTINES FOR THREE-DIMENSIONAL PLOTTING; GRAPH: A SYSTEM FOR TELEVISION GRAPHICS, Part 1: Software, Video Graphics; A PROGRAMMABLE CHARACTER GENERATOR, Part 1: Hardware; TUNE IN AND TURN ON: An AC Wireless Remote Control System; HOW TO MULTIPLY IN A WET CLIMATE: Design Details; THE PHOTOGRAPH IS ALSO A HARD COPY; Product Description: THE MATROX ALT-256 VIDEO BOARD; COLOR GRAPHICS ON THE COMPUCOLOR 8051; A LOW COST LIGHT WAND AMPLIFIER.

June 1978

A PROGRAMMABLE CHARACTER GENERATOR, Part 2: Software; A PROGRAMMABLE IC TESTER; MORE MUSIC FOR THE 6502; TALK TO ME: Add a Voice to Your Computer for $35; A THEATRICAL LIGHTING GRAPHICS PACKAGE; GRAPH: A SYSTEM FOR TELEVISION GRAPHICS, Part 2: Software, Video Graphics; AUDIO PROCESSING WITH A MICROPROCESSOR; NATURAL LANGUAGE PROCESSING AND SMALL SYSTEMS; GIVE AN EAR TO YOUR COMPUTER: A Speech Recognition Primer; THE HP-67 AND HP-97: Hewlett-Packard's Personal Computers; NOTES ON TEACHING WITH MICROCOMPUTERS; A LOOK AT SHUGART'S NEW FIXED DISK DRIVE.

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August 1978

COMPILATION AND PASCAL ON THE NEW MICROPROCESSORS; PASCAL: A Structurally Strong Language; DESIGNING STRUCTURED PROGRAMS; LET YOUR FINGERS DO THE TALKING: Add a Noncontact Touch Scanner; ON BUILDING A LIGHT-SEEKING ROBOT MECHANISM; THE NUMBER CRUNCHING PROCESSOR; PHILADELPHIA'S 179 YEAR OLD ANDROID; ANTIQUE MECHANICAL COMPUTERS, Part 2: History; IN PRAISE OF PASCAL; PASCAL VERSUS COBOL: Where Pascal Gets Down to Business; JACPOT; PASCAL VERSUS BASIC: An Exercise.

September 1978

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NO POWER FOR YOUR INTERFACES?: Build a 5 W DC to DC Converter; A "TINY" PASCAL COMPILER, Part 2: The P-Compiler; TESTING MEMORY IN BASIC; FIRST STEPS IN COMPUTER CHESS PROGRAMMING; LINEAR CIRCUIT ANALYSIS; SOLVING THE EIGHT QUEENS PROBLEM; A SIMPLER DIGITAL CASSETTE TAPE INTERFACE; SOUPING UP YOUR SwTPC 6800; A NOVEL BAR CODE READER; A COMPUTER CHESS TUTORIAL; A MEMORY PATTERN SENSITIVITY TEST; PAM/8: A New Approach to Front Panel Design; ASSEMBLING THE H9 VIDEO TERMINAL; CREATING A CHESS PLAYER.

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January 1979

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May 1979

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June 1979

A MODEL OF THE BRAIN FOR THE ROBOT CONTROL, Part 1; MIND

OVER MATTER: Add Biofeedback Input to Your Computer; COMPUTER GENERATED MAPS, Part 2: A general purpose perspective projection program; THE NATURE OF ROBOTS, Part 1: Defining Behavior; DESIGNING A COMMAND LANGUAGE: Using theory of finite state machines to design input command language; SIMPLE MAZE TRAVERSAL ALGORITHMS; MORE COLORS FOR YOUR APPLE; A HOME FOR YOUR COMPUTER: Increase the utility and enjoyability of your equipment with a carefully planned cabinet; TALK TO A TURTLE: Build a Computer Controlled Robot; MY COMPUTER RUNS MAZES: Using simple tree searches to reach a goal; The 1802 OP CODES: The instruction set of the RCACHughes 1802 microprocessor; THE HISTORY OF COMPUTING: THE IBM 7070; ARTIFICIAL INTELLIGENCE AND ENTROPY: Chemistry, artificial intelligence, and the second law of thermodynamics; BASIC TEXT EDITOR; BUBBLE MEMORIES: A Short Tutorial. STACKS IN MICROPROCESSORS: Learn the ups and downs of stacks in your microprocessor; TIMESHARING: SQUEEZING THE MOST FROM YOUR MICRO; THREE TYPES OF PSEUDORANDOM SEQUENCES.

July 1979

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September 1979

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October 1979

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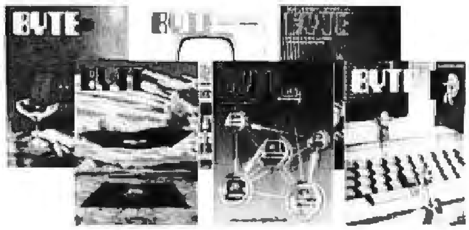

January 1980

COMPUTERIZE A HOME; A COMPUTER-CONTROLLED LIGHT DIMMER, Part 1: Design; A FURNACE WATCHDOG; TELEPHONE DIALING BY COMPUTER; ANALYSIS OF POLYNOMIAL FUNCTIONS WITH THE TI-59 CALCULATOR, Part 2; ALPHA LOCK FOR YOUR ASCII KEYBOARD; RELOCATING 8080 SYSTEM SOFTWARE; EIGHTEEN WITH A DIE, A LEARNING GAME PLAYER; MAKING COLOR SLIDES WITH AN INTECOLOR MICROCOMPUTER; WHAT COMPUTERS CANNOT DO; INDIRECT ADDRESSING FOR THE 6502; THE PLOT CONTINUES; A COMPUTER-GENERATED REMINDER MESSAGE.

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April 1980

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May 1980

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June 1980

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July 1980

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Listing 1 continued:

```
L07     001E     177
L10     0020     178
L11     0022     179
L12     0024     100
L13     0026     181
L14     0028     18.
L15     002A     183
L16     002C     184
L17     002F     185
LCRAM   02AB     774  124
LCRAM0  02BC     782  777
LCRAM1  02CF     792  775
LCRAM2  02FA     811  793
LOOP    0094     248  250
LPIX    0314     869  125
LPIX0   033A     885  882
LPIX1   033F     887  880
LPIX10  037C     912  910
LPIX2   0342     888  884  886
LPIX3   0346     890  878
LPIX4   034A     892  876
LPIX5   034D     893  871
LPIX6   0364     902  899
LPIX7   0367     903  896  901  913  915
LPIX8   036E     906  904
LPIX9   0379     911  907
LREG    0387     939  126
LSUB    039F     978  127
LSYM    03CB    1022  128
LSYM0   0304    1026 1029
LSYM1   030D    1031 1023
M       0044     207 1706 1724 1734 1741
MAIN    008E     246   22
MICROG  0000      21
MM      0045     208 1699 1702 1704 1718 1729 1746
MN      0046     209 1700 1703 1726
MOV     03FB    1081  129
MOV0    0427    1101 1098
MOV1    0434    1109 1106
MOV2    0438    1112 1091
MOV3    0448    1122 1089
MOV4    0454    1128 1125
MOV5    0461    1135 1132
MOV6    0465    1138 1123
MOV7    046A    1141 1111 1121 1137
MOV8    0475    1146 1144
MOV9    047F    1150 1148
MSTACK  103F     148  149  246
NMINT   0066     109
NULL    004C     214  215  392
OUTPUT  0176     446  121
PBOTTM  1000     147  148
PEEK    0BA4    2042 1319 1332
PENTER  006E     122  678
PIXEL   0BAA    2080 2043 2345
PIXEL0  08C5    2093 2087
PIXEL1  08F0    2122 2119
PIXEL2  0909    2128 2123
PIXEL3  0910    2133 2114
PIXEL4  0924    2147 2138
PIXEL5  0938    2161 2148
PIXEL6  0942    2170 2089
PIXEL7  0972    2195 2192
PIXEL8  097E    2201 2196
PIXEL9  0985    2206 2187
PIXELA  0999    2220 2211
PIXELB  09A0    2234 2221
PIXELC  09B7    2243 2091
PIXELD  09E1    2265 2263
PIXELE  09E9    2269 2266
PIXELF  09F5    2275 2270
PIXELG  09FC    2280 2258
PIXELH  0A0D    2292 2285
PIXELI  0A1B    2302 2293
PIXELJ  0A2F    2316 2303
PLOT    0A3F    2366 1714
POKE    0A39    2344  888  911 2409
PRIMAT  0255     671  636
PTOP    17FF      .1
PUT     0A7E    2406 1151 1554 2366 2370 2372 2374 2376 2378 2380 2382
                     2384
RBOTTO  2000     221  514  516  517 2107 2181 2253
RCRAM   0485    1183  130
RCRAM0  0496    1191 1186
RCRAM1  049B    1192
RCRAM2  04A9    1201 1184
RCRAM3  0404    1220 1202
REF     0043     206  872  873  874 1083 1312 1313 1314 1496 1598 1831
                     1839 1898 1906
RELOC   FFFC     151  152  153  154  155  156  157  158  159  160  161
                      162  163  164  165  166  167  168  169  170  171
                      172  173  174  175  176  177  178  179  180  181
                      182  183  184  185  186  187  188  189  190  1[illegible]
                      192  193  194  195  196  197  198  199  200  201
                      202  203  204  205  206  207  208  209  210  211
                      212  213  214
RESTAR  0000     146  298  941
RETN    04EE    1260  131
```

Listing 1 continued on page 260

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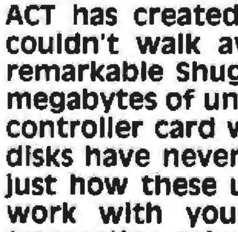

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Name ____________
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City, State, Zip ____________
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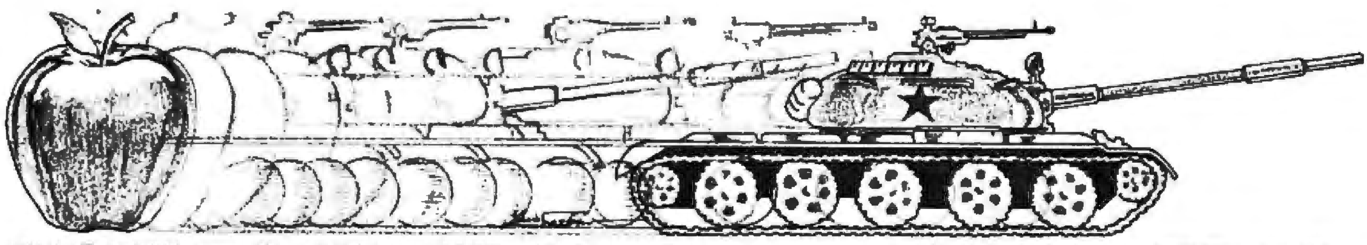
Listing 1 continued:

```
RPIX    050E   1310  132
RPIX0   052C   1322 1318
RPIX1   0530   1324 1316
RPIX2   0533   1325 1323
RPIX3   053B   1327 1335 1337
RPIX4   0546   1332 1328
RPIX5   054C   1334 1331
RREG    0557   1360  133
RSUB    0565   1395  134
RSYM    0587   1433  135
RSYM0   05A9   1450 1434
RTOP    37FF    222  517
S00     0030    187
S01     0031    188
S02     0032    189
S03     0033    190
S04     0034    191
S05     0035    192
S06     0036    193
S07     0037    194
S10     0038    195
S11     0039    196
S12     003A    197
S13     003B    198
S14     003C    199
S15     003D    200
S16     003E    201
S17     003F    202
SENDBK  0A88   2433 1189 1199 1232 1407 1448 1452 1453 1454 1455 2437
SENDBY  0A91   2460  303  305  307  309  311  313  315  318  320  323
                     325  331  333  355 1214 1216 1218 1320 1333 1366
                    2435 2461
SLINK   0010    169  591  720  986 1399
SLONG   0030    186  981 1403
SOFF    0041    204  595  597  736  741 1269
SPTR    0040    203  577  588  734  740 1260 1272
STRUCT  1080    150  215  316  321  392  504  506  507  508  511  591
                     720  944  981  986 1363 1399 1403 1838 1841 1905
                    1908
SX      0047    210 1671 1673 1738 1749
SY      0048    211 1685 1687 1737 1752
SYM     05B8   1493  136
SYM0    05D4   1503 1530
SYM1    0608   1527 1544
SYM2    061C   1537 1556
SYM3    062E   1545 1539
SYM4    063A   1552 1548
SYM5    063E   1554 1551
SYMTAB  1400    216 1024 1041 1439 1450 1524
USER    0AA5   2486   57   58   59   60   61   62   63   64
VEC     0646   1596  137
VEC0    066F   1615 1612
VEC1    067C   1623 1620
VEC10   06D9   1673 1670
VEC11   06E1   1677 1672
VEC12   06F6   1687 1684
VEC13   06FE   1691 1686
VEC14   0713   1702 1698
VEC15   0719   1704 1701
VEC16   0726   1710 1760
VEC17   0739   1722 1720
VEC18   075E   1740 1733
VEC19   0771   1750 1748
VEC2    0680   1626 1605
VEC20   0777   1753 1739 1751
VEC3    0690   1636 1603
VEC4    069C   1642 1639
VEC5    06A9   1649 1646
VEC6    06AD   1652 1637
VEC7    06B2   1655 1625 1635 1651
VEC8    06B8   1659 1656
VEC9    06BE   1660 1658
WAIT    0788   1782  138
WAIT0   0791   1786 1783
WAIT1   0793   1787 1785
WAIT2   0798   1789 1791
XERR    009C    283  110 2092
XERR0   00AB    289  290 [illegible]  358
XERR1   0116    337  300
XERR2   0119    340  341
XERR3   012B    347  348
XERRT   004A    213  316  317 [illegible]  321  322  324
```

Text continued from page 238:
clipping routines (CLIP and CASE). There are several utility routines maintaining the frame buffer (ie: PEEK and POKE, which place or return a pixel value at a given coordinate; PUT, which pokes a series of pixel values; and PIXEL, which does the transformation from the coordinate plane to the physical memory). Only one routine in the entire package, PIXEL, directly manipulates the frame buffer. Besides PIXEL, all subroutines operate in a Cartesian coordinate system. Because of this structure, only PIXEL must be altered



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REBEL FORCE puts you in the role of a Soviet commander whose regiment must face a computer-directed guerrilla uprising which has overrun a vital town. Armed with your tank, heavy-weapons, and infantry units, your mission is to regain the town through the annihilation of the Rebel Force.

Your advance will be brutally opposed by minefields, ambushes, militia, and anti-tank guns — all skillfully deployed by your computer. Survival and success of your units will depend on your ability to take advantage of the variable terrains - open, forest, and rough - each of which has different movement costs and shelter values.

In this finely-balanced solitaire wargame, every move is played under real-time conditions: Procrastinate and lose. At the same time, caution cannot be cast aside; severe unit losses will only result in a Pyhrric victory at best.

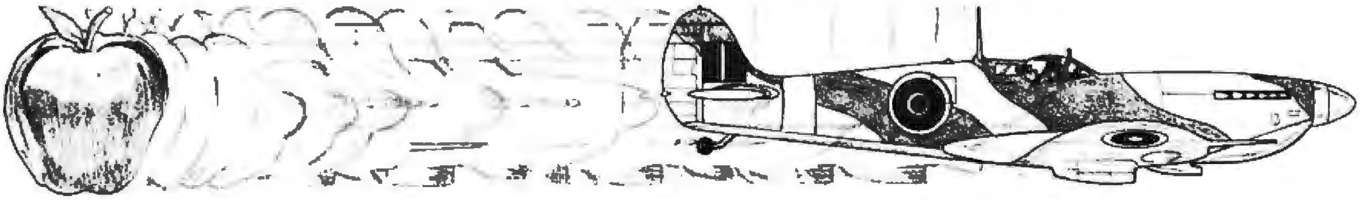
With its five levels of difficulty (plus one where you make up your own), the computer can and will stress your tactical skills to their fullest.

RED ATTACK! simulates an invasion by a mixed Soviet tank and infantry force against a defending battalion. As the defender, your task is to deploy your infantry units effectively to protect three crucial towns — towns that must not fall!

As the Russian aggressor, your objective is to crush the resistance by taking two of these three towns with your tanks and infantry. With control of these strongpoints, the enemy's capitulation is assured.

Red Attack! is a two-player computer simulation of modern warfare that adds a nice touch: At the start of each game, the computer displays a random setup of terrains and units, providing every game with a new, challenging twist.

Computer Conflict, for $39.95, comes with the game program mini-disc and a rule book.



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PLAY THE COMPUTER. Aside from being the game's perfect administrator and referee, the computer will serve as a fierce opponent in the solitaire scenarios provided: Dogfight, Bomber Formation, radar-controlled Nightfighter, and V-1 Intercept. There's even an Introductory Familiarization Flight (with Air Race option) to help you get off the ground.

With the number and type of planes and pilot ability variable, you can make the computer as challenging as you want to give you the ultimate flying experience.

PLAY A HUMAN. Two can play this game as well, in dogfights and bomber attacks. Given a handicap of more or better planes or an ace pilot (or all of the above), even a novice at Computer Air Combat stands a chance to defeat a battle-hardened veteran.

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if different video-display hardware is used.

Also, there are five interrupt-service routines. Four of these routines are directly connected to a hardware interrupt. For example, INPUT is called whenever the host sends a byte of data, and OUTPUT is called whenever the host receives a byte. XERR is called either by a non-maskable interrupt (which signifies a fatal error in the hardware or in a user-supplied subroutine) or by any other routine capable of detecting an error. XERR then provides a debugging capability to the host and allows examination of memory or registers. Finally, FRAME is connected to the frame interrupt.

Whenever the video-display generator grants the bus to the microprocessor, an interrupt signal is generated on PIO (peripheral input/output) port 0. This interrupt allows a process to synchronize with the frame rate, since the interrupt occurs at the end of each frame. FRAME maintains a frame count, but also calls a routine, called NULL, located in programmable memory. If you desire to execute a routine at the frame rate, perhaps to perform some calculation for a game, simply load (via LSUB) a routine at NULL, and the software will call the routine at the start of every frame.

There isn't sufficient room to describe all of the features of this software. The source listing has many comments and provides a preamble to each routine describing the routine name, who calls it and whom *it calls*, a description, the registers affected, and the structures affected. Comments are also provided for every line of executable code; and there actually are more comments than code. The remainder of this discussion will cover some of the major structures and algorithms implemented in the Micrograph software.

Software Structures

As we mentioned in Part 1 of this article, there are two important abstractions that must be implemented in the Micrograph software. *Abstractions* denotes that the software appears as one thing to the user, while hiding the actual implementation. In this case, the abstractions allow the user to deal with manipulating images, rather than dealing with the bits and pieces of the frame buffer itself.

Text continued on page 266

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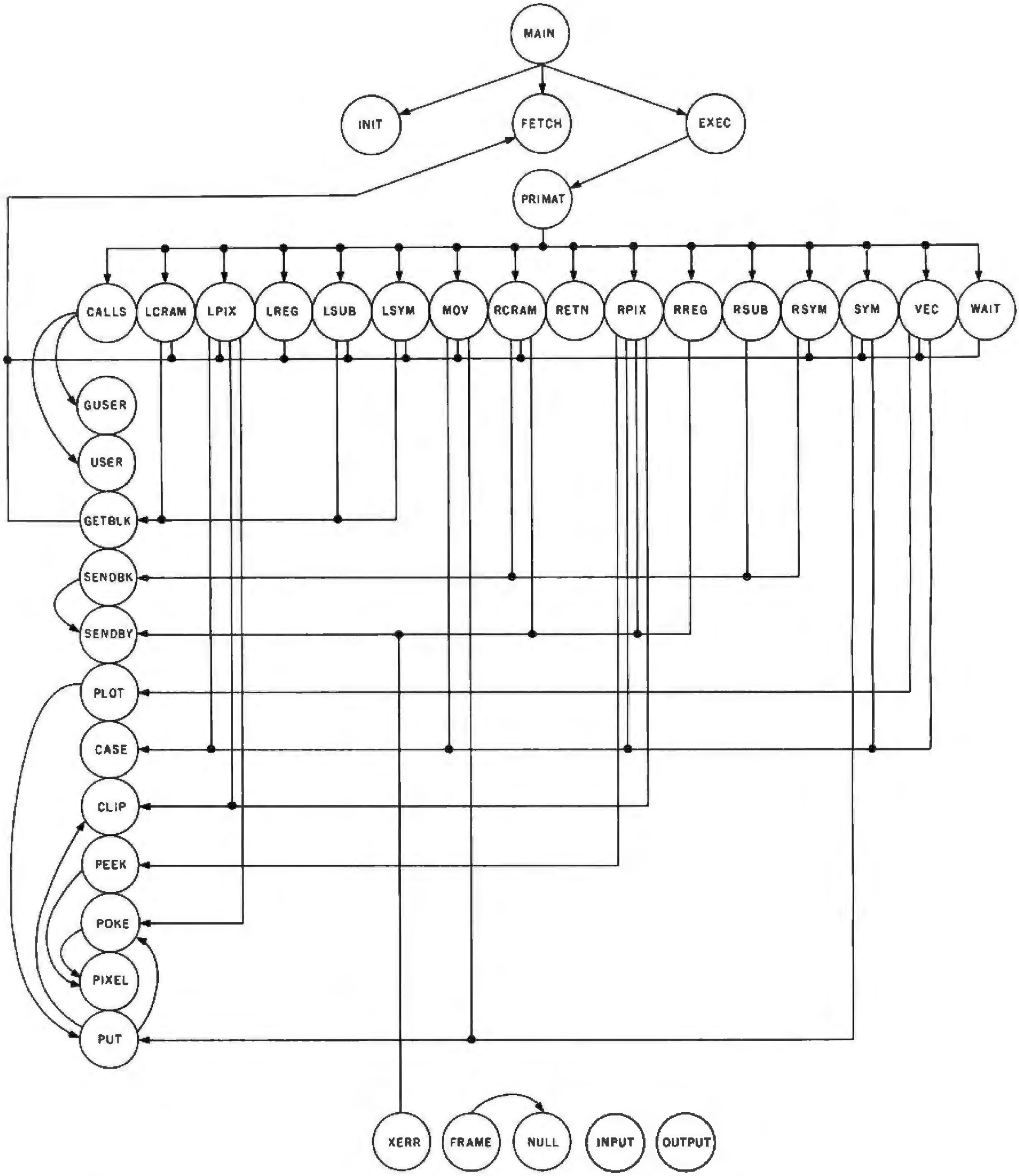

Figure 1: *Hierarchy of subroutine calling in the Micrograph display-control program. The graphics primitives described in Part 1 are represented by the subroutines in the long horizontal row; all are called by the routine PRIMAT through an indirect process. The graphics-primitive routines may then call other routines, shown in the vertical column. The five routines shown in the horizontal row at the bottom are called by processor interrupts. Execution of a subroutine-return instruction causes control to branch to the routine EXEC.*

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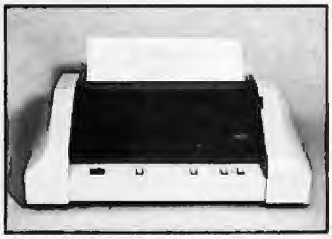

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Mnemonic	Name
GDR 0	X
GDR 1	Y
GDR 2	Primary color
GDR 3	Secondary color
GDR 4	Frame count
GDR 5	Vector mode
GDR 6	Viewport 0 left X
GDR 7	Viewport 0 left Y
GDR 8	Viewport 0 right X
GDR 9	Viewport 0 right Y
GDR 10	Viewport 1 left X
GDR 11	Viewport 1 left Y
GDR 12	Viewport 1 right X
GDR 13	Viewport 1 right Y
GDR 14	Display format
GDR 15	Status

Table 2: *Functions of the sixteen graphics-display registers of Micrograph.*

Text continued from page 262:

One of the more important abstractions is the structure of the frame buffer appearing to be a Cartesian plane. In Micrograph, the user sees the system as a 256 by 256 pixel by 256 color display, which is physically and internally truncated to a lower resolution (eg: 64 by 64 pixels with four colors, 128 by 128 pixels with four colors, or 256 by 192 pixels with two colors). In reality, the frame buffer cannot be physically accessed using these same coordinates. Instead, the Micrograph firmware does the translation through the routine PIXEL from the Cartesian coordinates to the physical frame buffer.

Figure 2 shows the structure the system implements for the three resolutions available through Micrograph. Actually, all the 6847-supported resolutions are possible: the software, however, directly supports only three. The figure also indicates a border in which no individual pixels may be accessed.

The other critical structure that Micrograph must implement is the graphics-display register set. As Parts 1 and 2 explained, the graphics-display registers define system-global parameters, such as line type (eg: solid, dashed, small, or fat), current color, viewport coordinates, and so on. In Micrograph, there are sixteen graphics-display registers, whose functions are summarized in table 2. Remember that these registers may be directly accessed through the instructions LREG and RREG and that they effect the execution of most of the other instructions.

There are a few other abstractions implemented by the Micrograph soft-

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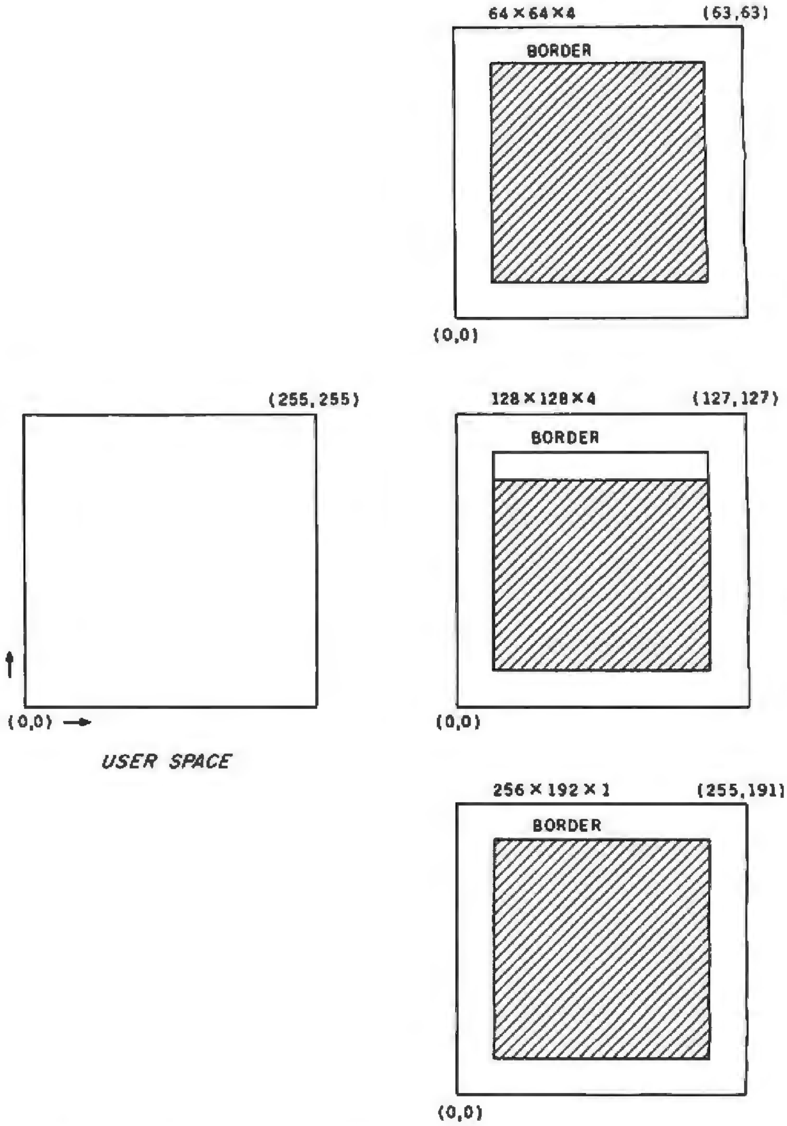

Figure 2: *Pixel mapping structure of Micrograph firmware.*

ware worthy of mention and mostly relating to display-list subroutine implementation, as shown in figure 3. For user-called microcomputer machine-language subroutines (accessed through CALLS), the microcomputer stack is used to handle subroutine nesting. A similar structure must be implemented for the graphics-primitive subroutines, as the figure indicates. In this case, a second stack is maintained and is pointed to by a base-register offset by another byte (GPC). This stack holds the nested graphics-subroutine names, not addresses. Another byte (SPTR) holds the current subroutine name.

To find the actual entry point of a subroutine, two more tables are used (SLINK, the subroutine address in memory, and SLONG, the subroutine length). To access the actual address or length of a subroutine, SPTR is added to the table base for indexing the appropriate data. SLONG directly provides the subroutine length with a maximum of 256 bytes. The value in SLINK is added to SOFF, the subroutine offset, to point to the next instruction in the current subroutine.

Major Algorithms

The implementation of the Micrograph instruction set is relatively straightforward. However, there are a number of algorithms buried in the software that you should be aware of, including the algorithm for the routine PIXEL, the scan-line conversion routine, and the clipping routine. Since these routines are utilities used by several of the command-processing subroutines, they will be discussed first, followed

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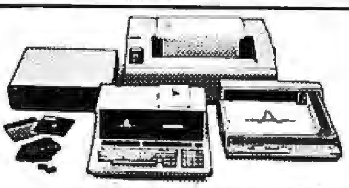

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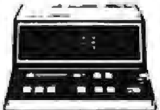

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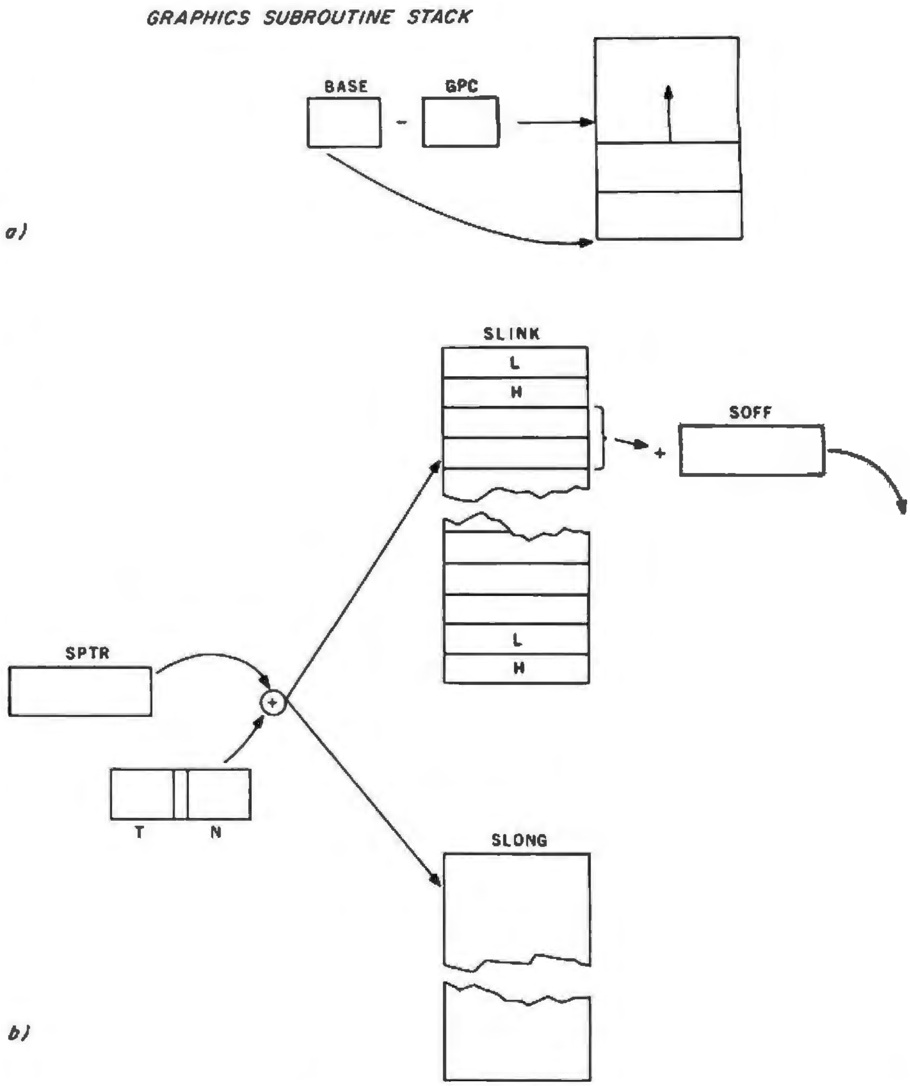
Figure 3: *Micrograph display-list subroutines. Figure 3a shows the stack used for nested user-called subroutines. Figure 3b shows the scheme used for keeping track of nested graphics subroutines.*



by some details on the command (ie: instruction) processing itself. Even if you don't plan to build a complete version of Micrograph, or if you have an existing graphics system, the following algorithms may easily be used to implement some important graphics-processing functions.

The routine PIXEL is the only routine that directly accesses the frame buffer: all other routines operate in the abstraction of the Cartesian plane. Hence, PIXEL must provide the mapping between these two frames of reference. Remember that the frame buffer is actually a block of memory up to 6 K bytes long. As figure 4 indicates, this block of memory is mapped directly to the display by the video-display generator. Since Micrograph supports three different formats, this mapping is not necessarily constant. Figures 5a, 5b, and 5c describe this transformation for each display resolution. These are essentially bit-manipulation operations, and because they are very similar, it will suffice to discuss one in detail, the 128 by 128 pixel (four-color) resolution in figure 5b.

PIXEL starts with clipped X and Y coordinates and, through the given bit manipulations with some moving, complementing, and shifting, forms a 16-bit offset from the start of the refresh memory. This offset is added to the start of the frame-buffer memory, which then points to a particular byte in the refresh memory. Since, in this case, there are four pixels packed in 1 byte, bits 3 and 4 of the clipped X value are used to point to one particular pixel. Since PIXEL sets or reads the color-value bits that correspond to the pixel, we must also match the byte representing the selected color to the pixel data. In this case we actually truncate the selected color and use only the top 2 bits as significant, which equates to four possible colors. Thus, there's a potential of 256 possible colors, if the hardware will support it.

Recall the description of a viewport in Part 1: a rectangular block that is part of (or the entire) display screen. Therefore, you can *clip* (ie: make in-

Text continued on page 274

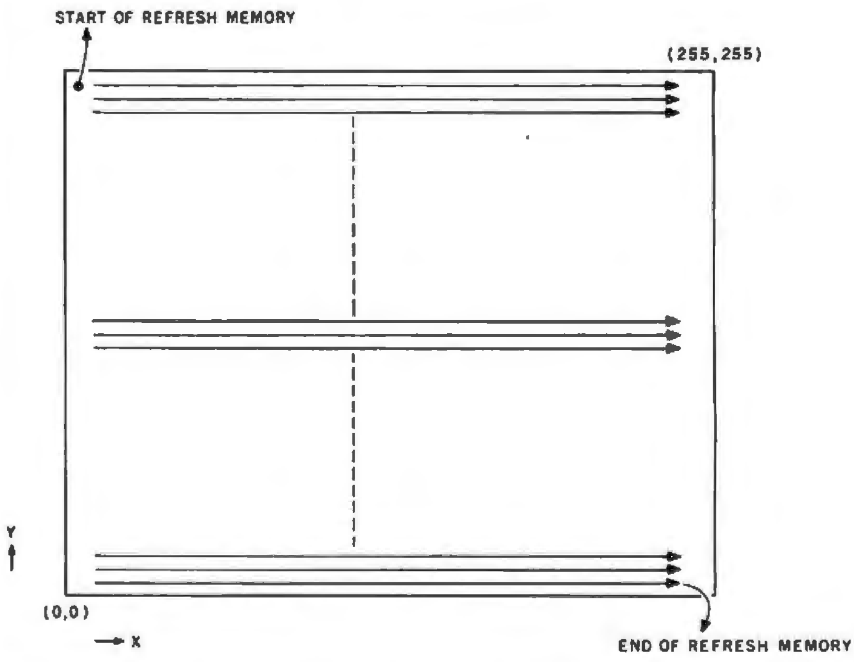


Figure 4: *Mapping of picture elements to the video display.*

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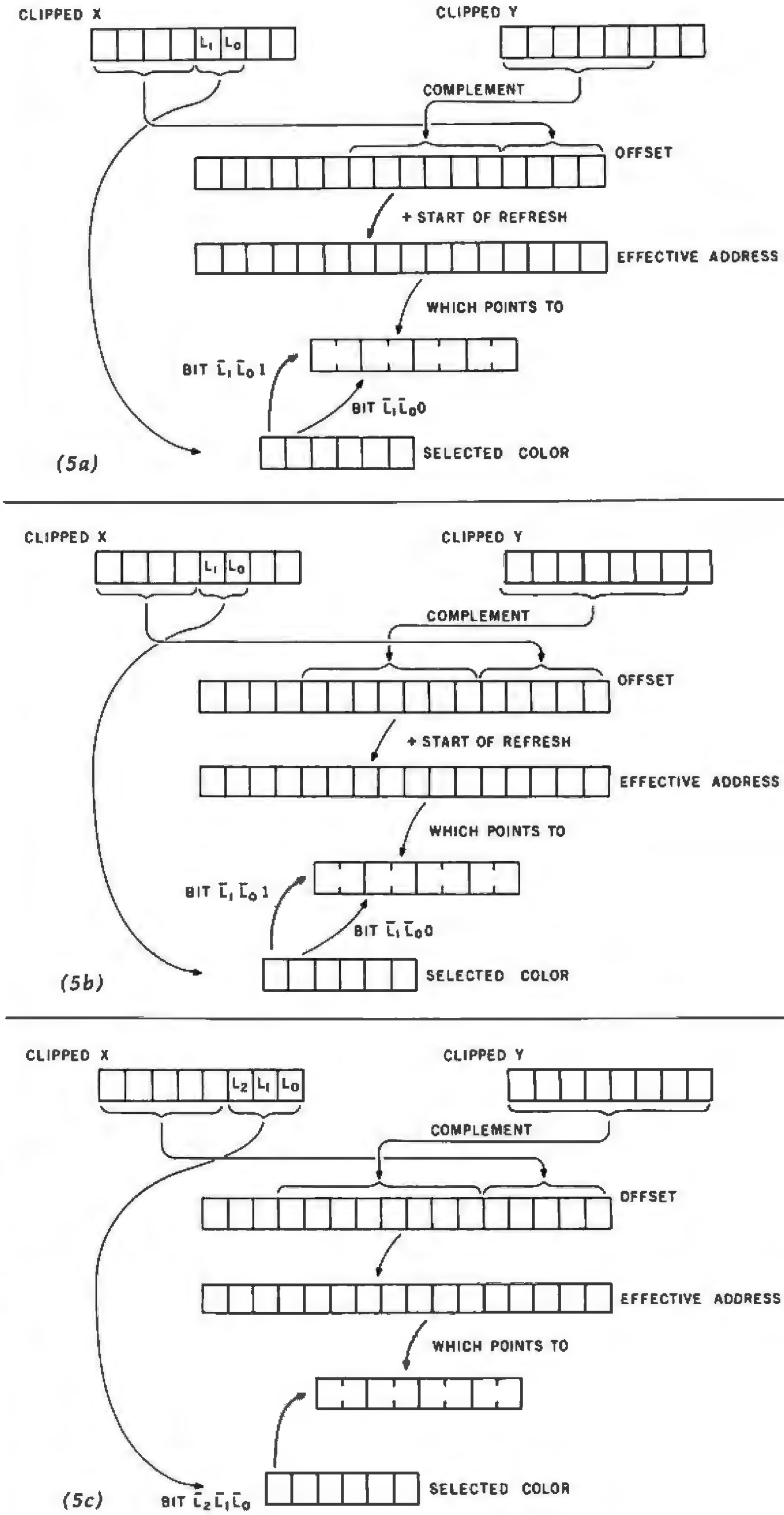

Figure 5: *Variations in pixel mapping among the three available resolutions and formats. Figure 5a represents the X,Y to memory mapping for a 64 by 64 pixel by 4 color display format. Figures 5b and 5c represent mapping for 128 by 128 pixel by 4 color and 256 by 192 pixel by 2 color formats, respectively.*

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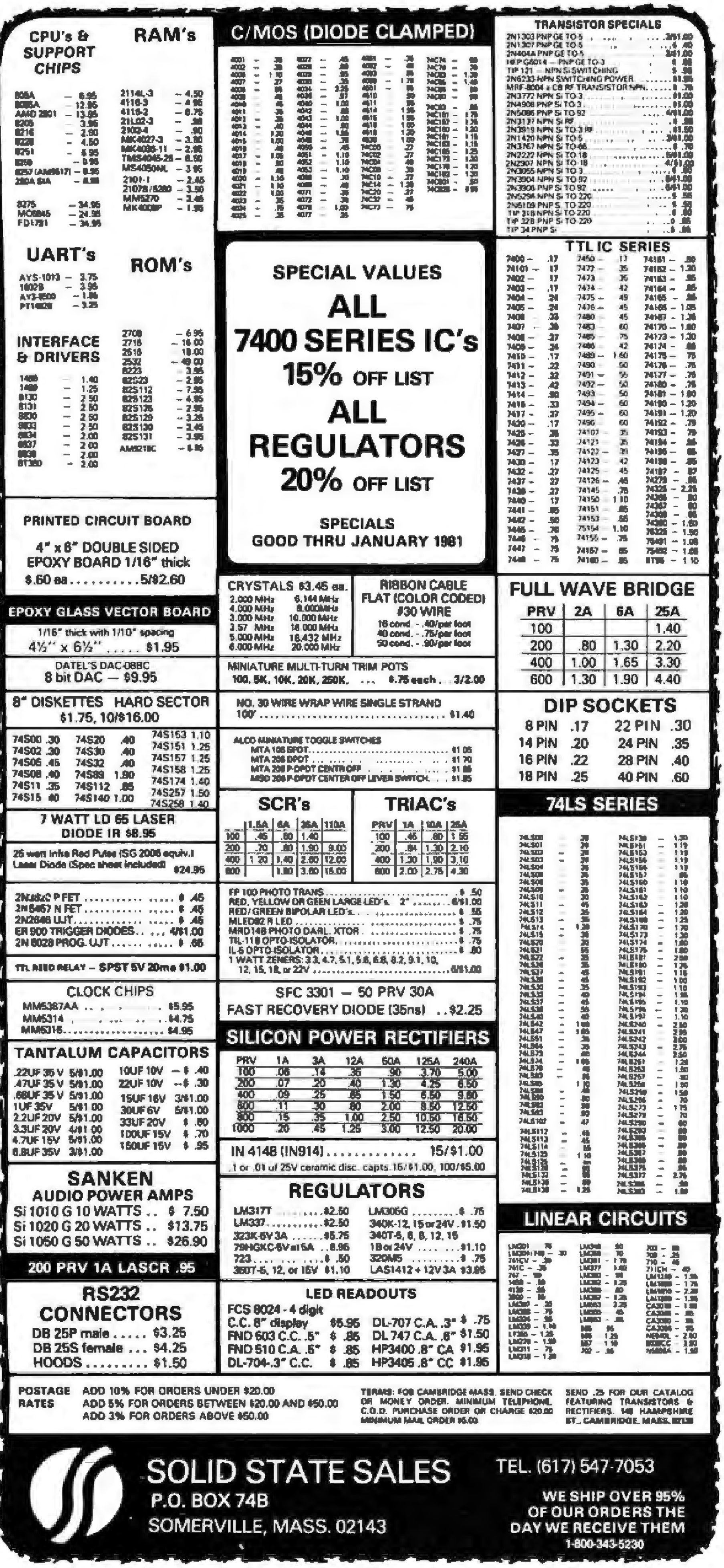

Text continued from page 270:
visible) all points that are outside (or inside, in the case of masking) the viewport. This feature allows multiple images to be placed on the display and for selective updating.

In Micrograph, four possible cases of clipping are defined, as shown in figure 6. These cases allow more flexible masking and selective updating. Of course, you must have some sort of algorithm to determine if a point should be clipped. The input parameters needed for this algorithm are the current X and Y points and the coordinates of the viewport, which we call X_1, Y_1, X_r, and Y_r. Figure 7 describes the algorithm for determining the case of the viewport, which is done by determining the relationship of the four viewport coordinates. Continuing, as the figure shows, you compare the current X and Y coordinates to determine where in the display they are located. Finally, to complete the clip algorithm, note what parts of the screen are not clipped relative to the case of the viewport.

There is one final algorithm that must be discussed, namely, the scan-line conversion routine. This routine, actually located in routine VEC, draws a clipped line on the display given the current X and Y points as the start of the vector and the endpoint coordinates. Figure 8 provides the scan-line algorithm used by Micrograph, which computes every point along the vector. As the flowchart indicates, the routine first sets counter C to 0. This counter tallies the number of points that have been generated. Next, MM and MN are set to the maximum and the minimum, respectively, of the ΔX (delta X) and ΔY values (ie: the current X or Y value minus the respective endpoint value). These values determine whether the line is longer in the X or the Y axis. M is then set to half of the maximum value.

Next, a loop is started that first compares C and MM to verify that all the points have been plotted; if not, then M and MN are added. M is then compared to MM, to determine the necessity to increment your position in the shorter axis. Following the flowchart, the increment values for the X and Y axes are determined next. The longer axis is always incremented, and the shorter axis is only incremented if M is greater than or equal to MM. Next, the new X and Y

Text continued on page 278

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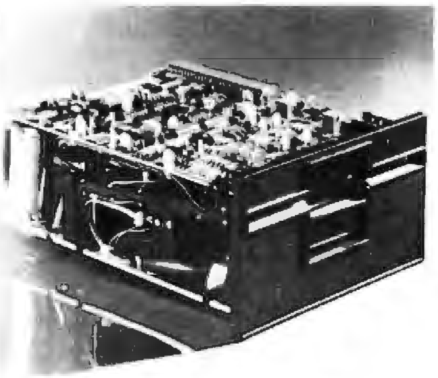

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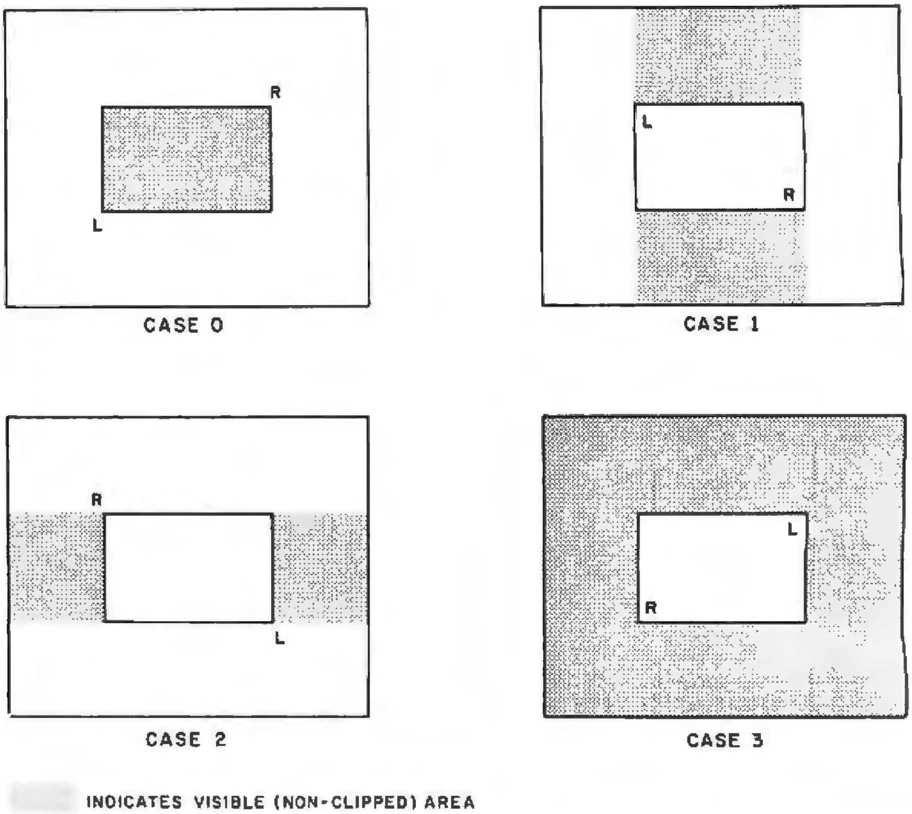

Figure 6: *Four possible cases of clipping. The L and R refer to the viewport's left and right boundaries.*

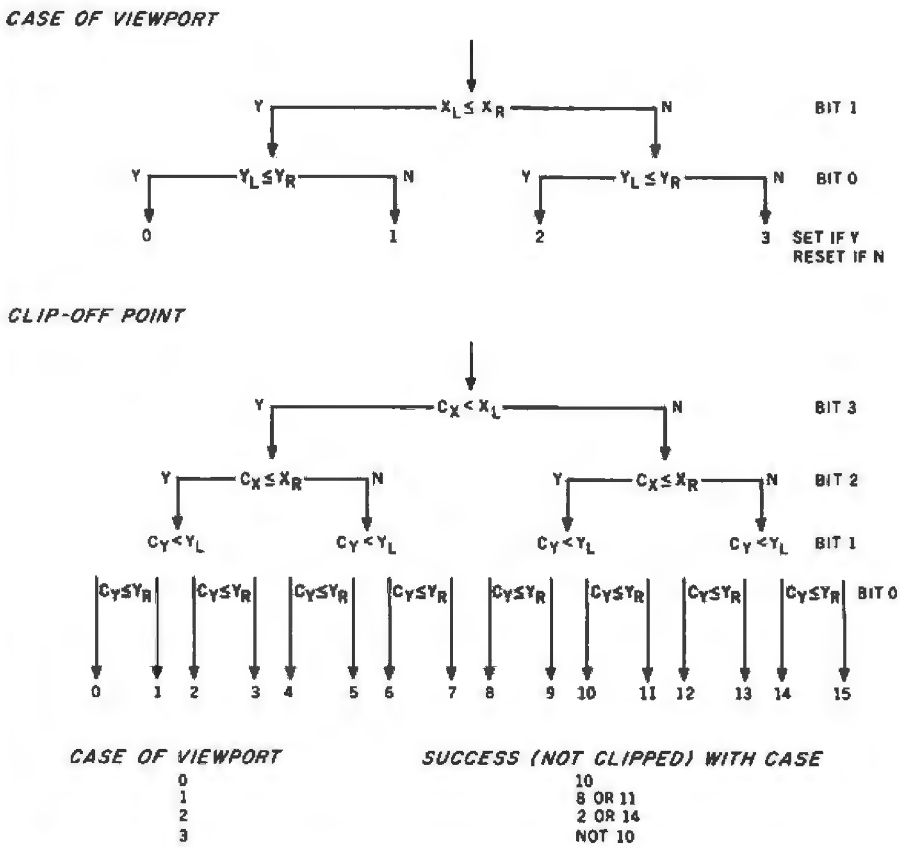

Figure 7: *Algorithm used for determining the clipping case of the viewport.*

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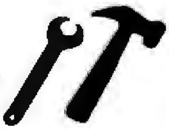

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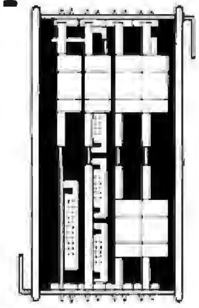

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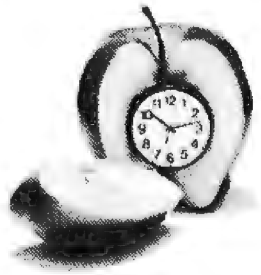

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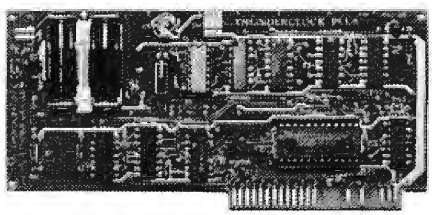

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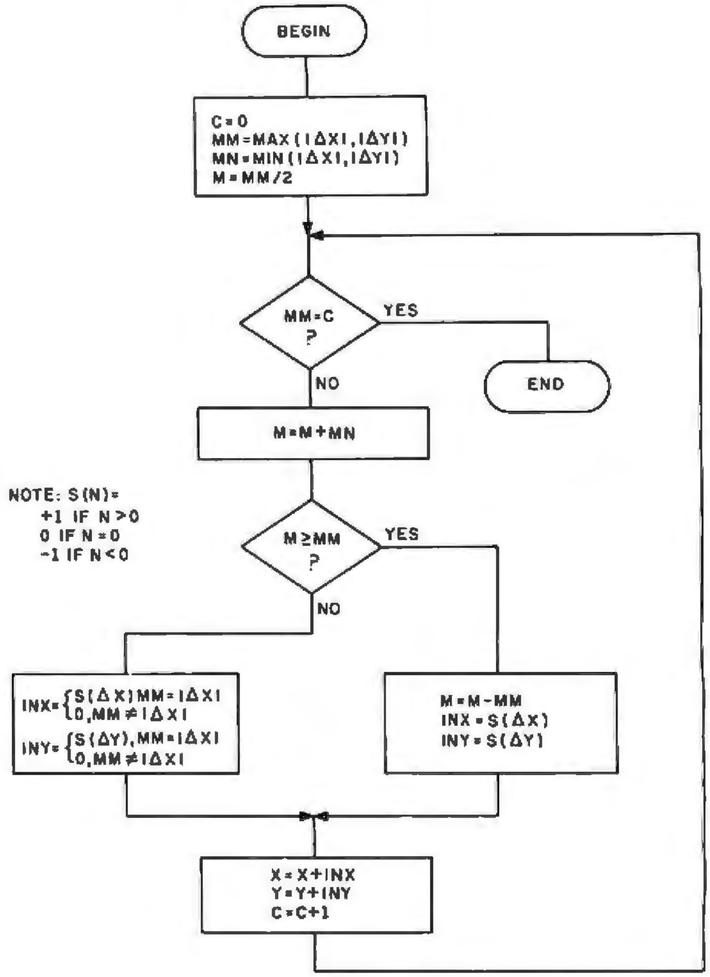

Figure 8: *Micrograph scan-line algorithm. This algorithm computes the set of points along the vector to be displayed.*

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values are determined, the counter is incremented, and the point is plotted. Figure 9 provides an example of the use of this algorithm.

One final note: scan-line conversion routines are inherently slow, since they must compute *every* point along a vector. This particular routine has the advantage of requiring no division (except by 2, which can be done by shifting) or multiplication. Using a Z80 at about 2 MHz, the line is drawn faster than you can detect.

Operation

Once you have completed the Micrograph construction as in Part 2 and your software has been burned in the three EPROMs, the system is ready for use. First connect the RF (radio-frequency) or video output to your receiver. (This section should have already been checked as specified in Part 2.) Next, the input, output, and status ports must be connected to your host computer. There is nothing special about this connection. Three 8-bit ports are required, plus a strobe line for each. There are no particular timing specifications for this interface. In this initial checkout, however, you can connect LEDs (light-emitting diodes) to the status and output lines, and rig the input and strobe lines. After this, Micrograph can be powered up.

First, the display will appear in the 64 by 64 pixel, four-color format, with the display area blanked. A border will also appear, and if you watch the status port, it will come up in the INIT status, followed by the FETCH status. (If you have problems here, try powering up again....I had problems with an unreliable power-up circuit.) The INIT status indicates that the system is ready to accept commands.

The protocol for communicating with the system is simple: whenever the INPUT status is low (ie: false), Micrograph is ready for data or a

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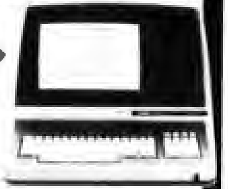

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Video—80x24 or 16x64 w/scrolling
Storage—2 disk units 250 kbytes each
Language—Microsoft Basic
O/S—CP/M

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command. Remember that some of the instructions require several bytes and the host must keep track of how many bytes to send. If the INPUT is high (ie: true), then the system is busy processing, and the input is pending. If Micrograph is sending data, the OUTPUT status will be high, indicating that there is data to be received. OUTPUT will go low once the host has strobed the output port, signifying that data has been received.

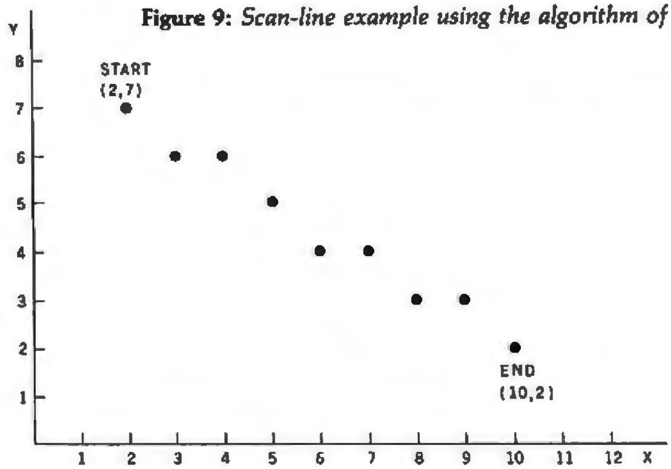
Finally, the host may detect frame interrupts and error conditions. If the ERROR status bits go high, this signifies that Micrograph has detected a hardware or software failure. Diagnostics are available through the command XERR to examine memory or registers or to reset the system. Also, the formats and detailed descriptions of the commands and graphics-display registers are in the *Micrograph Reference Manual* (available from the author for $20.00, postage paid). The manual provides further details on the system design and construction.

Conclusion

This series of articles has examined interactive computer-graphics systems, with a particular emphasis upon raster-scan graphics-display processors. I have presented an instruction set for a color raster-scan display processor for a microcomputer, called Micrograph; the hardware construction details; and the software design for the system, which provides a color graphics and alphanumerics display in any of three resolutions.

The field of computer graphics is boundless. Especially with the availability of low-cost color-graphics systems for the consumer, such as Micrograph, further research is needed for determining how to produce good-quality images with moderate-resolution displays, using techniques such as *ordered dithering* and *shading*. This series of articles will enable you to achieve a low-cost color display. I hope that it has given you an understanding of some state-of-the-art graphics techniques, along with an appreciation of what remains to be studied. ■

Figure 9: *Scan-line example using the algorithm of figure 8.*



STEP	X	Y	C	MM	MN	M	INX	INY	ΔX	ΔY
INIT	2	7	0	8	5	4			8	5
1						9				
	3	6	1			1	+1	-1		
2						6				
	4	6	2			6	+1	0		
3						11				
	5	5	3			3	+1	-1		
4						8				
	6	4	4			0	+1	-1		
5						5				
	7	4	5			5	+1	0		
6						10				
	8	3	6			2	+1	-1		
7						7				
	9	3	7			7	+1	0		
8						12				
	10	2	8			4	+1	-1		
			STOP							

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Mark of the Unicorn

Mark of the Unicorn, an aggressive new software company, is currently supplying three products: Mince, Scribble, and Amethyst.

Mince is a display oriented screen editor which operates via continuous user interaction with the text rather than a carefully structured set of editing requests. It comes with a configuration program which allows the display processor to adapt to absolutely any terminal which has a cursor addressable display, allowing you to acquire new hardware at will without getting a new editor.

Mince allows you to move by characters, words, lines, sentences, paragraphs, and screens. It allows you to insert text at will (without going into "input mode"), either automatically making room for new text or overwriting the old. It allows you to delete characters, words, lines, sentences, or paragraphs, and define and delete regions of text. (These commands also allow you to undo your accidental deletion mistakes!) The commands are mnemonically picked for ease of learning and use. Mince implements a virtual memory system, thus allowing you to edit many documents at once via the use of multiple text buffers. This allows you to modify one file based upon another, and to move blocks of text (words, lines, paragraphs, ... you get the idea) from one file to another with great ease.

There are several other useful features: automatic word wrap, querying replace to globally change strings, "modes" which allow selective rebindings of the command characters to provide special functions or features (which may be user created and modified in Amethyst!), settable tab increments and left and right margins for use with the "fill paragraph" and "center line" commands. Not to mention the commands which uppercase, lowercase, or capitalize words, or the command which deletes surrounding whitespace, or ...

All this without the display clutter normally associated with such fancy screen editors. This is an editor that was previously available only to mini-computer users, now provided for the real world of microcomputing by Mark of the Unicorn.

Scribble is a text formatter that continues the philosophy of Mince. Its command set allows you to specify the logical structure of a document rather than the specific formatting details.
For example

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powerful commands
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produces

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2 powerful commands
3 proportionally spaced output

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Amethyst combines Mince, Scribble, the BDS C compiler, source code for the command set, and an extensive user support program. Inclusion of the command source code, which is written in C, makes it possible for you to reconfigure the programs to create any new or personal commands you like. Amethyst is ideal for use as a development system editor compiler combination, or as a user changeable text processing system. Of course, you can certainly run Mince, Scribble, or the Amethyst package on your 48K or larger 8080, 8085, Z80*, NS16000 CP/M** system with no modifications whatsoever. (Mince and Amethyst require a video terminal.)

Amethyst, Mince, and Scribble are all written in C and will be compatible with Unix*** and any C based Unix look alikes offered to the microcomputing community, as well as being compatible with current CP/M systems. A Vax VMS version will also be available in the near future.

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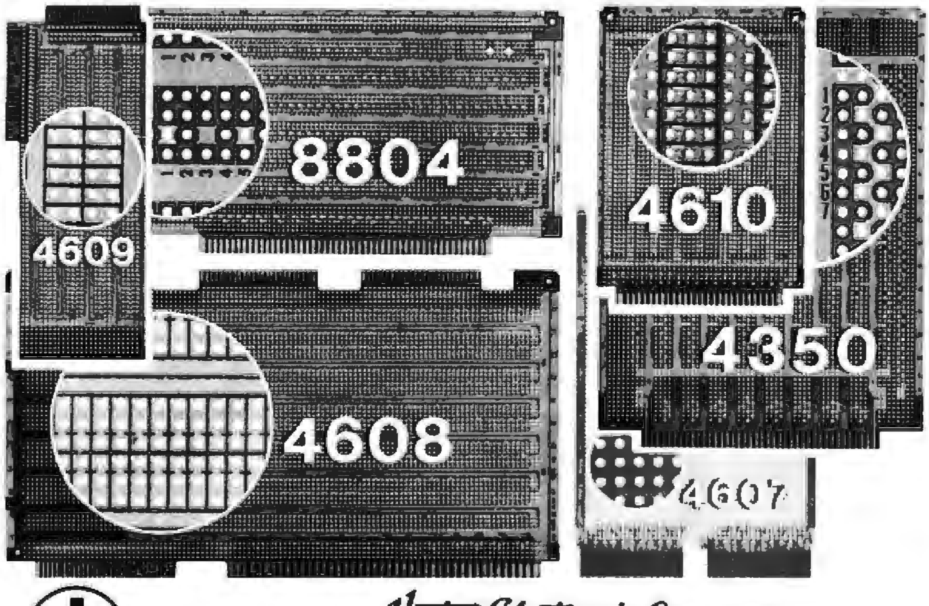

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Ask BYTE

Conducted by Steve Ciarcia

Bus-Signal Lines

Dear Steve,

I have a Radio Shack TRS-80 microcomputer, and would like to interface your LED (light-emitting diode) display. (See "Self-Refreshing Graphics Display," October 1979 BYTE, page 58.) Can you tell me what pins I should use on the TRS-80's 40-pin Expansion Interface connector?

Randy Biggs

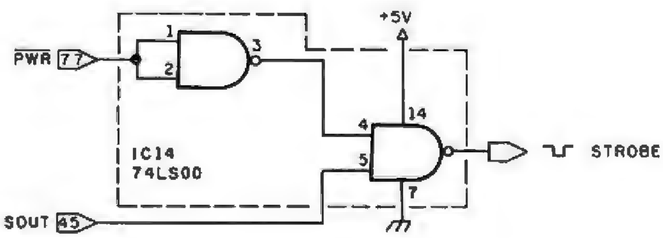
I am glad that you want to build this device. I listed the signal names on the schematic diagram, but am happy to list the bus-signal pins as well. (See table 1.)

...Steve

Table 1

	Pin Designations		
TRS-80	Signal	Apple II	S-100
20	D7	42	90
24	D6	43	40
28	D5	44	39
18	D4	45	38
26	D3	46	89
32	D2	47	88
22	D1	48	35
30	D0	49	36
36	A7	9	83
38	A6	8	82
35	A5	7	29
31	A4	6	30
34	A3	5	31
40	A2	4	81
27	A1	3	80
25	A0	2	79
39	+5 V	25	1 & 51(+8 V)
8	GND	26	100
12	$\overline{\text{STROBE}}$	1	see figure 1

Figure 1



In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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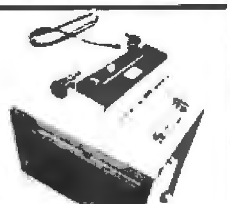

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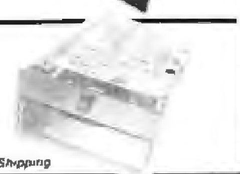

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Vocal Power

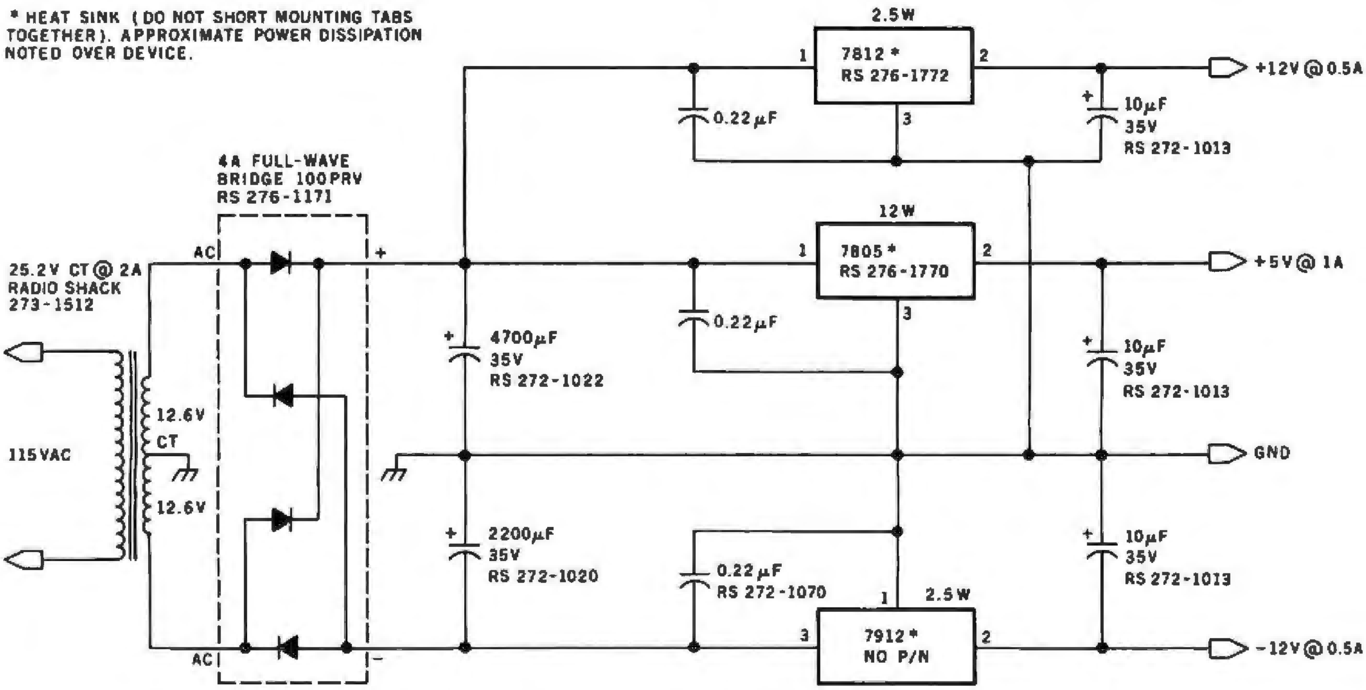
Dear Steve,

I need your expertise in circuit design once again. I recently interfaced a voice synthesizer to my Heath H-8 computer, and I need a power supply for it because the H-8 doesn't supply enough current for both itself and the synthesizer. The power supply I am using now is my own crude design, unregulated and poorly filtered. I have looked through past BYTE articles for something that might work, and I have found nothing. Could you be of help, Steve? What I need is ±12 V at 500 mA and +5 V at 350 mA. There is very little "surge" demand. The ±12 V should be within 10% and regulated, the +5 V within 5%, also regulated.

Ted G Benglen II

Figure 2 is a schematic diagram for the power supply you describe. If you have any more questions on seat-of-the-pants series-regulated power-supply design, I recommend you read my new book entitled Build Your Own Z80 Computer, *which will be available from BYTE Books (70 Main St, Peterborough NH 03458) in February, 1981. There is a complete chapter devoted to this subject....* **Steve**

Figure 2



EMG + TRS-80 = ??

Dear Steve,

I am currently using a TRS-80 Level II 16 K microcomputer in my classroom. I am a Special Education specialist who teaches 7th and 8th grade learning-disabled students. I am trying to put together a program using stress-free learning techniques. What I would like to do is interface an EMG (electromyogram) unit to the TRS-80. Your name was given to me as a possible resource. I would appreciate any assistance that you could provide.

William Engelhardt

It is not particularly difficult to connect the single-bit output of the EMG unit from my article "Mind Over Matter: Add Biofeedback Input to Your Computer" (June 1979 BYTE, page 49) to a TRS-80, if you have the Radio Shack Expansion Interface or a COMM-80. Either unit provides a printer port at memory address hexadecimal 37E8.

The easiest method is to attach the EMG output to pin 21 of the printer connector (ground is on pin 34). This is ordinarily used as the printer BUSY line. Pins 23, 25, 28, 29, 19, 32, and 30 should be grounded. In BASIC, execute a PEEK(14312) when you want to read the EMG input. If it returns as decimal 128, then the EMG output is high; if it returns 0, then its output is low.

If you would prefer not to go through the expense of the expansion interfaces for a single-bit input, then I refer you to my May 1980 BYTE article (see "I/O Expansion for the Radio Shack TRS-80, Part 1: Principles of Parallel Ports," page 22), which describes how to construct a parallel port for any address.... **Steve**

SDK-86 Inquiries

Dear Steve,

I am a subscriber to BYTE, and I have enjoyed reading your articles for over two years. Your articles have increased my knowledge of digital circuitry and microcomputers. Thus, one purpose of this letter is to thank you for your effort. Although I constantly read articles in BYTE and other technical magazines, I am only now thinking of assembling my own computer. Perhaps you could answer some of my questions:

In your article on the Intel SDK-86 computer kit (see "The Intel 8086," November 1979 BYTE, page 14), the data-rate generator is fed by a 612,500 Hz clock. It seems to me that the 8-bit counter (a 74LS393) would divide this by 256 to produce a minimum rate of over 2 kHz. Where does the 110 bps (bit per second) rate come from?

I am considering the purchase of an Intel SDK-85 kit and a Heathkit H-19 (smart video terminal). I believe that they will be compatible; how hard can the interfacing

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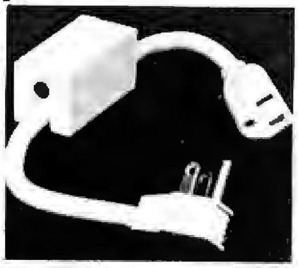

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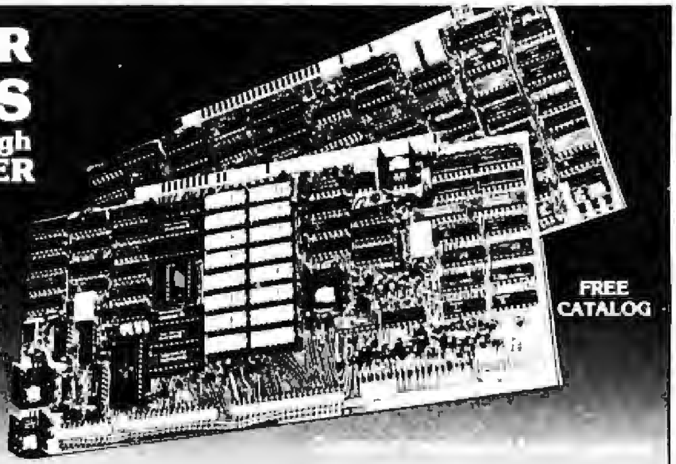

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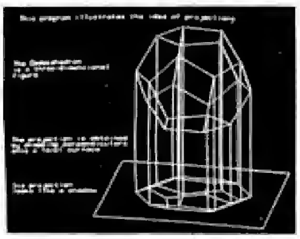

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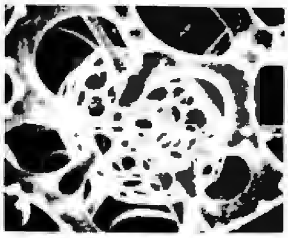

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be? Since the serial I/O (input/output) port of the SDK-85 runs at 110 bps, it seems that the initial loading of the H-19 may take as long as 3 minutes. What is the best way to interface a printer to the computer at the same time?

I am interested in obtaining BASIC firmware; I have seen advertisements for BASIC stored in ROM (read-only memory), but it seems that it may be written for a specific computer system, rather than the 8085 microprocessor in general. Can I get firmware compatible with the SDK-85 computer that will handle I/O? Is the performance increase of the SDK-86 over the SDK-85 really worth $550?

Chin Y Chang

Thank you for the vote of confidence. I'll try to answer your questions in order:

On the SDK-86 computer, the data-rate generator is fed by a 1.8432 MHz clock. The 74LS393 and other circuitry reduce this to approximately 1760 Hz (actually a bit higher) to provide 110 bps. This unit can go as high as 4800 bps, with the change of a few jumpers.

The H-19 and SDK-85 could communicate serially. Provision is made on the SDK-85 board for the addition of an MC1488 and an MC1489 (quad line driver and quad line receiver, respectively) for RS-232 operation. Since the only data rate is 110 bps, things will indeed be slow, unless you write your own I/O routines. Interfacing to a printer requires knowledge of the printer's specifications. If it communicates serially, then a switch would allow you to use the printer in place of the video monitor quite easily. Selection of the best printer for interfacing is dependent upon your programming abilities.

Lawrence Livermore BASIC is available in read-only memory from a few manufacturers (such as National Semiconductor). Call National's local sales offices for details. The memory devices contain only the BASIC interpreter, but no I/O routines; compatibility with the SDK-85 system will, again, depend on your abilities.

*The SDK-86 is not aimed at the experimenter market. While you may benefit in the long run, your questions suggest that you might be biting off a little too much. If you want a 16-bit computer, save the $1000 cost of an SDK-86 kit and put it toward an assembled system....*Steve

Questions, Questions, Questions

Dear Steve,

I have a couple of questions regarding your article "I/O Expansion for the Radio Shack TRS-80, Part 1." (See the May 1980 BYTE, page 22.) It appears that figure 7 is a diagram of the prototype board pictured in photo 3. Where do the capacitors come in? And what are their values?

I know just enough about electronics to get myself into trouble. I know *what* the components are and *how* they work, but I don't know how to match them up into a working circuit.

Also, could you furnish more information about using the extra logic on IC5 to operate the three additional ports? I am particularly interested in a combination security system and external-device control and monitor. I don't think 8 bits is enough for what I have in mind.

I have done some figuring on the additional ports. It appears to me that, for each additional port, I will need (to decode the port address) one 74LS04, one 74LS30, and one 14-pin DIP switch. For input capabilities, I would need two 74LS125s and two 74LS75s.

Since there are four inverters unused on IC7, three could be used with the latches for the three other ports.

Kerry A Wilson

You are correct. Figure 7 is the circuit of photo 3. The extra capacitors are for decoupling and protective filtering. These components are added because they are a good idea and not because they are necessary for the port function described. Whenever TTL (transistor-transistor logic) components are used in a design, capacitors are attached across the power-supply pins to eliminate noise in the power wiring. The value is usually 0.01 μF to 0.1 μF, and one should be added for every three integrated circuits (this figure is variable and depends on circuit density and power consumption as well).

The larger capacitor is a 10 μF electrolytic type which is attached between +5 V and ground where the power enters the board. Whenever an interface is remotely powered, it is possible that the wires attaching it to the power source will pick up noise. Adding a capacitor at the end of the power cable helps reduce this noise. The exact value is a function of cable impedances and circuit reactance, but, in low-current circuits, 10 μF to 100 μF is acceptable. High-quality designs may be a little more particular, and tantalum electrolytics are generally used.

The additional logic necessary to expand figure 7 for three more ports would be six 74LS125s, six 74LS75s, and three of the remaining inverter sections of IC7. For each port, you would duplicate the circuit of ICs 1, 2, 3, 4, and 7a; however, use the other strobe lines on IC5, the 74LS155. Those lines are described in detail in the second part of my article. (See the June 1980 BYTE, page

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42.) The addressing for the other ports is already decoded in the original circuit. As the switches are shown, the first port is 00. The other three will be 01, 02, and 03 respectively.

Be careful to keep your wiring short and neat because this circuit is attached to the main computer bus. If the computer malfunctions, then you may need to add extra buffers to the data and I/O buses.
...**Steve**

Transmission-Transmission Logic?

Dear Steve,

I have been interested in monitoring my car's gas mileage for several years, but until recently I have been prevented from doing anything about it because there was no inexpensive way for me to measure the low fuel-flow rate in a car. Now a fuel-flow sensor is available from Zemco Inc, 12907 Alcosta Blvd, San Ramon CA 94583, for $19. They sell The Compucruise and any replacement parts for the unit at reasonable prices. A speed sensor and magnet-replacement kit are also available for $4.50 and $15, respectively, but my odometer (I have a 1974 Toyota Celica) sends a marker pulse to an emissions-control device, which I can use.

I designed the circuit shown in figure 3 to display miles per gallon. The circuit is simple, and though it does not contain a microprocessor, it could be connected to a computer for more sophisticated analysis. It comprises two signal conditioners to convert the outputs of the speedometer and the fuel-flow sensor to TTL levels, a divide-by-*N* counter to count fuel pulses, and a 3-digit latching counter and display to count odometer pulses. A pair of one-shots (monostable multivibrators) are used to latch and then clear the display.

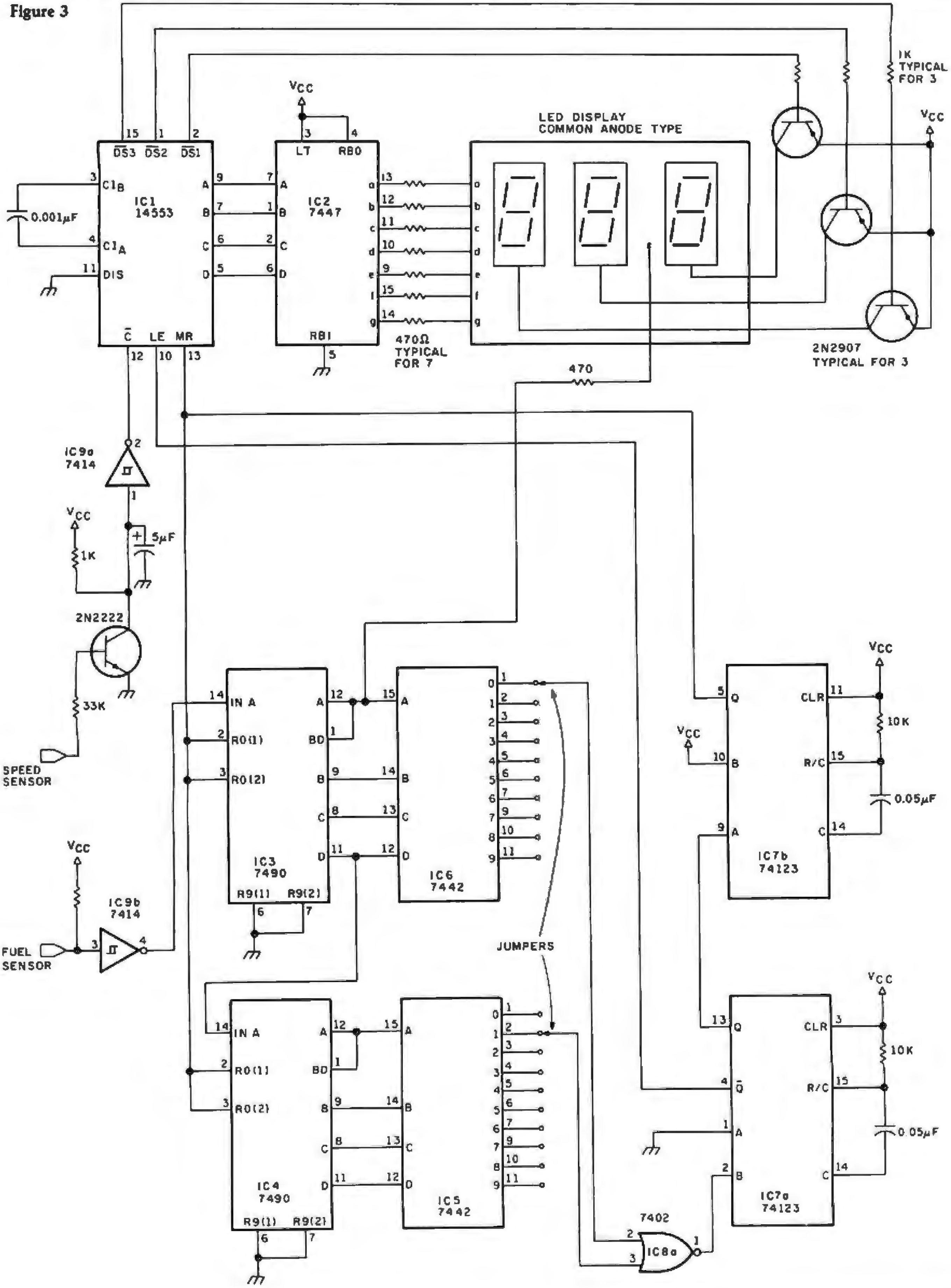
My odometer sends 376 pulses per tenth of a mile. I do not know how the pulses are created inside the speedometer case, but, with an oscilloscope and a resistor-substitution box, I determined that the pulse train switches between 0 and 5 V with a 50% duty cycle and has a 1 k-ohm impedance.

In the fuel sensor, a rotating vane interrupts a light beam from a 12 V bulb to a phototransistor 3730 times per gallon.

Dividing 3730 by 376 gives 9.92 (ie: roughly 10), so if I count 10 pulses from the flow sensor with the divide-by-*N* counter and then display the count from the odometer, it will read tenths of a mile per gallon. This reading is converted to mpg (miles per gallon) by shifting the decimal point left one place. Two 7490 decade counters, two 7442 BCD-to-decimal decoders, and a NOR gate make up the divide-by-*N* counter where *N* can be any number from 0 to 99 by moving the inputs to the NOR gate to the appropriate pins on the 7442s. As an extra, I tied the decimal point to the least-significant bit of the flow counter so that the decimal point blinks as the fuel flows. On the highway, the decimal point blinks about once per second and the mpg reading is updated about every five seconds. The readout can be converted to display miles per hour by switching the input to the first one-shot from the divide-by-*N* counter to a 555 timer with a 9.6-second period.

My question concerns the interfaces from the sensors to the TTL. The two interface circuits I show on the schematic were designed by trial and error because transistors are a mystery to me (I used the 2N2222 because it is ubiquitous). The buffer from the odometer seems to work well enough, but I occasionally get erratic readings from the flow sensor, which is mounted to the car body near the distributor and ignition coil. Should I be using shielded cable or provide filtering before feeding the signal to the Schmitt trigger? If you can

Figure 3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IC2
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TYPICAL FOR 3
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TYPICAL
FOR 7
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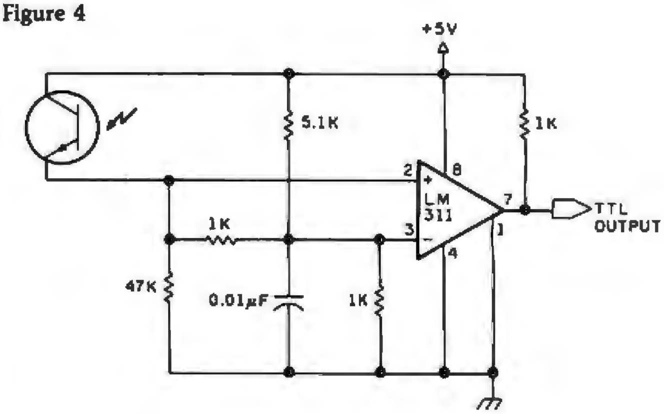
offer any improvements to either interface I would appreciate it.
Roger H James

*If I were you, I would use shielded cable between the sensors and the logic board. The pulse output, as you said, is a result of the gasoline flow causing the wheel to spin and interrupt a light beam. Figure 4 is a circuit which more readily conditions phototransistor pulse outputs. It might help. Also, I have provided a magnetic-transducer conditioner (see figure 5), if you eventually care to use a magnetic pickup to acquire speed data....*Steve ■

Power Connections for Figure 3

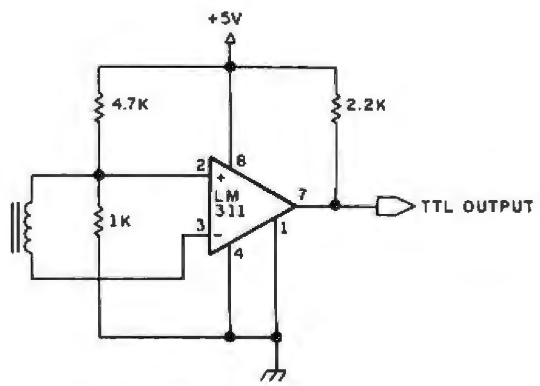
Number	Type	V_{cc}	GND
IC1	14553	16	8
IC2	7447	16	8
IC3	7490	5	10
IC4	7490	5	10
IC5	7442	16	8
IC6	7442	16	8
IC7	74123	16	8
IC8	7402	14	7
IC9	7414	14	7

Figure 4



ISOLATOR / PULSE CONDITIONER

Figure 5



MAGNETIC PICKUP CONDITIONER

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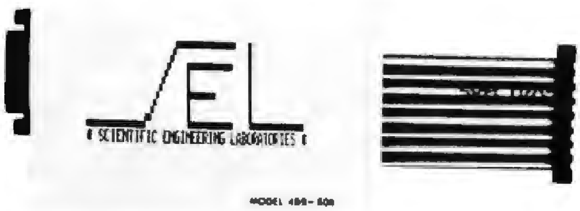

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BYTE's Bits

Clarifications to TRS-80 ROM Article

After reading Terry Li's article in the October 1980 BYTE ("Radio Shack's Modifications to the TRS-80," page 182), I feel I must make a few comments.

Adding lowercase to the TRS-80 Model I is *not* done by adding or changing a ROM (read-only memory). In an unmodified TRS-80, seven programmable memory integrated circuits are used for the video display. When the lowercase modification is performed, an eighth programmable memory device is added for bit 6, which indicates upper- or lowercase characters.

In some cases, a new character generator ROM is added because earlier model TRS-80s had character generators that did not give good lowercase characters.

To use lowercase, the Level II BASIC ROMs must be upgraded. The INKEY$ problem seems to indicate that this is done when the lowercase modification is installed.

LPRINTing a character after PEEKing it from video memory is possible. A simple BASIC statement can check to see if the character is in the valid range for the printer. If it is not, another statement can change the ASCII (American Standard Code for Information Interchange) value to a valid one.

The new Level II BASIC ROMs do not have a smaller capacity (less bytes of memory). Some changes have been made that consumed some of the memory space originally used by the messages "RADIO SHACK LEVEL II BASIC" and "MEMORY SIZE". The entry points for all I/O (input/output) routines are unchanged, so most of the present TRS-80 software will work. Also, no routines have been eliminated.

With the old Level II BASIC ROMs, the shift-down-arrow gives control characters when other keys are pressed with it simultaneously. However, the value 26 is generated first. When the shift-down-arrow key is not released, then pressing other keys generates the control values (eg: 01 for "A"). Most software that uses the control value feature of the TRS-80 neglects the value 26. Any of this software, however, should work with the new Level II BASIC ROMs.

In regard to using the Electric Pencil with the TRS-80, a number of publications have presented information on how to use the Electric Pencil with the Radio Shack lowercase modification. Some commercial software is also available for modifying the Electric Pencil.

Thomas de Man
Voszegge 7
2318 ZJ Leiden
Holland

Sources at Radio Shack told me that all points made in this letter are essentially correct. However, Radio Shack would like a few points clarified: When the lowercase modification is performed by Radio Shack, the character generator ROM is often replaced because early Model I TRS-80s had character generators that had lowercase characters without descenders that fell below the line (eg: "y," "g," and "p"). The new ROM gives these letters true descenders, thus making these letters much easier to read.

The new Level II BASIC ROMs use the same amount of memory as did their predecessors. Radio Shack has modified some code to correct keyboard bounce and cassette loading problems, and some new code has been added. Radio Shack stresses that all the original routines are still contained in the ROMs and the entry points for all published *routines remain unchanged*....SM

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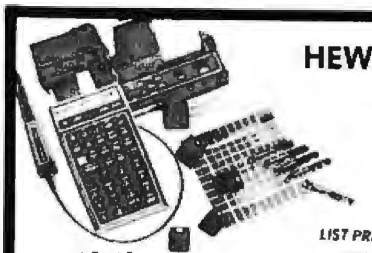

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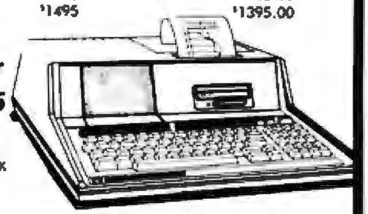

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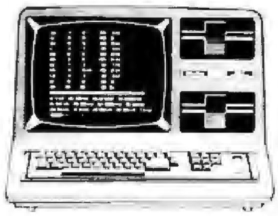

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The Pascal Data Base. Data base for the Apple II. Floppy disk, $400. Arizona Computer Systems Inc, POB 125, Jerome AZ 86331.

Information Master. Data base for the Apple II. Floppy disk, $150. High Technology, POB 14665, Oklahoma City OK 73113.

(T.(L.C))-LISP. Version of LISP programming language for CP/M computers. Cassette, $150. The LISP Company, POB 487, Redwood Estates CA 95044.

Linear Circuit Analysis Program. Electronics analysis program for the PET/CBM. Cassette, price not available. Commodore Business Machines (UK) Limited, 818 Leigh Rd Trading Estate, Slough Berks, England.

Single Disk Sort Version 2.0. Disk-sort utility for the Apple II. Floppy disk, $49.95. Datacope, 5706A W 12th St, PO Drawer AA, Hillcrest Sta, Little Rock AR 72205.

Text File Copy. Word-processing utility for the Apple II. Floppy disk, $49.95. Datacope, 5706A W 12th St, PO Drawer AA Hillcrest Sta, Little Rock AR 72205.

The Datacope Scribe. Word processor for the Apple II. Floppy disk, $79.95. Datacope, 5706A W 12th St, PO Drawer AA, Hillcrest Sta, Little Rock AR 72205.

Microcomputer-Aided Design of Active Filters. Electronics analysis program for the Apple II. Cassette, $16.95. Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662.

Super Nova. Graphics game for the TRS-80. Cassette, $14.95. Big Five Software Company, POB 9078-185, Van Nuys CA 91409.

Up Periscope. War game for the TRS-80. Cassette, $14.95. Ramware, 6 South St, Milford NH 03055.

Warpath. War game for the TRS-80. Cassette, $14.95. Ramware, 6 South St, Milford NH 03055.

Disk-O-Tape. Utility program for the Apple II. Cassette, $12. Dann McCreary, POB 16435, San Diego CA 92116.

Asteroids in Space. Graphics game for the Apple II. Floppy disk, $19.95. Quality Software, 6660 Reseda Blvd, Suite 105, Reseda CA 91335.

Monty Plays Monopoly. Computer-opponent program for the Apple II. Floppy disk, $34.95. Personal Software Inc, 1330 Bordeaux Dr, Sunnyvale CA 94086.

The Voice. Utility program for the Apple II. Floppy disk, $39.95. Muse Software, 330 N Charles St, Baltimore MD 21201.

Interactive Fiction: Six Micro Stories. Role-playing game for the TRS-80. Floppy disk, $14.95. Adventure International, POB 3435, Longwood FL 32750.

Pascal/Z Version 3.0. Version of Pascal programming language. Eight-inch floppy disk, $395. Ithaca Intersystems Inc, 1650 Hanshaw Rd, POB 91, Ithaca NY 14850.

Adaptable UCSD Pascal System for CP/M. Version of UCSD Pascal programming language for CP/M systems. Eight-inch floppy disk, $350. Softech Microsystems, 9494 Black Mountain Rd, San Diego CA 92126.

Asteroid. Graphics game for the Apple II. Floppy disk, $19.95. Adventure International, POB 3435, Longwood FL 32750, (305) 682-6917.

EMU 02. 6502 machine-language emulator for the TRS-80. Cassette, $24.95. Allen Gelder and Company, POB 11721, Main PO, San Francisco CA 94101.

Super Step. Single-step routine for Z80 machine language on the TRS-80. Cassette, price not available. Allen Gelder and Company, POB 11721, Main PO, San Francisco CA 94101.

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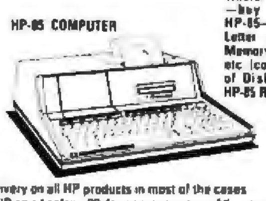

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Software Received

utility to relocate Radio Shack T-BUG software. Cassette, $9.95. Allen Gelder and Company, POB 11721, Main PO, San Francisco CA 94101.

Enhanced Paper Tiger Graphics Software. High-resolution image printer for the Apple II. Floppy disk, $44.95. Computer Station, 12 Crossroads Ctr, Granite City IL 62040.

Visilist. Utility program for VisiCalc and the Apple II. Floppy disk, $19.95. Computer Station, 12 Crossroads Ctr, Granite City IL 62040.

Mailing List. Mailing list software for Heathkit/Zenith computers. Floppy disk, $49.95. Hayden Book Company, 50 Essex St, Rochelle Park NJ 07662.

Programming in Apple Integer BASIC. Tutorial software. Floppy disk, $39.95. Hayden Book Company, 50 Essex St, Rochelle Park NJ 07662.

Conflict. War game for the Apple II. Cassette, price not available. Keating Computer Services Pty Ltd, POB 448, Double Bay, Australia 2028.

Indexed Sequential Access Method. ISAM disk software for the PET/CBM computers. Floppy disk, $99.95. Creative Software, POB 40, Mountain View CA 94040.

Mychess. Chess program with graphics for the TRS-80. Floppy disk, $50. Computer Services, 2431 Lyvona, Anchorage AK 99502.

Helicopter Battle. Graphics game for the Atari 400 or 800. Cassette, $9.95. Custom Electronics Inc, 238 Exchange St, Chicopee MA 01013.

Tractor Beam. Graphics game for the Atari 400 or 800. Cassette, $9.95. Custom Electronics Inc, 238 Exchange St, Chicopee MA 01013.

Disk Cataloger. Disk-utility program for the TRS-80. Cassette, $16.95. Hayden Book Company, 50 Essex St, Rochelle Park NJ 07662.

Energy Miser. Energy-use estimation utility. Cassette, $19.95. Hayden Book Company, 50 Essex St, Rochelle Park NJ 07662.

Chem Lab Simulations 1 and 2. Tutorial simulation programs for the Apple II. Floppy disk, $99.95 each. High Technology, POB 14665, Oklahoma City OK 73113.

Infinite BASIC. BASIC-language utility for the TRS-80. Floppy disk, $49.95. Racet Computes, 702 Palmdale, Orange CA 92665.

Infinite Business. Extension to Infinite BASIC (see separate listing). Floppy disk, $29.95. Racet Computes, 702 Palmdale, Orange CA 92665. ■

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BYTE's Bugs

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The program for "Lost Dutchman's Gold," by Bob Liddil (December 1980 BYTE, page 268) was translated from the Radio Shack TRS-80 to the Apple II by Jamie Tietjen.

Moore's Number

The October 1980 BYTE contained an error on page 347 in the "What's New" section. The phone number for Moore Business Forms Inc should read (800) 323-8325. We are sorry for the inconvenience this has caused. ■

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	DT80/5 APL CRT	2,095	200	112	75
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	1500 CRT Terminal	1,095	105	58	40
	1552 CRT Terminal	1,295	125	70	48
QUME	Letter Quality KSR, 55 CPS	3,395	326	181	123
	Letter Quality RO, 55 CPS	2,895	278	154	104
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	2621P CRT Terminal	2,650	255	142	96

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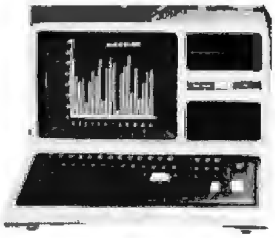

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Books Received

The following is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

The Art of Electronics. Horowitz and Hill. New York: Cambridge University Press, 1980. 17.7 by 25.1 cm (7¼ by 10¼ inches), 716 pages, hardcover, ISBN 0-521-23151-5, $24.95.

Computer Programming in the BASIC Language. Neal Golden. New York: Harcourt, Brace, Jovanovich Inc, 1981. 15.3 by 22.6 cm (6¼ by 9¼ inches), 312 pages, hardcover, ISBN 0-15-359090-4, $7.50.

Computer Security, A Management Audit Approach. Norman L Enger and Paul W Howerton. New York: AMACOM, 1980. 15.3 by 22.6 cm (6¼ by 9¼ inches), 264 pages, hardcover, ISBN 0-8144-5582-4, $21.95.

Data Base: Structured Techniques for Design, Performance, and Management. S Atre. Somerset NJ: John Wiley & Sons, 1980. 15.3 by 22.6 cm (6¼ by 9¼ inches), 442 pages, hardcover, ISBN 0-471-05267-1, $27.95.

Electrical Wiring Handbook. Edward L Safford. Blue Ridge Summit PA: Tab Books Inc, 1980. 12.5 by 20.2 cm (5⅛ by 8¼ inches), 432 pages, softcover, ISBN 0-8306-1245-9, $8.95; hardcover, ISBN 0-8306-9932-5, $15.95.

Handbook of Microprocessor Applications. John A Kuecken. Blue Ridge Summit PA: Tab Books Inc, 1980. 12.5 by 20.2 cm (5⅛ by 8¼ inches), 308 pages, softcover, ISBN 0-8306-1203-3, $8.95; hardcover, ISBN 0-8306-9935-X, $14.95.

Pascal. David L Heiserman. Blue Ridge Summit PA: Tab Books Inc, 1980. 12.5 by 20.2 cm (5⅛ by 8¼ inches), 350 pages, softcover, ISBN 0-8306-1205-X, $9.95; hardcover, ISBN 0-8306-9934-1, $15.95.

Principles of Firmware Engineering in Microprogram Control. Michael Andrews. Potomac MD: Computer Press Inc, 1980. 15.3 by 22.6 cm (6¼ by 9¼ inches), 347 pages, hardcover, ISBN 0-914894-63-3, $21.95.

Programming in BASIC for Personal Computers. David L Heiserman. Englewood Cliffs NJ: Prentice-Hall Inc, 1981. 15.3 by 22.6 cm (6¼ by 9¼ inches), 333 pages, softcover, ISBN 0-13-730739-X, $7.95; hardcover, ISBN 0-13-730747-0, $17.95.

A Reference Guide to Practical Electronics. Robert G Krieger Sr. New York: McGraw-Hill Book Company Inc, 1981. 13.1 by 20 cm (5⅜ by 8 inches), 212 pages, softcover, ISBN 0-07-0345492-8, $7.50.

6502 Software Design. Leo J Scanlon. Indianapolis IN: Howard W Sams Company Inc, 1980. 13.1 by 20.8 cm (5⅜ by 8½ inches), 270 pages, softcover, ISBN 0-672-21656-6, $10.50.

Z8000 Assembly Language Programming. Leventhal, Osborne, Collins. Berkeley CA: Osborne/McGraw-Hill, 1980. 15.9 by 22.6 cm (6½ by 9¼ inches), 604 pages; softcover, ISBN 0-931988-36-5, $19.99.■

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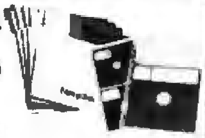

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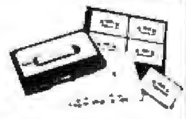

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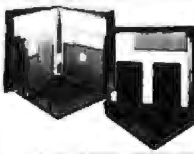

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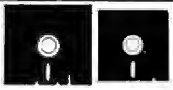

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Book Reviews

How To Program Your Programmable Calculator

by Dr Stephen L Snover and Dr Mark A Spikell, Prentice-Hall Inc, Englewood Cliffs NJ, 1979, 271 pages, softcover, $7.95

Reviewed by
Richard Keck
Rte 1
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How To Program Your Programmable Calculator is a very versatile book, with many examples from simple straightline programs to complex decision-making loop programs for calculus. The book has two sections: one for the TI-57 and EC-4000 calculators, and the other for the HP-33E. Examples and presentation are identical with the exception of different keystrokes for the different sections.

The book can also be used as an aid in deciding which calculator to buy. Using the book does not require a programmable calculator.

Due to the large number of examples and explanations, this book should be useful in a classroom environment. Since it has over 100 problems, as well as answers, it can easily be used as an introduction to programming or as a mini-unit on the use of programmable calculators in the classroom.

The book is specifically designed for the less expensive programmable calculators. However, as a TI-58 owner, I believe its usefulness as a reference manual for subroutines is reason enough for even experienced calculator programmers to purchase it. Whether you are new to programmable calculators or an old pro, *How To Program Your Programmable Calculator* is a valuable addition to your library of programs and books. ■

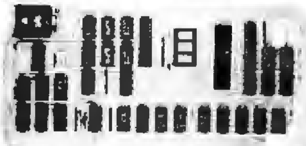
Structured Pascal

by Jean-Paul Tremblay, Richard B Bunt, and Lyle M Ospeth, McGraw-Hill Book Company, Hightstown NJ, 1980, $10.95

Reviewed by
Peter Grogono
4125 Beaconsfield Ave
Montreal, Quebec
H4A 2H4 Canada

Structured Pascal is a textbook for a first course in a computer-science curriculum at the university level. It is a supplement to *An Introduction to Computer Science: An Algorithmic Approach* by the same authors, but can be used independently. It is a bulky book, measuring 8½ by 11 inches, and although it contains more than 400 pages, there are no diagrams. Although primarily intended as a language manual, *Structured Pascal* is also concerned with programming style and contains many example programs. These programs are more varied than those customarily found in introductory texts, and each is presented in the form of a complete listing with examples of input and output, not as a collection of fragments. The range of applications is wide. In addition to programs that implement standard algorithms such as sorting, searching, Gaussian elimination, and numerical integration, there are programs which compute pari-mutuel payoffs and mortgage payments, and which process hockey-league results, transpose musical scores, and add polynomials. The book is fairly well organized, but there are some anomalies. For example, the Pascal CASE statement is described in a chapter entitled "Advanced String Processing."

It is unfortunate that a book that attempts to do so much should be so flawed.



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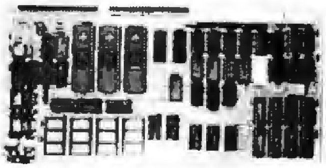

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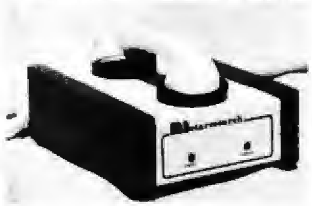

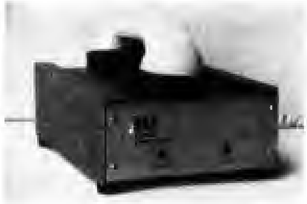

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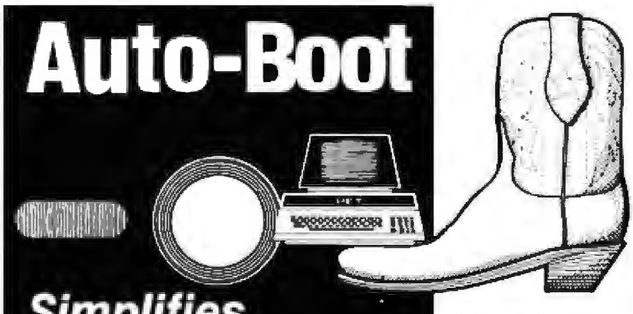

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Some of the flaws are minor; they seem to be due to the fact that this book, like so many recent texts, is a set of lecture notes prepared for publication. The choice of the programming language used for the examples (a local dialect of Pascal called Manitoba Pascal) seems to be the cause of some major problems.

There are two differences between standard Pascal and Manitoba Pascal that have a major impact on the value of the book to the ever-growing Pascal community. The first difference is that Manitoba Pascal provides slightly more flexibility in string processing than does standard Pascal. String-handling capabilities are used extensively in the examples, and two chapters are devoted almost entirely to "strings and things." The examples make frequent use of a predefined set of somewhat inefficient and inflexible string-handling procedures and functions. Consequently, they are not really Pascal programs at all; they are programs in a primitive string-processing language that happens to have been embedded in Pascal. The problem here, and in other sections of this book, is that Pascal is treated as a poor man's PL/1, and is not allowed to stand on its own.

The second difference between Manitoba Pascal and standard Pascal is minor, but it has had a serious effect on the book. Students at the University of Saskatchewan punch their programs on cards, and keypunch machines do not have keys for square brackets. Consequently, where standard Pascal has '[...]', Manitoba Pascal has '(...)'. Computer users of 1980 are inconvenienced by the technology of 1890. In Pascal, '(A,B,C,D)' is an enumerated-type descriptor, and '[A,B,C,D]' is a set constant. Enumerated types are an abstraction of the constant identifiers frequently used in assembly-language programs to represent a small number of states or choices, and sets are an abstraction of bit-strings. They are among the innovations of Pascal that are particularly notable for their expressive power. Yet, in *Structured Pascal* these two useful constructions are hopelessly confused. On page 11, we are shown an enumerated-type declaration and told that it is a "set"; furthermore, we are incorrectly told that "set operations" may be applied to enumerated types, but we are told neither here nor elsewhere how these set operations are represented in Pascal. Later, on page 255, we are told, "Pascal does not have bit-strings." It is not surprising that the example programs make use of neither set types nor enumerated types; in fact, the programs hardly employ user-defined types at all.

Is this just a question of style? Does it really matter if some people use more type declarations than others in their Pascal programs? My own view is that it does matter. The lesson of the Sixties was that programming languages must be more expressive, not just more powerful. This is what structured programming and data abstraction are all about. In *Structured Pascal* (note the title!), structured programming is defined in one sentence on page 4: "Structured programming is really little more than the application of a particular discipline to the practice of programming." This is the attitude of people who "go on a diet" rather than eat nutritious food regularly. It is more than a question of style when a textbook that professes to describe a programming language entirely omits the most expressive features of that language. ■

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January
Courses from Zilog, Boston MA and Cupertino CA. Three- to 5-day courses on microprocessors, the Z8000 and Z8 circuits, programming, and architecture are being offered by Zilog, Training and Education, 10340 Bubb Rd, Cupertino CA 95014, (408) 446-4666, Attn: Kathy Trappen. Contact Zilog for a complete schedule of places and times.

January-February
Courses from George Washington University, Washington DC. Computer-performance evaluation, communication systems and networks, microcomputers in control systems, structured programming, and protection of computer assets are some of the areas of study being presented in these courses from George Washington University. Contact the Director, Continuing Engineering Education, George Washington University, Washington DC 20052, (800) 424-9773.

January-February
Data Processing Courses, Houston and Dallas TX, and London, England. Data-processing operations management and fundamentals of data processing for executives are the courses offered by the University of Chicago. For schedules of times, and additional information, contact the University of Chicago, Center for Continuing Education, MC Seminar Division, 1307 E 60th St, Chicago IL 60637, (800) 223-7450. In New York state, call collect (212) 953-9022.

January-March
Courses from Intel, Boston MA, Chicago IL, and San Francisco CA. Introductions to microprocessors and microcomputers; 8080/8085, and 8086/8088 system design workshops; development systems workshops; peripheral integrated-circuit-design workshops; and other courses are being offered by Intel Corporation. For a list of times and fees, contact Intel Corporation, Customer Training Department, 3065 Bowers Ave, Santa Clara CA 95051, Attn: Registrar—MS SV3-1.

January-June
Seminars from Worcester Polytechnic Institute, various cities in eastern Massachusetts. The Continuing Professional Education Department of WPI (Worcester Polytechnic Institute) is presenting 2-day seminars on fundamentals of data processing, distributed systems, data communications, microprocessors, and other computer-related

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January 8-11
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January 17-23
The First Annual Alpha Micro User's Society Convention, Deauville Hotel, Miami Beach FL. Seminars; conferences; demonstrations; meetings for businessmen, programmers, and analysts are being featured. The convention is strictly for Alpha Micro users. Contact William L Miller & Associates, 8380 SW 151 St, Miami FL 33158, (305) 233-1216.

January 27-29
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January 28-31
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February 1981

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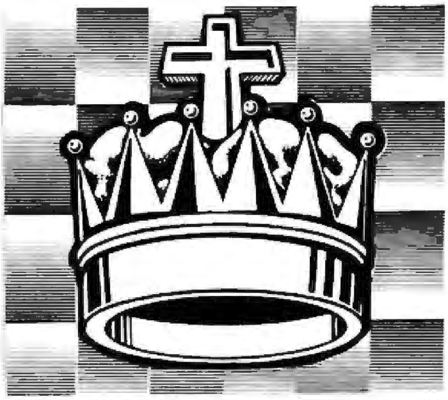

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FINPLAN: A Financial Planning Program for Small Business (Montgomery) Allows you to enter data from a balance sheet into the program, to make assumptions about future growth of business, and to have the computer project results for up to a five year period based on those assumptions. And if you change any data, the program revises all resulting data automatically. The disk version can only be used with TRSDOS Version 2.3. *05103, TRS 80 Level II tape, $69.95; 05108, TRS-80 Level II Disk Version, $74.95*

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MCAP: A Microcomputer Circuit Analysis Program (Savon) Performs a linear voltage, impedance, or transfer impedance analysis of an electronic circuit. *04501, PET; 04503, TRS-80 Level II; 04504, Apple II; each tape $24.95; 04513, Heathkit-Zenith Disk, $29.95*

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DISK CERTIFIER AND COPIER (Jace Inc.) A handy utility program that certifies the acceptability of blank diskettes and rejects those with flaws. It also includes a fast machine language disk copying program that will work on single and dual drive systems. *07809, APPLE II Disk, $19.95*

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February 14-16

International Conference on Microcomputer Applications to Industrial Controls, Jadavpur University, Calcutta, India. Papers will be presented on the applications of microcomputers to industrial controls in the areas of general systems. Contact Dr Sushil Dasgupta, Professor and Head, Electrical Engineering Department, Jadavpur University, 40B, Southern Ave, Calcutta-700029, India.

February 17-18

Integrating Word Processing and Electronic Data Processing: Technology, Architecture, Planning, The Harvard Club, New York NY. The topics of this seminar will be the study of word processing today and its future, the evaluation and selection of systems, electronic mail and communications, and the automated office. For further details, contact the seminar coordinators at the Center for Management Research, 850 Boylston St, Chestnut Hill MA 02167, attn: Ms Karen Smolens, (617) 738-5020.

February 18-20

Business- and Personal-Computer Sales and Exposition and the Houston Business Show, Houston Civic Center, Capitol Ave and Bagby St, Houston TX. Data-processing managers, systems analysts, programmers, educators, hobbyists, and user's groups will find this exposition useful. The business show is primarily designed for purchasing and office managers, executives, business owners, attorneys, accountants, and physicians. For details, contact Produx 2000 Inc, POB 2000, Bala Cynwyd PA 19004, (215) 457-2300.

February 23-26

Computer Science Conference, Stouffer's Riverfront Towers Hotel, St Louis MO. The conference is sponsored by the ACM (Association for Computing Machinery). The Ninth Annual Computer Science Employment Register will be conducted. This register aids in matching computer scientists and data-processing specialists with employer opportunities. For information, contact Orrin E Taulbee, ACM Computer Science Employment Register, Department of Computer Science, University of Pittsburgh, Pittsburgh PA 15260, (412) 624-6475.

February 26-27

Louisiana Computer Exposi-

tion, University of Southwestern Louisiana, Lafayette LA. Papers will be read on operating systems, data-base management and support, distributed computers systems, and related topics. Contact William R Edwards, c/o the Computer Science Department, University of Southwestern Louisiana, POB 44330, Lafayette LA 70504, (318) 264-6284.

March 1981

March 8-11
TI-MIX 1981, Marriott Hotel, New Orleans LA. This is a conference for Texas Instruments equipment users. Thirty-six sessions consisting of individual presentations, panel discussions, and workshops, are planned. Two exhibit rooms featuring the latest computer equipment from Texas Instruments will be open. Contact TI-MIX, M/S 2200, POB 2909, Austin TX 78769, (512) 250-7151.

March 11-13
Business- and Personal-Computer Sales and Exposition and New York Business Show, Madison Square Garden, New York NY. See February 18-20 for details.

March 17-20
The Fourteenth Annual Simulation Symposium, Tampa FL. Papers describing digital discrete simulation and other techniques, such as continuous or analog, will be read. This symposium is a forum for the exchange of ideas and techniques in computer simulation. Contact Annual Simulation Symposium, POB 22621, Tampa FL 33622.

March 23-25
Office Automation Conference, Albert Thomas Convention Center, Houston TX. This conference will present seminars on concepts and methods behind the latest office technologies and an exhibit of equipment. Contact Office Automation Conference, POB 9659, Arlington VA 22209, (703) 558-3617.

March 24-26
The Southwest Semiconductor Exposition, Phoenix Civic Plaza Convention Center, Phoenix AZ. Over 140 equipment and materials makers will exhibit over $12 million of semiconductor, hybrid, and printed-circuit-board production, processing, and test equipment. Contact Cartlidge & Associates Inc, 491 Macara Ave, Suite 1014, Sunnyvale CA 94086, (408) 245-6870.

March 31-April 2
Cincinnati Business Show, Cincinnati Convention-Exposition Center, Cincinnati OH. Office equipment and services including automated systems, communications, computers, telephone systems, word processing, data processing, printing equipment, and other office supplies, will be featured. A program of business seminars is also scheduled. Contact Ray G Nemo, 5679 Creek Rd, Cincinnati OH 45242, (513) 531-5959.■

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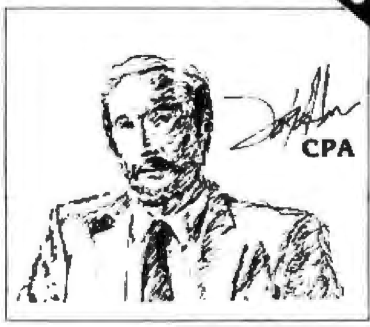

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Heath Users Club

The Triad Heath Users Group meets at 1 PM on the second Saturday of each month at the Sears Activity Room in the Hanes Mall in Winston-Salem, North Carolina. Contact Hughes Hoyle at (919) 378-1050, or Steve Minor, 424 Cliffdale Dr, Winston-Salem NC 27104, (919) 765-7717.

WATNEWS

The Computer Systems Group at the University of Waterloo is the publisher of *WATNEWS*, a newsletter on educational computing. *WATNEWS* describes software systems that are developed at the University of Waterloo. The newsletter's purpose is to communicate with people involved in the presentation of computer science, business data processing, and related courses. Some of the software featured in the newsletter includes Waterloo BASIC for the Commodore PET and an enhanced version for the IBM Series I computer. Other articles have featured a Pascal compiler and structured programming in macroassembly languages. For more information, contact *WATNEWS*, Computer Systems Group, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1, (519) 885-1211.

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Individual memberships for $10 and corporate memberships for $25 can be obtained from Group/380, POB 1131, Mt Shasta CA 96067. Members will receive a newsletter, instructions for program submissions, and access to a computerized data base of relevant hardware and software information.

Independent Heathkit Vendors Listed

Heathkit computer owners can find the hardware and software they need with this directory of suppliers compiled by *Buss: The Independent Newsletter of Heath Company Computers*. The newsletter includes over sixty suppliers of Heathkit-compatible products. The suppliers are not affiliated with Heath. The *Buss* directory is available for $7.50 from *Buss*, 325-B Pennsylvania Ave SE, Washington DC 20003, (202) 544-0484.

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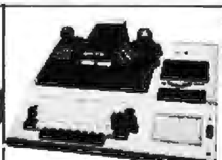

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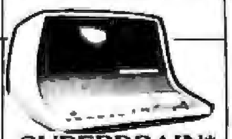

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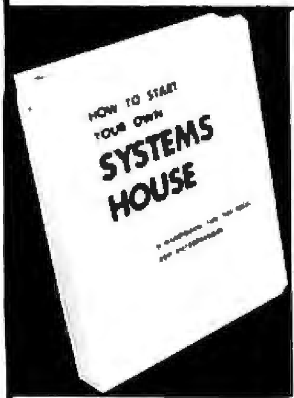

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6th edition, March 1980

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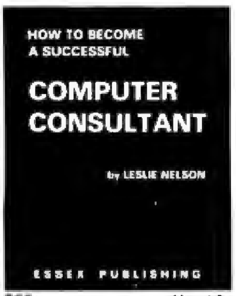

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Newsletter for the Sinclair ZX80 Microcomputer

Syntax ZX80 is a monthly newsletter for Sinclair ZX80 users. Featuring news and reviews of ZX80 hardware and software, the publication focuses on the Z80A-based microcomputer from Sinclair Research Ltd, Cambridge, England. The newsletter provides forecasts of applications, technical details for homebrewers, and a forum for users to share advice about programs and vendors. The yearly subscription rate (twelve issues) is $25. *Syntax ZX80* is available from Ann Zevnik, Editor, The Harvard Group, Bolton Rd, RD 2, Box 457, Harvard MA 01451, (617) 456-3661.

OSI Users Group

An OSI (Ohio Scientific) users group is forming in New Jersey. Contact the OSI Users Group, 4 Swimming River Rd, Lincroft NJ 07738, (201) 747-8888, atten: Bob Childs.■

BYTE's Bits

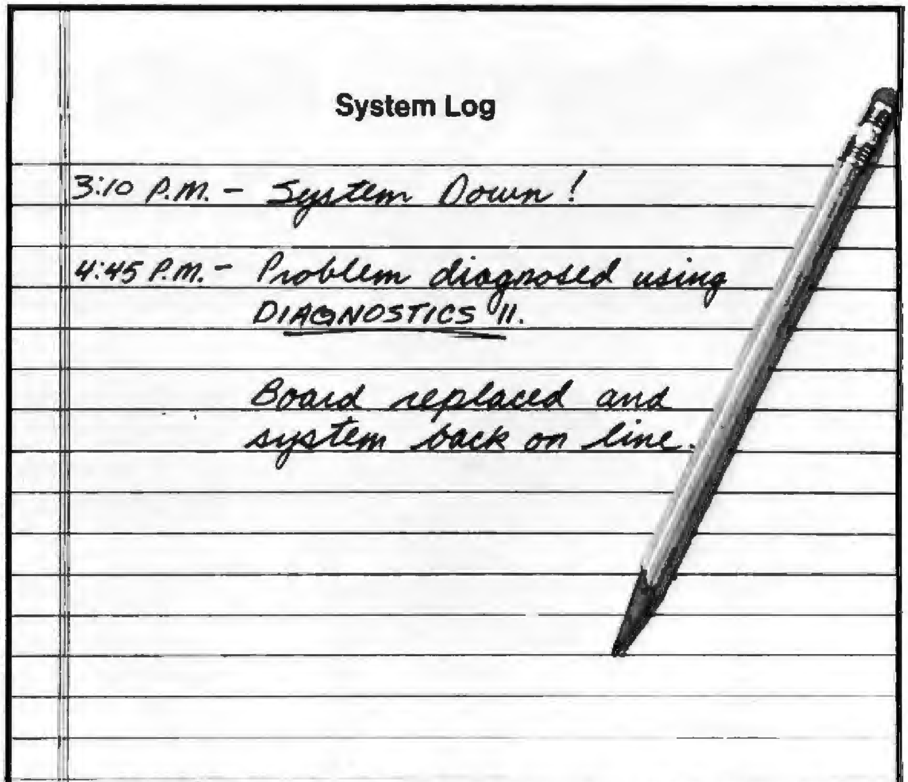
Free MusicSystem Updates

If you have purchased Mountain Hardware's MusicSystem, a music-synthesis package for the Apple II contained in a combination of hardware and software, you are entitled to receive, free of charge, version 2.0 of the MusicSystem software, if you did not receive it with your purchase. According to Avery E Dee, vice president of marketing at Mountain Hardware, copies of the MusicSystem with earlier releases of the software (probably version 1.2) were sold with the intention of sending the version 2.0 software free of charge to registered owners. Unfortunately, the company has no way to contact owners who have not sent in the MusicSystem warranty card.

Version 2.0 of the software includes significant improvements in the capabilities of the system, including user definition of musical instruments, quicker file loading, and printout of musical scores on the Apple Silentype printer. MusicSystem owners who have not received version 2.0 of the system software should send in their warranty cards (indicating the version received with the system) or call or write Mountain Hardware Inc at 300 Harvey West Blvd, Santa Cruz CA 95060, (408) 429-8600.

Radio Network for 6502 Microcomputer Users

There now are three radio nets for the microcomputer user on the amateur-radio frequencies. The East Coast Apple Net is on or near 7260 kHz every Saturday morning at 1300 UTC (Coordinated Universal Time)—ie: 9 AM Eastern Daylight Time. Transmission mode for this 40-meter net is lower sideband with W1UKZ in Scituate, Massachusetts, as net control. In the Greater Boston area there is a 2-meter net for those interested in Apple computers on the Norwell repeater (144.65/145.25 MHz). This net meets at 8 PM local time every Wednesday. W1UKZ, WA1ZKB, and others act as a control for this net. The Atari International Computer Net meets Tuesdays at 0100 UTC—ie: 9 PM Eastern Daylight Time, Monday evenings—with W1UKZ in Scituate again serving as the control. These nets transfer news about everyday computer subjects and specific news on computers and new products, and there are program swaps. For more information, contact David P Allen, W1UKZ, 19 Damon Rd, Scituate MA 02066. ■



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CABLES

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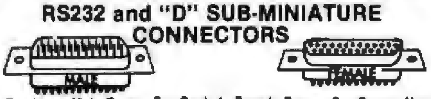

P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

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CND-DA15C	15 PIN COVER	$ 1.50	$ 1.30	$ 1.10
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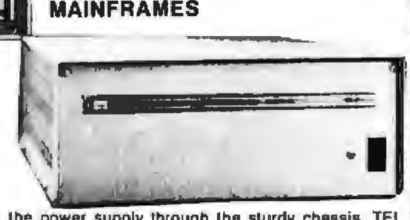

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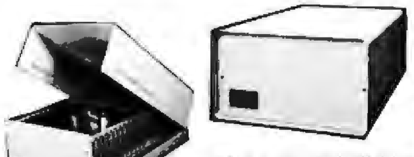

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Whose BASIC Does What?

Teri Li
POB 481
Peterborough NH 03458

Many articles have been written about the various new personal computers now on the market, including the Atari 400 and 800 and the Texas Instruments (TI) 99/4, but few have tried to compare these newer units against the most popular computers.

Because of this, I have decided to do a comparison of the four most popular computers (Apple II, Commodore PET, Exidy Sorcerer, and the Radio Shack TRS-80 Model I) against the TI 99/4 and the Atari 400 and 800. (The BASIC is the same for both the Atari 400 and 800.) To make this as fair as possible, I have compared only the computers that come with versions of BASIC supplied with the machines in ROM (read-only memory) at the time of purchase, without extended hardware (such as disk drives).

This comparison is in the form of three tables. (See tables 1 thru 3 on pages 320 thru 327.) The BASIC command, statement, or function is on the left, followed by six columns, one for each of the computers (PET, Apple II, TRS-80, Atari, TI 99/4, Sorcerer). To the right of these columns is a brief explanation of each of these commands (since not all are self-explanatory). If a particular computer interprets a BASIC command differently from the others, a notation of the difference is made.

For the Apple II computer, especially, this is true as there are two versions of BASIC which you can get with it: Integer BASIC and Applesoft. Unless otherwise stated for the Apple, the commands apply to both versions.

There are only a few additional comments that I need to make about these comparison tables.

I have not gone into a great deal of detail on the graphics capabilities of these machines, but briefly speaking, the TRS-80 has the worst point resolution, while only the Apple II, Atari 400 and 800, and TI 99/4 have color graphics. In graphics mode, the Apple II, Atari 400 and 800, and Sorcerer offer the most versatility, while the PET is the easiest to use.

Last, the TI has the most cumbersome BASIC to use. It lacks a "free memory" command, it allows only line numbers (not statements) to be used in IF . . . THEN statements, and it does not allow the use of multiple statements per line.

As for the rest, check out the tables and decide for yourself which of these computers is best suited to your needs.

The tables also have one other use. They can assist in the translation of programs from one computer to another, since they do give comparable keywords for the different computers. ■

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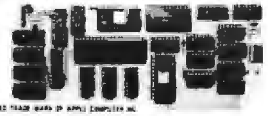

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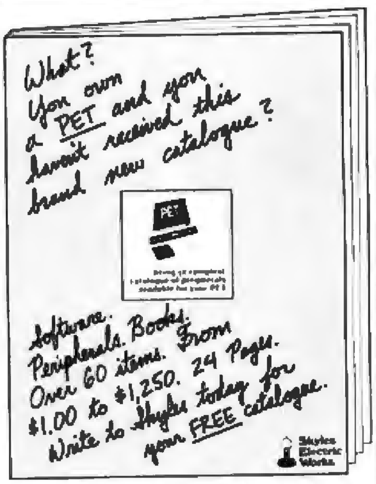

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Vancouver, WA 98665

Circle 266 on inquiry card.

System	Commodore PET	Apple II	Radio Shack TRS-80	Atari 400,800	TI 99/4	Exidy Sorcerer
AUTO *mm, n*		✓	✓		Number	
BREAK *mm*					✓	
CLEAR	CLR	✓	✓	✓		✓
CLEAR *n*			✓			
CLOAD	LOAD	LOAD	✓	✓	OLD	✓
CLOAD?	VERIFY		✓			
CONTINUE	CONT	CONT	CONT	CONT	✓	CONT
CSAVE	SAVE	SAVE	✓	✓	SAVE	✓
DELETE *mm*		DEL	✓			
EDIT *mm*	cursor	cursor	✓	cursor	cursor	
HOME		✓				
HIMEM		✓				
LIST *mm-nn*	✓	✓	✓	✓	✓	✓
LOMEM		✓				
MAN		✓				
NEW	✓	✓	✓	✓	✓	✓
RESEQUENCE *mm, nn*					✓	
RUN *mm*	✓	✓	✓	✓	✓	✓
SYSTEM	SYS	CALL – 151	✓	BYE	BYE	BYE
TROFF		NOTRACE	✓		UNTRACE	
TRON		TRACE	✓		TRACE	
UNBREAK					✓	
(Screen Format)	40 by 24	40 by 24	64 by 16	40 by 24	32 by 24	64 by 30
(Character Resolution, *m* by *n*)			3 by 2		8 by 8	8 by 8
(Total pixels)		280 by 192	128 by 48	320 by 192	256 by 192	512 by 240

Table 1: *Availability of BASIC system commands in six microcomputer families. In this table, and tables 2 and 3, a check indicates the presence of a feature in a given microcomputer BASIC, while a blank indicates its absence. A word or words in the table entry*

BASIC Statements	Commodore PET	Apple II	Radio Shack TRS-80	Atari 400,800	TI 99/4	Exidy Sorcerer
General Statements						
APPEND					✓	
CLS		✓	✓		CALL CLEAR	
CALL *address*		✓				
CALL CHAR					✓	EN
CALL COLOR				COLOR	✓	

Table 2: *Availability of BASIC statement types in six microcomputer families.*

Explanation of Command

Automatically numbers the lines of a program as you enter them from the keyboard, starting with line *mm*, using the increment *n*. Not available in Applesoft.

Sets a breakpoint at line number *mm*; program execution will halt upon reaching this breakpoint.

Sets all numeric variables to zero and all string variables to null.

Sets aside *n* bytes of memory for storage of strings; also sets numeric variables to zero and string variables to null.

Loads a BASIC program from cassette tape.

Compares a program in memory to a program on tape; the two must match exactly.

Continues execution of a program after reaching a BREAK (TI) or STOP statement (all) during program execution, or after program is halted by operator (after a Control-C, Break key, Stop key, etc).

Saves a BASIC program in memory to cassette tape.

Deletes program line *mm* from the program. The TI uses this command to delete programs or data files from its filing system.

Enters EDIT mode for line number *mm*. Lets you manipulate the characters in line number *mm*. The Apple, Atari, Exidy, and PET computers use on-screen editing to do this via LIST and cursor controls.

Moves cursor to top line, leftmost position of video, in Applesoft only. CALL −976 has same function for Integer BASIC.

Sets address of highest memory address available to a BASIC program; protects data, graphics, or machine-language routines located in high memory.

Lists all program lines between (and including) line numbers *mm* and *nn*. Apple Integer BASIC uses comma instead of hyphen.

Sets lowest address available to a BASIC program. Reset by NEW, DEL, and Control-C key.

Apple Integer BASIC only: resets AUTO line-numbering feature to manual numbering.

Deletes entire program from memory and resets all pointers and variables to zero and null.

Renumbers program from beginning or starting with line *mm*, incrementing in steps of *nn*.

Begins execution of program, starting at beginning or at line number *mm*.

Puts you in monitor mode for execution of machine-language programs. Atari and TI use BYE only to go to calculator mode from BASIC.

Turns off trace features.

Tells you which line number of the program is currently being executed. Very useful in tracking down programming bugs.

Removes breakpoint set by the BREAK command.

Normal screen format for text operation, number of characters per line by number of lines on screen.

Individual character positions on screen can be broken down into a matrix of dots, *m* rows of *n* dots per row. Not applicable to Apple II, Atari 400/800 or the PET.

Actual number of total pixels (picture elements) that can be individually turned on and off by the program when in full graphics mode.

indicates that the feature described under the "Explanation" column is available for a given computer using this name. These tables are not meant to be an exhaustive description of any of the six computer systems.

Explanation of Statement

Allows data to be added to the end of a data file.

Clears the video screen and returns the cursor to the top line, leftmost position of the video. See also HOME.

Branches to the machine-language subroutine at the specified address *addr*.

Allows you to define a new character for the video display to be used by your program.

Allows you to define the background color to be used for the individual characters.

System	Commodore PET	Apple II	Radio Shack TRS-80	Atari 400,800	TI 99/4	Exidy Sorcerer
CALL JOYSTK				STICK	✓	
CALL SCREEN		HCOLOR =		SETCOLOR	✓	
CALL SOUND				SOUND	✓	
CLOSE	✓				✓	
COLOR = *n*	✓					
DATA	✓	✓	✓	✓	✓	✓
DEF FN (*name*)	✓	✓			DEF	
DEFINT			✓			
DEFDBL			✓			
DEFSNG			✓			
DEFSTR			✓			
DIM *var(k)*	✓	✓	✓	✓	✓	
DISPLAY					✓	
DRAWTO		HPLOT		✓		
DSP *var*		✓				
END	✓	✓	✓	✓	✓	✓
EOF					✓	
ERROR (*mm*)			✓			
FOR . . . TO . . . STEP, NEXT	✓	✓	✓	✓	✓	✓
GOSUB *linenum*, RETURN	✓	✓	✓	✓	✓	✓
GOTO *linenum*	✓	✓	✓	✓	✓	✓
GR		✓				
GRAPHICS				✓		
HLIN . . . AT					CALL HCHAR	
IF *expr* THEN *linenum*	✓	✓	✓	✓	✓	✓
IF *expr* THEN . . . ELSE			✓		✓	
IF *expr* GOSUB . . . RETURN	✓	✓	✓			✓
IF *expr* GOTO	✓	✓	✓			✓
IN (*port*)		IN#*expr*	✓			✓
INPUT "*msg*", *var*	✓	✓	✓	✓	✓	✓
INPUT#*n*,*var*	✓	RECALL	✓		✓	✓
LET *var* = *expr*	✓	✓	✓	✓	✓	✓
LPRINT "*msg*" or LPRINT *var*			✓	✓		
ON ERROR GOTO *linenum*		ONERR	✓	TRAP		
ON *expr* GOSUB, RETURN	✓	✓	✓	✓	✓	✓
ON *expr* GOTO *linenum*	✓	✓	✓	✓	✓	✓

Explanation

Checks the joystick port for input.

Allows you to select the background color of the video. HCOLOR = *exp* lets you select the color to be used in hi-res (high-resolution) graphics mode in Applesoft.

Lets you define the sound output to be used by your program.

Closes device (tape, printer, etc) data file.

Sets the color of the point for the next plot (in low-resolution graphics for the Apple II).

Holds data for access by a READ statement.

Lets you define a single-line function, called by using FN and the function name.

Defines as integer all variables beginning with the specified letter, letters, or range of letters.

Defines as double-precision floating-point all variables beginning with the specified letter, letters, or range of letters.

Defines as single-precision floating-point all variables beginning with the specified letter, letters, or range of letters.

Defines as string variables all variables beginning with the specified letter, letters, or range of letters.

Allocates space in memory for a variable array with as many dimensions as numbers in *k*, and with the specified size per dimension. Apple Integer BASIC allows one-dimensional arrays only.

May be used in place of PRINT, or to specify the format of data stored on tape. DISPLAY specifies ASCII format.

Draws a line from the last plotted point to this position. HPLOT can also plot a single point in high-resolution graphics or a series of points connected in sequence.

Displays value of the specified variable each time it changes. Available in Apple Integer BASIC only.

Ends execution of program and returns to command mode.

Writes End-of-file mark to a data file.

Simulates the error specified by the number *mm*, to test ON ERROR GOTO routines.

Creates an iterative loop, with optional step size specified. If no step size is given, a step of 1 is used. Leaving a loop before it is finished will cause problems later.

Branches to the specified line number and continues program execution from that point until a RETURN is found. Execution then returns to the statement following the GOSUB command.

Branches to the specified line number.

Turns on low-resolution graphics. HGR selects page 0 of high-resolution graphics, HGR2 selects page 2.

Turns on graphics mode.

Draws a horizontal line at the specified line number. TI lets you specify the number and type of characters in the line.

Tests an expression. If it is true, the statement following the THEN is executed before executing the next program line. If it is false, program execution proceeds to the next line.

Same as above, except execution goes to the ELSE only if the argument is false. In either case, execution continues on the next program line. TI allows only line numbers after THEN and ELSE.

Same as an IF . . . THEN, except a GOSUB is executed.

If the expression is true, then program execution proceeds directly to the specified line number and continues from there.

Goes to the specified port and gets the value there. Both the argument and the result must be in the range of 0 thru 255. IN# selects specified motherboard slot for input, with 0 being the keyboard.

Goes to keyboard and awaits user input. An optional message may be printed to the video display as a prompt.

Inputs data from cassette. RECALL (for Applesoft only) reads data into single array. (Applesoft and Apple Integer BASIC have INPUT statement, too.)

Assigns the argument to the specified variable.

Sends value of the variable specified or a message contained within quotes to a printer. See also PRINT# for the PET and TI.

Error-trapping routine: if an error occurs within the program, then program execution goes to the specified line number and continues from there.

Evaluates expression; on the integer value of the expresssion, *expr*, transfers control to the *expr*th number after the word GOSUB. Returns to line after this line when RETURN is encountered.

Same as above except control does not return to next line.

System	Commodore PET	Apple II	Radio Shack TRS-80	Atari 400,800	TI 99/4	Exidy Sorcerer
OPEN	✓				✓	
OPTION BASE (x)					✓	
OUT *portnum, val*		PR#*expr*	✓			
PADDLE		PDL		✓		
PEEK	✓	✓	✓	✓	CALL GCHAR	✓
POINT			✓			
POP		✓		✓		
POKE *locn, val*	✓	✓	✓	✓		✓
PRINT *"msg"* or PRINT *var*	✓	✓	✓	✓	✓	✓
PRINT@			✓	POSITION		
PRINT#	✓	✓	✓		✓	✓
PRINTUSING			✓			
PTRIG				✓		
READ *var,var . . .*	✓	✓	✓	✓	✓	✓
RECALL		✓				
REM	✓	✓	✓	✓	✓	✓
RESET *(x,y)*			✓			
RESTORE	✓	✓	✓	✓	✓	✓
RESUME *linenum*		✓	✓			
SET *(x,y)*		PLOT, HPLOT	✓	PLOT		
SPEED = *expr*		✓				
STOP	✓	✓	✓	✓	✓	✓
STORE		✓				
TAB	✓	✓	✓		✓	✓
TEXT		✓				
UPDATE					✓	
VLIN . . . AT		✓			CALL VCHAR	
VTAB (x)		✓				
WAIT *A,B,C*	✓	✓				✓
String Functions						
ASC (*string*)	✓	✓	✓	✓	✓	✓
CHR$ (*code*)	✓	✓	✓	✓	✓	✓
FRE (X$)	✓		✓	✓		✓
INKEY$	GET	GET	✓		CALL KEY	
LEFT$ (*string,n*)	✓	✓	✓			✓
LEN (*string*)	✓	✓	✓	✓	✓	✓
MID$ (*string,p,n*)	✓	✓	✓		SEG$	✓
POS (*str1,str2,n*)					✓	
RIGHT$ (*string,n*)	✓	✓	✓			✓
STR$ (*expr*)	✓	✓	✓	✓	✓	✓

Explanation

Opens a device to either input or output a data file.

Sets the lowest-allowable subscript of an array, *x*, to either 0 or 1.

Sends the specified value (0≤ *val* ≤255) to the specified I/O port (0≤ *portnum* ≤255). PR# selects motherboard slot (0 thru 7) for output, where 0 = video monitor.

Gets the value of the paddle input.

Returns the value stored in the specified location. Atari and TI are restricted to video locations only.

Checks the specified video location (graphic) and returns a 1 if it is on, returns a 0 otherwise.

Removes the most recent addition from the stack.

Loads the specified value into the specified location. Both numbers are decimal, and 0≤ *val* ≤255.

Sends the message within the quotes or the value of the specified variable(s) to the video display.

Same as above, except printing begins at the specified video location.

Sends data to the cassette drive.

Prints according to the specified format.

Returns a 0 if the game-paddle pushbutton is depressed, otherwise a 1 is returned. STRIG is used for the joystick button.

Assigns the values stored in the data statements to the variables listed.

Reads contents of a numeric array from cassette; available in Applesoft only.

Remark indicator; computer does not execute anything following the REM (for the rest of that line only).

Turns off the graphics block at position *(x,y)*.

Resets the data pointer to the first item in the first DATA line. With Atari and TI, a line number may be specified, and the pointer will be set to the first item of data in that line.

In Applesoft only, resumes program execution from the error routine at the specified line number.

Turns on the graphics block *(x,y)*. Apple Integer BASIC and Applesoft can plot low-resolution graphics with PLOT. Applesoft can also plot a high-resolution graphics point with HPLOT.

Determines speed at which characters are sent to the screen or other output device (Applesoft only).

Halts program execution and returns to the READY prompt.

Writes contents of a numeric array to cassette (Applesoft only).

A print modifier: the variable or message is printed at the specified column.

Converts from graphics mode to all-text mode.

Allows an opened file to be both read from tape and written to tape, changing values in the process.

Draws a vertical line at the specified column. TI lets you specify number and type of characters in the line.

Moves the cursor *x* lines down from the top of the display screen.

Temporarily halts program execution until certain conditions are met.

Returns the ASCII value of the first character of the string.

Returns a one-character string defined by the value of code, 0≤ *code* ≤255. If a control code is specified, that function is executed.

Returns the amount of memory available for string-variable storage.

Scans the keyboard once and returns the character pressed. If none of the keys are pressed during the scan, returns a null.

Returns *n* characters from the specified string, starting at the left.

Returns the length of the specified string, 0 for a null string.

Returns a substring of length *n*, starting at position *p* in the specified string; Atari uses a subscripting procedure.

Returns the starting position of substring *str2* inside of string *str1*, beginning the scan at character position *n* in *str1*.

Returns *n* characters from the specified string, starting at the right.

Converts the specified numeric expression to a string.

System	Commodore PET	Apple II	Radio Shack TRS-80	Atari 400,800	TI 99/4	Exidy Sorcerer
STRING$ (*n,char*)			✓			
VAL (*string*)	✓	✓	✓	✓	✓	✓
VARPTR *var*			✓	ADR		

BASIC Functions	Commodore PET	Apple II	Radio Shack TRS-80	Atari 400,800	TI 99/4	Exidy Sorcerer
(Precision)	9	10	6 or 16	10	14	6
ABS (*expr*)	✓	✓	✓	✓	✓	✓
ATN (*expr*)	✓	✓	✓	✓	✓	✓
CINT (*expr*)			✓			
CDBL (*expr*)			✓			
CLOG (*expr*)		✓		✓		
CSNG (*expr*)			✓			
COS (*expr*)	✓	✓	✓	✓	✓	✓
ERL (*expr*)			✓			
ERR (*expr*)			✓			
EXP (*expr*)	✓	✓	✓	✓	✓	✓
FIX (*expr*)			✓			
FRE (*expr*)	✓		✓ (also MEM)	✓		✓
INT (*expr*)	✓	✓	✓	✓	✓	✓
LOG (*expr*)	✓	✓	✓	✓	✓	✓
MOD (*expr*)		✓				
POS (*expr*)	✓	✓	✓			✓
RANDOMIZE	RANDOM		RANDOM		✓	
RND (0)	✓	RND	✓	✓	RND(1)	✓
RND (*expr*)		✓	✓			
SCRN (*x,y*)		✓				
SGN (*expr*)	✓	✓	✓	✓	✓	✓
SIN (*expr*)	✓	✓	✓	✓	✓	✓
SPC (*expr*)	✓					
SPC (*num*)		✓		NULL		✓
SQR (*expr*)	✓	✓	✓	✓	✓	✓
TAN (*expr*)	✓	✓	✓		✓	✓
TI (*expr*)	✓					
USR (X)	✓	✓	✓			✓
AND, OR, NOT	✓	✓	✓			✓

Table 3: *Availability of BASIC mathematical and other functions in six microcomputer families.*

Explanation

Returns a string of length *n* composed of the specified character.

Converts a string of numerals (eg: "68") to its numeric value (eg: 68).

Returns the memory address where the name, value, and pointer of variable *var* are stored.

Explanation

The number of significant digits with which the computer operates. The TRS-80 has double-precision (sixteen-digit) capability, but all machine-supplied functions are truncated to six digits.

Gives the absolute value of the specified expression.

Gives the arctangent in radians; Atari can be set up to use angular measures in degrees.

Converts the expression into the largest integer not larger than the expression; $-32768 \leq$ *expr* ≤ 32768.

Converts the expression to double-precision (sixteen-digits).

Returns the base-10 (common) logarithm of the specified expression; CLOG (0) will give an error, CLOG (1) = 0.

Converts the expression to single-precision (six digits).

Returns the cosine of the expression, where *expr* is in radians.

Returns the line number of the current error.

Returns a value related to the current error.

Returns the natural exponential (e^{expr} = EXP (2expr)).

Returns the integer equivalent of the expression, truncated.

Tells you total number of unused and unprotected bytes in memory. MEM does not include unused string space. FRE(A$) will tell you amount of unused string space.

Returns largest integer not greater than the expression ($-32768 \leq$ *expr* ≤ 32768).

Returns natural logarithm (base *e*) of the expression; the expression must be positive.

Modulo arithmetic: returns remainder after two numbers are added/subtracted, allows for some division. Available in Apple Integer BASIC only.

Returns a number indicating the current position of the cursor on a line: available in Applesoft only.

Reseeds the random-number generator.

Returns a pseudorandom number between .000001 and .999999; in Applesoft and TI BASIC, RND(0) returns the last random number given.

Returns a pseudorandom number between 1 and the value of the expression ($1 \leq$ *expr* ≤ 32768). In Applesoft if *expr* < 0, then the same value is returned each time *expr* is used.

Returns the color value at screen position *(x,y)*; available in Integer BASIC only.

Returns a -1 if the expression is negative, 0 if it is 0, or $+1$ if it is positive.

Returns the sine value of the expression; *expr* must be in radians.

Returns the number of skips specified in the argument. Range $0 \leq$ *expr* ≤ 255. SPC(0) = 256 skips.

Prints the specified number of spaces.

Returns the square root of the specified expression: *expr* cannot be negative.

Returns the tangent of the expression, the expression must be in radians.

Sets the real-time clock to the value specified.

Passes the value X to a machine-language subroutine and executes subroutine. Address of the routine must already have been POKEd into memory.

These three operators perform the given logical operations on numeric variables or expressions. (NOT works on a single number.) In most cases, these operators work bit-by-bit on the numeric values expressed in binary. For example, 3 OR 5 equals 7: 3 is binary 011, 5 is binary 101, and 7 (the result) is 111 (011 OR 101).

Rotation Algorithm

Samuel Bates, SPO 1263, Sewanee TN 37375

Many unique and elegant designs can be produced using straight lines. Listing 1 shows a program for creating such designs. Using the "rotation" algorithm, curved patterns that appear to be three-dimensional will be produced.

The main functions of the program (which is written in Hewlett-Packard HP 3000 BASIC) are POLY and ROTATE. When given information on the size and location of a polygon, POLY draws the figure and numbers the vertices. ROTATE takes a number of points and does the following:

- A small distance is measured along the line between the first two points.
- The same distance is measured between the second and third points, and a line is drawn between these points.
- The first two steps are repeated until the program cycles back to the beginning point.
- The program begins again, measuring along the lines of the new polygon just formed.

Other functions in the program are JOIN, which draws a line between two points; MID, which takes the midpoint of two lines; PRINT, which prints the coordinates of a point; and POINT, which creates a point when given X and Y coordinates. TO, RECALL, and LIST are for creating and using specific routines.

All figures shown (1 thru 5) were drawn with a Hewlett-Packard 7202A plotter.■

Listing 1: *"Rotation" written in HP 3000 BASIC. The READ statements retrieve graphic parameters from the individual files shown with each figure.*

```
10  FILES *
20  DIM A$[72],B$[72],E[30,2]
30  DIM M[100,2],N[40],F$[3],R[10]
40  IMAGE 4D,X,4D,"+"
50  IMAGE 4D,X,4D
60  DEF FNE(Z)=(E[I+1,Z]-E[I,Z])↑2
70  P$="FLT"
80  F=25
90  P=0
100  PRINT "FILE NAME";
110  INPUT A$
120  ASSIGN A$,1,S
130  IF S=3 THEN 100
140  PRINT "BEGIN"
150  PRINT ":";
160  ENTER 255,A9,A$
170  PRINT
180  GOSUB 240
190  GOTO 150
200  STOP
210  DATA "POLY","JOIN","MID","ROTATE"
220  DATA "PRINT","POINT","TO","RECALL"
230  DATA "CLEAR","LIST","QUIT"
240  X9=11
250  RESTORE
260  FOR D=1 TO X9
270  READ B$
280  IF A$[1,LEN(B$)]=B$ THEN 320
290  NEXT D
300  PRINT "NONEXISTENT COMMAND"
310  RETURN
320  IF D>6 THEN 550
330  L=LEN(B$)
340  B$="0123456789"
350  C=N=0
360  FOR I=L+2 TO LEN(A$)
370  IF A$[I,I]=" " THEN 450
380  FOR J=1 TO 10
390  IF A$[I,I]=B$[J,J] THEN 420
400  NEXT J
410  RETURN
420  N=N+1
430  R[N]=J-1
440  NEXT I
450  X=0
460  FOR J=1 TO N
470  X=X+R[J]*10↑(N-J)
480  NEXT J
490  C=C+1
500  N[C]=X
510  N=0
520  MAT R=ZER
530  IF I <= LEN(A$) THEN 440
540  IF D>X9 THEN 580
550  GOSUB D OF 590,710,790,840,1090
560  GOSUB D-5 OF 1410,1130,1270,1460
570  GOSUB D-9 OF 1510,200
580  RETURN
590  N[2]=N[2]/(2*SIN(3.14159/N[1]))
600  N[3]=N[3]*3.14159/180
610  PRINT P$;"L"
620  FOR I=P TO N[1]+P
630  G=(I-P)*6.28319/N[1]+N[3]
640  M[I+1,1]=N[4]+10*N[2]*COS(G)
650  M[I+1,2]=N[5]+10*N[2]*SIN(G)
660  PRINT  USING 50;M[I+1,1],M[I+1,2]
670  NEXT I
680  PRINT P$;"T"
```

```
690  P=P+N[1]+1
700  RETURN
710  IF C/2#INT(C/2) THEN 780
720  PRINT P$;"L"
730  FOR I=1 TO C STEP 2
740  PRINT  USING 40;M[N[I],1],M[N[I],2]
750  PRINT  USING 50;M[N[I+1],1],M[N[I+1],2]
760  NEXT I
770  PRINT P$;"T"
780  RETURN
790  P=P+1
800  M[P,1]=(M[N[2],1]+M[N[1],1])/2
810  M[P,2]=(M[N[2],2]+M[N[1],2])/2
820  PRINT "POINT"P"="M[P,1];M[P,2]
830  RETURN
840  FOR I=1 TO C
850  E[I,1]=M[N[I],1]
860  E[I,2]=M[N[I],2]
870  NEXT I
880  E[I,1]=E[1,1]
890  E[I,2]=E[1,2]
900  PRINT P$;"L"
910  FOR I=1 TO C
920  N[I]=F*L/SQR(FNE(1)+FNE(2))
930  IF N[I]>.5 THEN 1070
940  NEXT I
950  FOR I=1 TO C
960  E[I,1]=E[I,1]+N[I]*(E[I+1,1]-E[I,1])
970  E[I,2]=E[I,2]+N[I]*(E[I+1,2]-E[I,2])
980  IF I#1 THEN 1010
990  PRINT  USING 40;E[I,1],E[I,2]
1000  GOTO 1020
1010  PRINT  USING 50;E[I,1],E[I,2]
1020  NEXT I
1030  E[I,1]=E[1,1]
1040  E[I,2]=E[1,2]
1050  PRINT  USING 50;E[1,1],E[1,2]
1060  GOTO 910
1070  PRINT P$;"T"
1080  RETURN
1090  FOR I=1 TO C
1100  PRINT "POINT"N[I]"="M[N[I],1];M[N[I],2]
1110  NEXT I
1120  RETURN
1130  READ #1,1
1140  IF  END #1 THEN 1190
1150  READ #1;B$
1160  IF B$#A$[4] THEN 1150
1170  PRINT "DUPLICATE NAME"
1180  GOTO 1260
1190  PRINT #1;A$[4]
1200  PRINT ">";
1210  ENTER 255,49,A$
1220  PRINT
1230  PRINT #1;A$
1240  IF A$#"END" THEN 1200
1250  PRINT #1; END
1260  RETURN
1270  READ #1,1
1280  A$=A$[8]
1290  IF  END #1 THEN 1330
1300  READ #1;B$
1310  IF B$=A$ THEN 1350
1320  GOTO 1300
1330  PRINT "NONEXISTENT ROUTINE"
1340  RETURN
1350  READ #1;A$
1360  PRINT A$
1370  IF A$="END" THEN 1400
1380  GOSUB 240
1390  GOTO 1350
1400  RETURN
```

Listing 1 continued on page 330

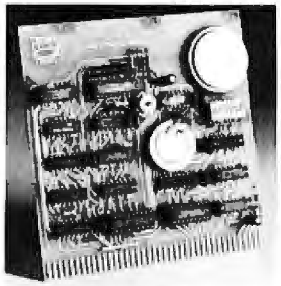
Circle 254 on inquiry card.

What is a

CLOCALPEEP?

Another name for the **CCB-II**, which is:

- a clock
  hour, minute, second
- a calendar
  day, day of week, month, year
- an audio alarm



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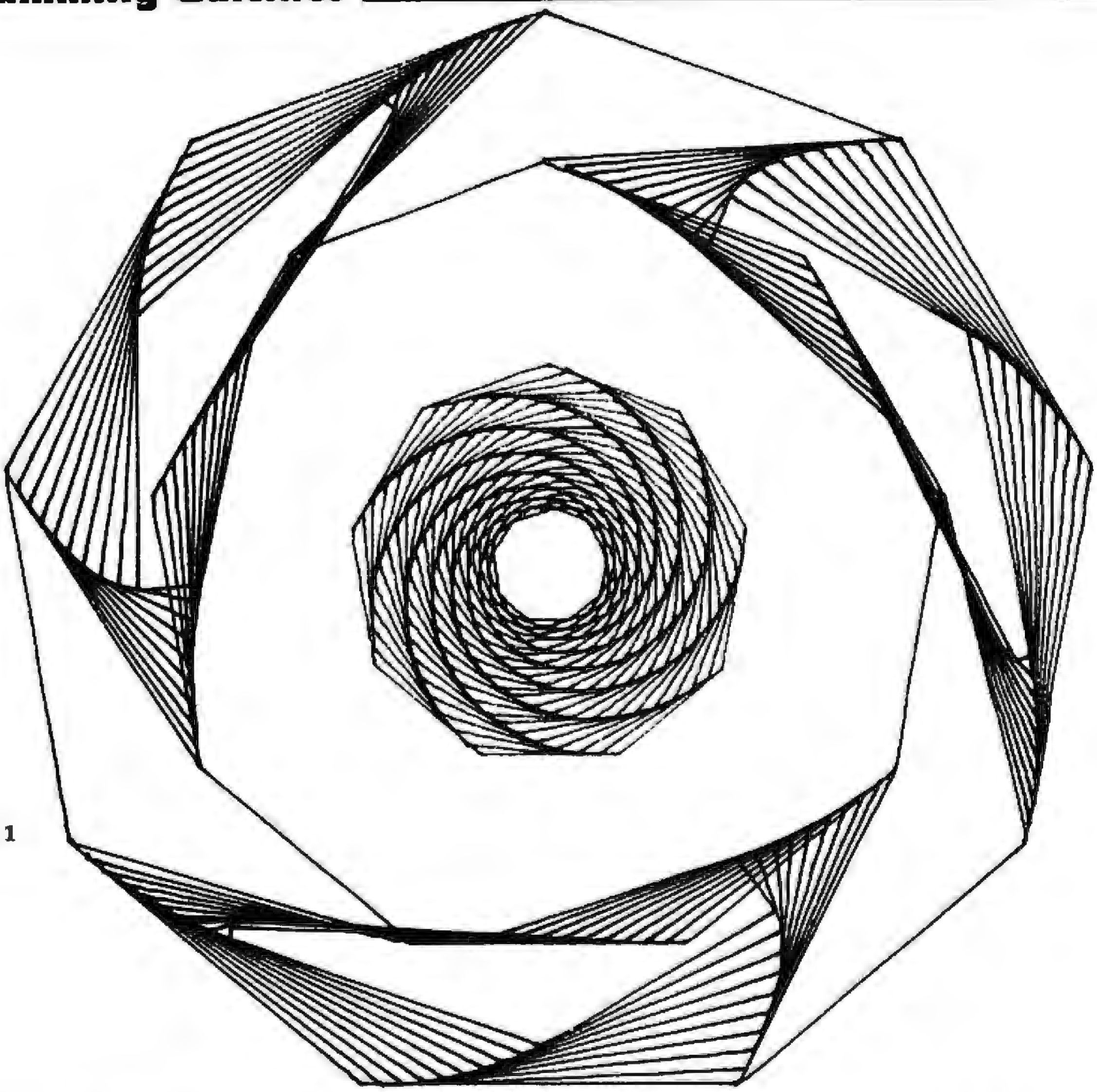

Figure 1

```
:POLY  9  200  0  5000  5000
PLTL
:POLY  9  275  0  5000  5000
PLTL
:JOIN  11  2  13  4  14  5  16  7  17  8  19  1
PLTL
:ROTATE  11  12  13  4  3  2
PLTL
:ROTATE  14  15  16  7  6  5
PLTL
:ROTATE  17  18  19  1  9  8
PLTL
:CLEAR
PLOT CLEARED
:POLY  9  100  0  5000  5000
PLTL
:ROTATE  1  9  8  7  6  5  4  3  2
PLTL
:QUIT

DONE
```

Listing 1 continued:

```
1410  P=P+1
1420  M[P,1]=N[1]
1430  M[P,2]=N[2]
1440  PRINT "POINT"P
1450  RETURN
1460  MAT M=ZER
1470  MAT N=ZER
1480  P=0
1490  PRINT "PLOT CLEARED"
1500  RETURN
1510  READ #1,1
1520  R=0
1530  PRINT
1540  IF LEN(A$)>4 THEN 1630
1550  IF  END #1 THEN 1620
1560  READ #1;A$
1570  PRINT "    ";A$
1580  IF A$#"END" THEN 1560
1590  PRINT
1600  IF R THEN 1620
1610  GOTO 1560
1620  RETURN
1630  R=1
1640  IF  END #1 THEN 1690
1650  READ #1;B$
1660  IF B$#A$[6] THEN 1650
1670  A$=B$
1680  GOTO 1570
1690  PRINT A$" NON-EXISTENT"
1700  RETURN
1710  END
```

```
:POLY  9  200  0  5000  5000
PLTL
:MID  5  6
POINT  11     =  2252.52          4999.99
:JOIN  4  1  7  1  11  1
PLTL
:ROTATE  1  11  5  4
PLTL
:ROTATE  1  11  6  7
PLTL
:ROTATE  1  4  3  2
PLTL
:ROTATE  1  7  8  9
PLTL
:QUIT

DONE
```

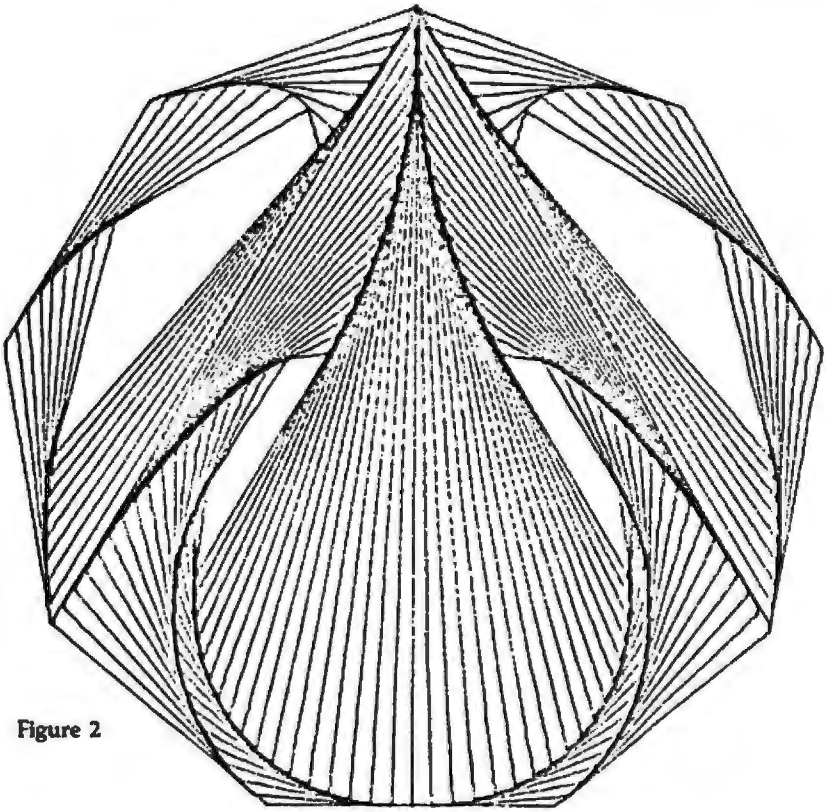

Figure 2

```
:POLY  12  150  0  5000  5000
PLTL
:JOIN  1  7  4  10
PLTL
:MID  1  7
POINT  14     =  5000          5000.
:ROTATE  1  14  4  3  2
PLTL
:ROTATE  7  14  4  5  6
PLTL
:ROTATE  1  14  10  11  12
PLTL
:ROTATE  7  14  10  9  8
PLTL
:QUIT

DONE
```

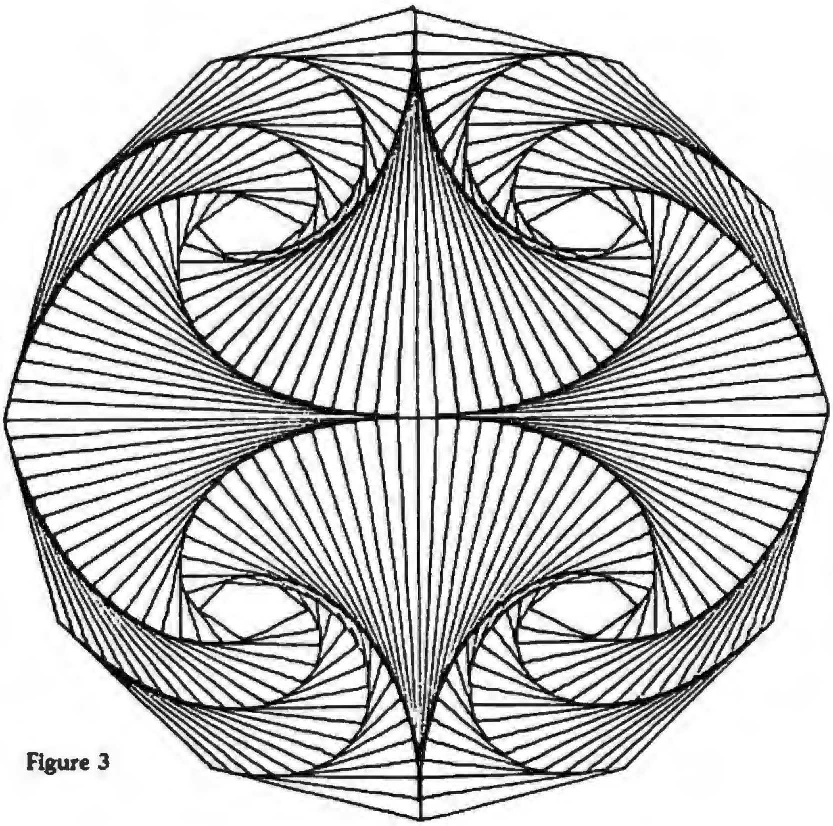

Figure 3

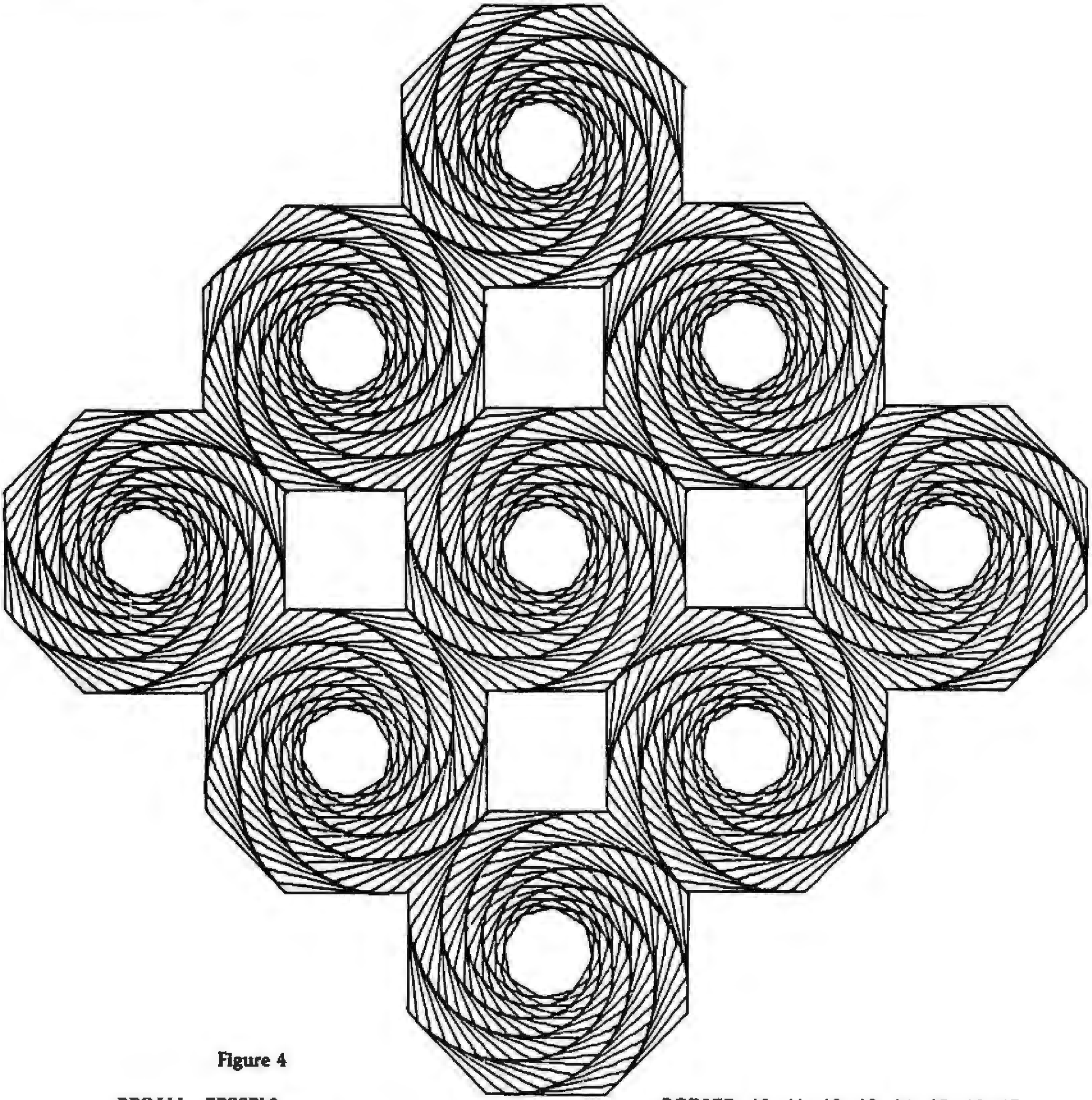

Figure 4

```
:RECALL  TESSEL8
POLY  8  100  22  5000  5000
PLTL
POLY  8  100  22  5000  1585
PLTL
POLY  8  100  22  6707  3293
PLTL
POLY  8  100  22  8415  5000
PLTL
POLY  8  100  22  6707  6707
PLTL
POLY  8  100  22  5000  8415
PLTL
POLY  8  100  22  3293  6707
PLTL
POLY  8  100  22  1585  5000
PLTL
POLY  8  100  22  3293  3293
PLTL
ROTATE  1  2  3  4  5  6  7  8
PLTL
ROTATE  10  11  12  13  14  15  16  17
PLTL
ROTATE  27  26  25  24  23  22  21  20
PLTL
ROTATE  28  29  30  31  32  33  34  35
PLTL
ROTATE  45  44  43  42  41  40  39  38
PLTL
ROTATE  46  47  48  49  50  51  52  53
PLTL
ROTATE  63  62  61  60  59  58  57  56
PLTL
ROTATE  64  65  66  67  68  69  70  71
PLTL
ROTATE  81  80  79  78  77  76  75  74
PLTL
END
:QUIT

DONE
```

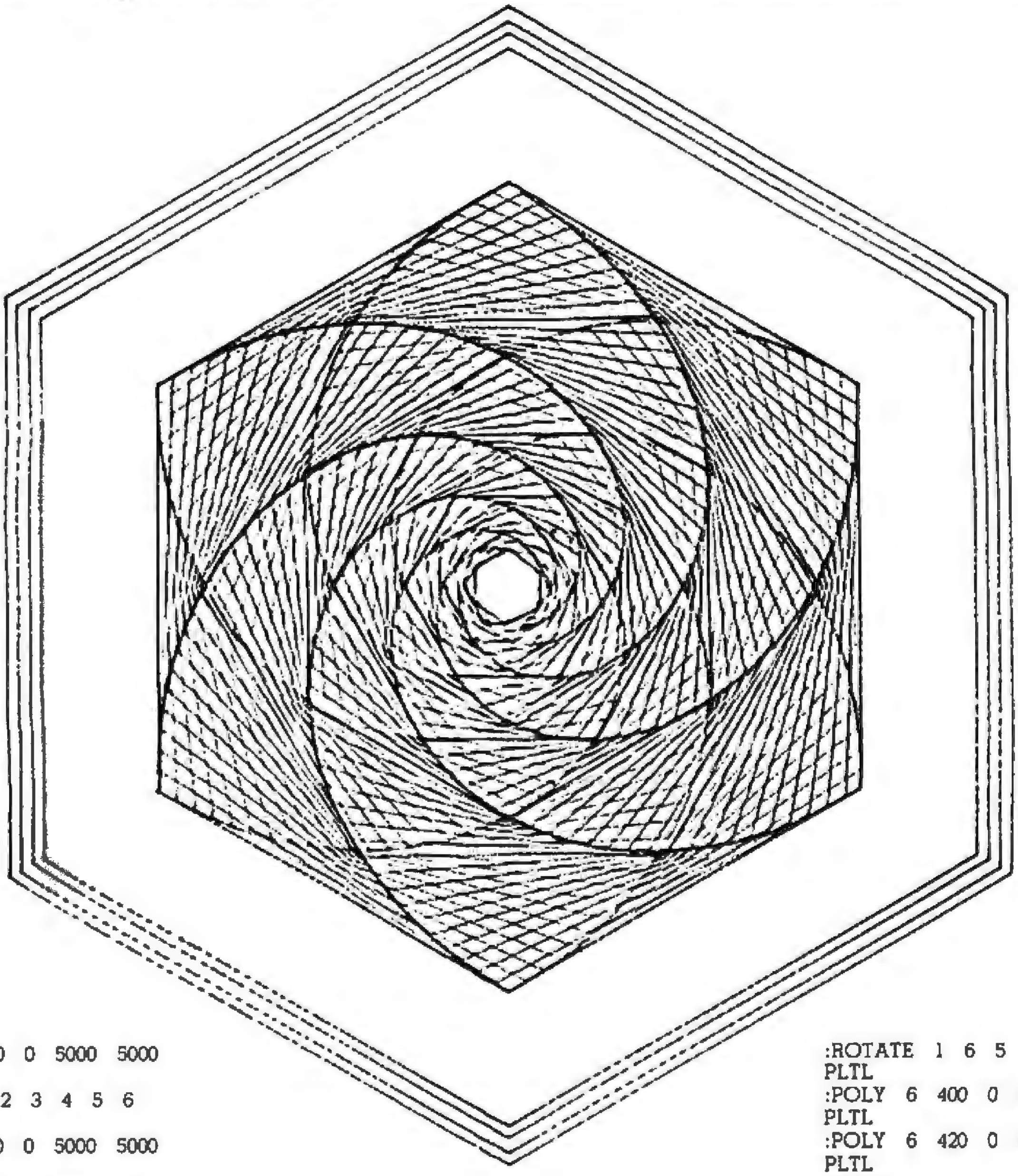

Figure 5

```
:POLY   6   300   0   5000   5000
PLTL
:ROTATE   1   2   3   4   5   6
PLTL
:POLY   6   410   0   5000   5000
PLTL
:POLY   6   430   0   5000   5000
PLTL
:POLY   6   300   0   5000   5000
PLTL
:ROTATE   1   6   5   4   3   2
PLTL
:POLY   6   400   0   5000   5000
PLTL
:POLY   6   420   0   5000   5000
PLTL
:QUIT

DONE
```

Change Your GOTOs to FOR...NEXT Loops

David Carew, Interactive Management Systems,
3700 Galley Rd, Colorado Springs CO 80909

In terms of computer architecture, virtually all currently available microprocessors are termed "stack-oriented" machines. Virtually all implementations of BASIC interpreters on stack-oriented machines make use of a push-down stack to implement FOR . . . NEXT loops. Because of this, FOR . . . NEXT loops run much faster than loops implemented with a GOTO statement. GOTO statements involve some sort of line search; whereas FOR . . . NEXT statements get their "traffic direction" directly from the stack.

My purpose here is to demonstrate how you can gain the extra efficiency of FOR . . . NEXT loops for *all* the looping constructs you write in BASIC.

Suppose you want to access a particular part of an internal table of data items (in DATA statements). Perhaps you enter a string which you convert to a particular negative number. Later you wish to find that negative number in your DATA table, knowing that the data-table items immediately following the matching "key" can be processed further to satisfy your requirements.

Obviously, you'll wish to RESTORE the data-table pointer and loop through the table, READing and comparing until you have a match. However, there can be no assumptions made in your BASIC program code as to how many READs it will take to get the match. How, then, can you implement such a loop using FOR . . . NEXT construction?

Two methods are shown in listings 1 and 2. Either of them will run in virtually any BASIC dialect. The simpler is shown in listing 1.

Almost any BASIC that allows the user to STEP the loop-index variable will also allow you to STEP 0. A STEP 0 does not increment the index and results in an endless loop. To get out of this loop, test as shown in line 530 of listing 1 and set the loop index high when you wish to exit the loop. This method will even run in Radio Shack's Level I BASIC.

An alternative method, shown in listing 2, also uses manipulation of the loop index from within the loop. It may be implemented in those versions of BASIC which may not allow STEP 0.

If you need more than 32,766 iterations of a loop, then you need this speed optimization. For the extreme case or for the purist who wants his endless loops really endless, the user could manipulate the index again by adding:

```
515 IF I = 32765 THEN I = 1
```

However, for short loops, the added processing overhead of the extra IF statement will cut much of the speed advantage.

Some may consider the manipulation of a FOR . . . NEXT loop index from within the loop a bit too devious for their taste, but I believe that, even without considering speed advantages, such constructs are preferable to "backward GOTO" implementations. Modern structured-programming techniques place emphasis on elimination of GOTO statements. GOTO implementations require more care to get up and running and are prone to go awry when later modification requires line-number changes. Tracking down and reworking GOTO references after a change has been made is tedious business, and the one you overlook is sure to generate a fine example of Murphy's Law. Using the method I have described, you no longer lack an alternative to "backward GOTO" loop implementations in BASIC. ■

Listing 1: *An example of using a FOR...NEXT loop to replace a GOTO statement. The technique shown in this listing works with versions of BASIC that allow STEP 0, including Radio Shack Level I and Level II BASIC.*

```
          .
          .
          .
140 REM CALL READ LOOP SUBR: K = KEY ITEM
150 GOSUB 500
          .
          .
          .
500 RESTORE
510 FOR I = 1 TO 2 STEP 0
520 READ X
530 IF X = K THEN I = 3
540 NEXT I
550 RETURN
```

Listing 2: *An alternative method of replacing a GOTO statement with a FOR...NEXT loop. This method can be used in versions of BASIC that do not allow STEP 0.*

```
          .
          .
          .
140  REM CALL READ LOOP SUBR: K = KEY ITEM
150  GOSUB 500
          .
          .
          .
500 RESTORE
510 FOR I = 1 TO 32766
520 READ X
530 IF X = K THEN I = 32767
540 NEXT I
550 RETURN
```

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Circle 281 on inquiry card.

What's New?

MISCELLANEOUS

Analog Interface Switching Modules

ATEC Systems, POB 128, Mendon NY 14506, (716) 924-3822, has introduced a series of switching modules that can be used as an analog interface between any microprocessor 8-bit I/O (input/output) port and the signals to be switched in automatic test equipment, instrumentation, and control-system applications. In the matrix mode, any switch selected can be latched or unlatched. In the multiplexer mode, only one switch can be closed at any time. The latches are solid state, and the switches are sealed reed relays, with a life of more than 100 million operations. By selecting the required interface module, the complete matrix or multiplexer can be controlled from an 8-bit I/O port or from the IEEE-488 bus. The modules range in price from $80 to $100. Complete systems can also be ordered.

Circle 460 on inquiry card.

Cryptography Kit

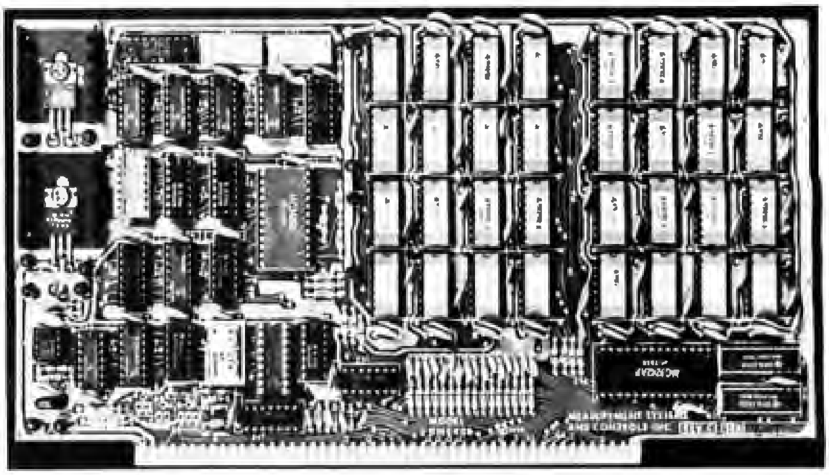
The Cryptographic Primer Kit educates computer users about cryptography, thereby enabling them to encode and protect data against unauthorized access. An RS-232 interface board is included in the kit. The interface board functions at 300 bps (bits per second) and contains the WD20001F LSI (large-scale integration) implementation of the National Bureau of Standards Data Encryption Standard. A Cryptographic Primer describes how the user can implement different cryptographies in software in conjunction with the board. It also provides examples for debugging software. An assembly and wiring manual includes wiring diagrams, assembly and operating instructions. The kit is priced at $395 unassembled or $495 assembled. Contact Western Digital, 3128 Redhill Ave, Newport Beach CA 92663, (714) 557-3550.

Circle 461 on inquiry card.

Socket Wrap Identification

The Socket Wrap-ID is used to identify pin numbers on wire-wrapping sockets. It consists of a socket-sized plastic panel with numbered holes in the pin location. The Socket Wrap-ID is slipped onto the socket before wrapping. Users can write on it for identification of location, integrated-circuit part number, or function. It is available from O K Machine and Tool Corporation, 3455 Conner St, Bronx NY 10475, (212) 994-6600.

Circle 462 on inquiry card.



S-100-Compatible, Bank-Selectable, 64 K-Byte Memory Board

The DMB6400 is a 64 K-byte, bank-selectable, dynamic memory module from Measurement Systems & Controls, 867 N Main St, Orange CA 92668, (714) 633-4460. It is compatible with Alpha Micro, Cromemco, North Star, MP/M, and most other S-100 bus computers. It uses output port addressing for the bank select and is configured as four independent 16 K banks of memory. Any of the 256 possible I/O (input/output) ports can be decoded, and eight banks of memory are possible for each port. Each bank can be turned on or off at system reset, and phantom can be used by any of the four banks. The board will run with all 8080 and 8085 microprocessors at 3 MHz. It will also run with most Z80As and the Marin Chip M9900 microprocessor.

Circle 463 on inquiry card.

AIM16 A/D Converter

The CmC AIM16 is a sixteen-channel A/D (analog-to-digital) converter designed for most microcomputers, including the PET, Apple II, TRS-80, and KIM. The converter is connected through the computer's 8-bit I/O (input/output) port or through one of CmC's (Connecticut microComputer) custom interfaces. Each of the sixteen inputs is converted to an 8-bit digital signal. The input voltage range for the AIM16 is 0 to 5.12 V, with input voltage converted to a count between 0 and 255. Resolution is 20 mV per count, with accuracy at 0.5% ± 1 bit. Conversion time is less than 100 microseconds per channel. The converter has a suggested retail price of $179. Power supplies are available for $14.95 and $24.95, depending upon the required voltage. Contact Connecticut microComputer Inc, 34 Del Mar Dr, Brookfield CT 06804, (203) 775-4595.

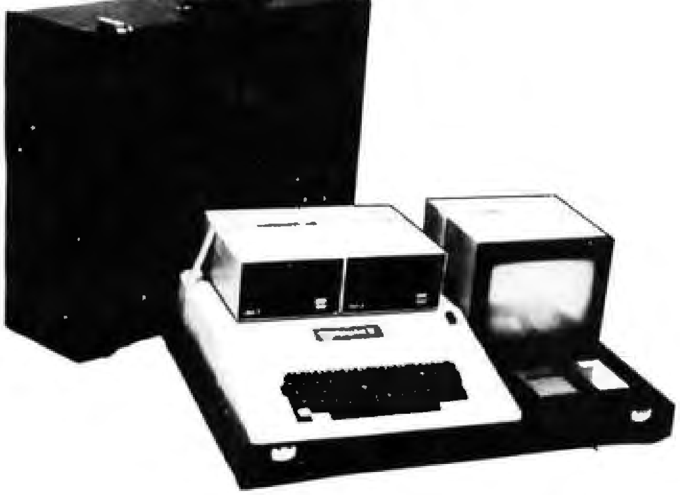
Circle 464 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

What's New?

MISCELLANEOUS



Computer Carrying Cases

A series of carrying cases for the Apple II and TRS-80 Model I computers have been introduced by Computer Case Company, 5650 Indian Mound Ct, Columbus OH 43213, (614) 868-9464. These cases can hold the computer, disk drives, and monitor in a fully operational configuration. There is no need to disconnect and reconnect cables each time the computer is moved. The lids have storage space for manuals, disks, papers, and other items. The computers and disk drives are held in position with security straps and cradled in foam rubber for protection. The cases are constructed of luggage material covered in vinyl with padded handles, protective pads, and steel skids. The AP101S case holds the Apple with a single disk drive or a tape recorder; it sells for $109. A larger case, the AP102D, selling for $119, holds the Apple and two disk drives. The AP103M holds the Apple, two drives, and a 9-inch monitor. The RS201 case will hold the TRS-80 keyboard, the expansion unit, and up to two disk drives. This case also has a power strip. It sells for $109. The RS202 case holds the monitor with additional space for a small printer, modem, or similar equipment.

Circle 492 on inquiry card.

Screen-Management Transaction System

The E-Code language provides screen-management capabilities to the VT-100 video terminal. Designed to support four VT-100s and an LA-120 under the RT-11 operating system, E-Code allows DEC (Digital Equipment Corporation) LSI-11 and PDP-11/03 applications to operate simultaneously in key-to-disk, data entry, data edit, and record-management functions. The features include a structured programming language, multiterminal support, virtual memory, and provisions for validating operator input in character or block mode. Multifile capabilities allow independent data-file manipulation from each attached terminal. The price is $850 and the manual is $15. Contact MCPC Systems, 2344 Nicollet Ave S, Suite 220, Minneapolis MN 55404, (612) 870-3841.

Circle 493 on inquiry card.

Asynchronous-Synchronous Translator

The AST (asynchronous-synchronous translator) enables users to access large data bases and mainframes. The data base is accessed by communicating under the Bisync protocol. The single circuit board utilizes the 6809 microprocessor, controlling advanced data-link protocol, with the controlling firmware contained on EPROM (erasable programmable read-only memory). This card also enables the company and the user to apply the AST boards under other operating systems. Peripherals and microcomputers will be able to access large data-processing centers, usually as a remote-job-entry station. For more information, contact SDS Technical Devices Ltd, POB 1998, Winnipeg, Manitoba, Canada, R3C 3R3, (204) 589-7507.

Circle 494 on inquiry card.

TI-990 Software

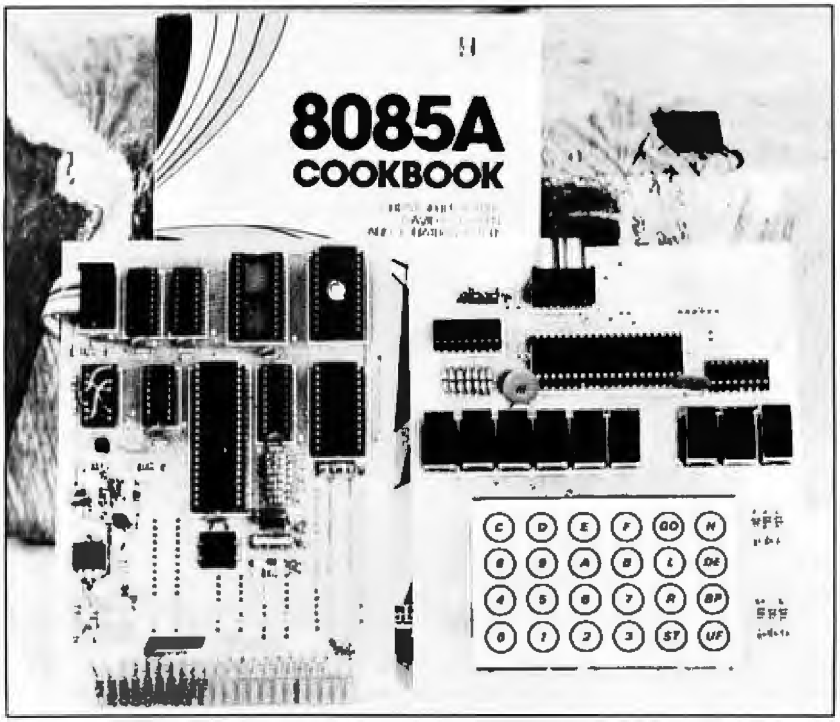
Synergistic Systems, Cobble Hill Rd, East Thetford VT 05043, (802) 785-4121, has several software packages for the Texas Instruments (TI) TI-990 computer written in TI BASIC. Mail-990 is a mailing-list program that maintains up to 10,000 addresses per disk. Text-990 is a text editor with screen-oriented text-preparation functions for documents of up to 400 lines. Index-990 is a set of multikey indexed-sequential-access routines that provide access to any record in a file by up to five keys, and sequential access in key or reverse-key order from any starting key. Forms-990 has functions and subprograms to simplify the development of forms-oriented input routines. The Seek-990 interactive data-base system for office personnel helps create and maintain data bases by means of menu specifications.

Circle 495 on inquiry card.

What's New?

MISCELLANEOUS

Microprocessor Training Course



The 8085AAT Microprocessor Training Unit includes a tested and assembled 8085A microcomputer with 1 K bytes of programmable memory, a 1 K-byte PROM (programmable read-only memory), a 1 K-byte EPROM (erasable programmable read-only memory), programmable I/O, keyboard, microprocessor card, display and operating system, a 44-pin edge connector that allows configuration to any bus structure, an area on the processor card for wire-wrap design or user-defined interface circuitry, and a 20 mA asynchronous port. The software comes with an instruction manual, a user's manual with programs, a 352-page 8085A cookbook that includes basic microprocessor concepts and actual designs of an 8085A microcomputer, an 8080/8085A software-design book with over 190 executable program examples, an examination of all 244 instructions, plus an overview of assembly language for the 8080/8085A microprocessors. The Training Unit is $299.95; a kit version is $249.95. Contact Paccom, 14905 NE 40th St, Redmond WA 98052, (206) 883-9200.

Circle 486 on inquiry card.

Backplane I/O Connectors with Up to 72 Contacts

Mupac Corporation, 646 Summer St, Brockton MA 02402, (617) 588-6110, has announced a family of plug-style connectors with 26, 36, 40, 52, and 72 contacts. They can be mounted onto backplanes, printed-circuit boards, or wire-wrappable panels. They are available with straight or right-angle pins and have either printed-circuit tails or wire-wrappable pins. Mating connectors that mass-terminate to flat cable are also available. The contact material is phosphor bronze with gold-over-nickel plating. Prices in quantities of one to nine range from $3.43 each to $8.37 each. Prices for mating connectors range from $4.33 to $8.54 each.

Circle 487 on inquiry card.

Asynchronous EPROM from RCA

A 256-word by 8-bit static CMOS (complementary metal-oxide semiconductor) EPROM, the CDP18U42CD, has been developed by RCA Solid State Division, Rt 202, Somerville NJ 08876, (201) 685-6423. The device is useful in general-purpose asynchronous ROM (read-only memory) applications and will interface directly with the CDP1802 microprocessor. It has common data inputs and outputs. The 100-unit price is $38.70.

Circle 488 on inquiry card.

Dual Integrated-Circuit Schottky Rectifiers

Intended for center-tap rectification, these 30 A Schottky rectifiers are available as full-wave bridges in medium-power switching supplies. The MBR 3020CT, 3035CT, 3045CT, and SD241 are single packages made up of two integrated circuits. These 20, 35, and 45 V units have an operating junction temperature of 150° C, with reverse voltages to 45 V. A built-in guard ring reduces junction stress and operates like a zener diode for transient protection. An extra layer of barrier metal acts as an interface between a working barrier metal of chrome or platinum and the nickel-gold ohmic contact metal, thus it virtually eliminates contamination and failure. Prices in 100- to 999-unit quantities range from $5.70 to $7. Contact Motorola Semiconductor Products Inc, POB 20912, Phoenix AZ 85036, (602) 244-4624.

Circle 489 on inquiry card.

Sixteen-Port Serial I/O Board

Konan's sixteen-port asynchronous serial I/O (input/output) board can communicate with peripherals on all S-100 bus systems, and also interconnects computers within networking systems. Omniport can talk to sixteen peripherals with RS-232 interfaces and has sixteen selectable data rates. It also features sixteen asynchronous channels with full handshaking capabilities. Omniport has a 4-character buffer on each channel, including the receive register. All operations, except the interrupt, are enabled with push-on jumpers. Omniport is compatible with all S-100 bus specifications proposed by the IEEE (Institute of Electrical and Electronics Engineers). The price for Omniport is $800 in OEM (original equipment manufacturers) quantities of two. Konan Corporation is located at 1448 N 27th Ave, Phoenix AZ 85009, (602) 269-2649.

Circle 490 on inquiry card.

Adapt for DG

Data Financial Systems Inc has introduced the Adapt Software Package for use on all DG (Data General) minicomputers. The package includes modules for General Ledger, Accounts Receivable, Accounts Payable, and Payroll Applications. These may be custom tailored by nontechnical personnel with little knowledge of programming, utilizing the Adapt tool. Data Financial Systems Inc is located at 4350 E Camelback Rd, Phoenix AZ 85018, (602) 959-9240.

Circle 491 on inquiry card.

What's New?

PERIPHERALS

It's Smooth Scrolling with Micro-Term

Micro-Term Inc, 1314 Hanley Industrial Ct, St Louis MO 63144, (314) 968-8151, is offering the ACT-5A and Mime-2A video terminals with a smooth-scroll feature. This feature allows the operator to read data as it passes over the screen in one continuous motion. This eliminates the jump scroll found in other terminals. Other features in the 5A-2A line include a bi-directional printer port and editing capabilities. In addition, the Mime-2A will emulate the DEC (Digital Equipment Corporation) VT-52, Hazeltine 1500, and Soroc IQ120. The ACT-5A and the Mime-2A cost $995 and $1045 respectively.
Circle 496 on inquiry card.

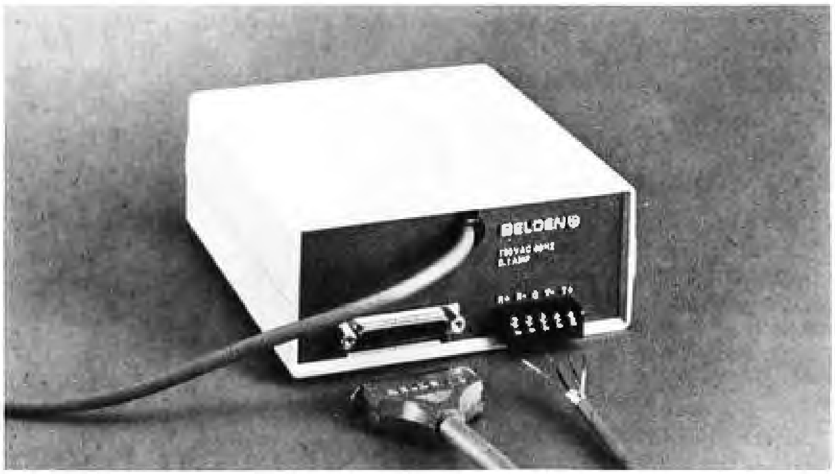
Power Supply with 200 W Peak Capacity

The Model AC-130 is a 130 W multi-output, switched-mode power supply with a 200 W peak output capability. The supply is compatible with the Boschert OL-130 unit, and has an input-voltage tolerance of 80 to 140 VAC and 160 to 264 VAC. The unit also has an adjustable power-fail signal. The outputs are +5 V ±3% at 15 A, +12 V ±5% at 4 A, −12 V ±5% at 2 A, and −5 V ±5% at 1 A. A +24 V at 2 A output can be substituted for the −5 V output. The single-unit price is $340 from Conver Corporation, 10629 Bandley Dr, Cupertino CA 95014, (408) 255-0151.
Circle 497 on inquiry card.

Dithertizer II

The Dithertizer II is a binary video-digitizer board for the Apple II. The board utilizes a video camera with external sync to load the video display of the Apple II. The device is designed as a frame grabber, DMA-type (direct memory address) digitizer that requires one frame, or one-sixtieth of a second, to capture a binary image. Software is included to build dithered (pseudo gray scale via half tones) images from multiple binary images and to capture image-intensity contours using image subtraction. The software allows the user to select and change the matrix size and view the effects on the monitor. Users may also adjust the contrast and density of the image with joysticks and adjust matrix size. The Dithertizer II requires a video camera with an external sync. The price for the unit is $300. A package consisting of the Dithertizer II and a Sanyo video camera is $650. Contact Computer Station, 12 Crossroads Plz, Granite City IL 62040, (618) 452-1860.
Circle 498 on inquiry card.

Belden Introduces a Short-Haul Modem



The Belden Model 9338 metallic-conductor Bit-Driver short-haul modem has been developed as part of an RS-232-compatible data-transmission system for in-house and in-plant applications. The 9338 provides asynchronous simplex and duplex data transmission, at speeds up to 56 K bps (bits per second). The metallic-conductor unit is recommended for use in clean electrical environments. The operating range extends from 1500 to 4500 meters (5000 to 15,000 feet). An LED (light-emitting diode) array on the front panel indicates system status and aids in diagnosis. The price of the Model 9338 is $195. Contact the Marketing Manager, Belden Corporation, 2000 S Batavia Ave, Geneva IL 60134, (312) 232-8900.

Circle 499 on inquiry card.

92 K-Bit Magnetic Bubble-Memory Kits

The TIBK090 and TIBK091 92 K-bit magnetic bubble-memory kits provide engineers with the bubble memory and integrated circuits required to lay out and assemble a 92 K-bit bubble-memory system. The 091 kit contains the parts required to construct one minimum memory system. The 090 kit contains all the parts required to construct one modular-memory unit (MMU). The MMU consists of all the parts in the 091 kit except the function-timing generator and controllers. The memory capability of the 091 kit can be expanded by assembling additional 090 kits and utilizing the timing generator and controller capabilities of the 091 kit. The TIBK090 kit costs $151, and the TIBK091 kit is priced at $191, both in quantities of one to twenty-four. Contact Texas Instruments Inc, Inquiry Answering Service, POB 225012, M/S 308, Attn: TIBK090, Dallas TX 75265.
Circle 500 on inquiry card.

What's New?

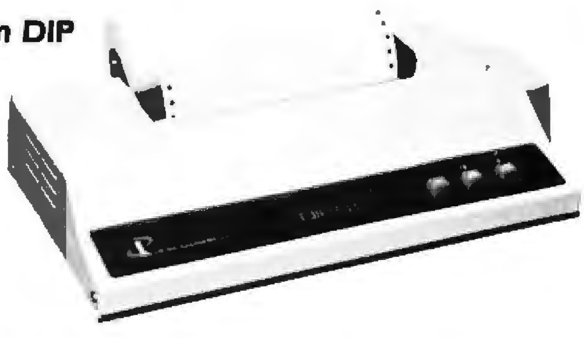
PERIPHERALS

Word-Processing-Quality Video Terminal

The WP2000 word-processing-quality video terminal is available from Industrial Micro Systems Inc, 628 Eckhoff St, Orange CA 92668, (714) 978-6966. The unit features an EPROM (erasable programmable read-only memory) character generator, special function keys, an IBM Selectric keyboard layout, and a fifteen-key cursor-positioning and editing keypad on a removable keyboard. Also included is a ten-key numerical keypad. The high-resolution video monitor utilizes a 9 by 13 dot matrix. The 12-inch screen displays 25 lines. The WP2000 also features normal and reverse video; blinking, underlined and highlighted fields; uppercase and lowercase characters with descenders; 2-page memory; automatic self-test; pen interface; and printer port.

Circle 482 on inquiry card.

Printer from DIP



The DIP-81 dot-matrix impact printer features 7 by 7 or 14 by 7 matrix printing, plus uppercase and lowercase character sets. The bidirectional printing speed is 100 cps (characters per second), and the DIP-81 uses ordinary bond paper in sheets, roll, or fanfold form. The printer has the full 96-character ASCII (American Standard Code for Information Interchange) set, printing both 40 and 80 characters per line on standard-sized paper. Operator control includes power, select/deselect, line feed, top of form, and self-test. A Centronics-compatible parallel interface is standard, and a serial RS-232 or 20 mA current-loop interface is optional. The printer costs $499. For more information, contact DIP Inc, 121 Beach St, Boston MA 02111, (617) 482-4214.

Circle 485 on inquiry card.

516-Megabyte Removable Disk Drive

Century Data Systems Inc, 1270 N Kraemer Blvd, Anaheim CA 92806, (714) 632-7500, has introduced the Trident T-600/602 disk drives, offering 516 megabytes storage capacity. The price per unit in lots of 100 is under $12,000 and single-unit prices are around $15,500. The T-600 is compatible with the Trident T-200 and T-300 drives. The capacity in the T-600 drive has been achieved by using narrower tracking heads that have increased output by 25% and resolution up to 5%. The servo surface has been rewritten to provide for 1349 cylinders. The unit's mean time between failures is specified at 4000 hours and calculated at 6000 hours, with a mean time to repair of less than one hour. Standard features include dual-access operation and fixed or variable sectoring.

Circle 483 on inquiry card.

High-Quality Cassette Tapes

Marathon cassettes, made by Magnetic Information Systems, 415 Howe Ave, Shelton CT 06484, (203) 735-6477, have 50% more storage capacity than other digital cassettes on the market. Each Marathon cassette contains 450 feet of a 0.30-mil-thick polyester-film-base tape. Tape quality and case tolerances exceed ANSI/ECMA/ISO specifications. Each tape is certified in the cassette to be 100% error free.

Circle 484 on inquiry card.

What's New?

SYSTEMS

Two Items for the Blind

Total Talk and Speak Easy are microprocessor-based products that convert computer-transmitted data into synthetic speech. Total Talk is a computer terminal that converts data into full-word synthetic speech. By translating data into phonetic characters and feeding that data into a synthesizer, the blind can have direct access to information stored on computers. Total Talk switches from full word to spelled speech output. The speech rate (45 to 720 words per minute), pitch, tone, and volume are adjustable. The unit is based on the Hewlett-Packard 2621A terminal. It is priced at $5995.

Speak Easy is a subset of Total Talk. It does not have the editing and cursor-control capabilities of Total Talk. Applications include computer-aided instruction, instrument control, vocal feedback, and more. Speak Easy costs $4000 with RS-232 interface and IEEE-488-bus interface capabilities. For details, contact Maryland Computer Services Inc, 502 Rock Spring Ave, Bel Air MD 21014, (301) 879-3366.

Circle 471 on inquiry card.

OSM System Allows 128 Terminals

OSM Computer Corporation, 2364 Walsh Ave, Santa Clara CA 95051, (408) 496-6910, has introduced a multi-user, multitasking microcomputer system called the OSM Model 6300. Each user has a microprocessor, memory, I/O (input/output) ports, and shares common disk storage of up to 128 megabytes, using CP/M 2.2 and DPOS/2 operating systems. A service processor, consisting of a Z80A microprocessor, programmable memory and I/O, links the user processors to the disk drives and printer. User hardware consists of the Z80 processors, 64 K bytes of memory, I/O, and optional printers. The Model 6300 allows up to 128 user terminals with no console-response degradation, because each user has his own microprocessor. This can be helpful in word-processing environments and other applications where console speed is critical. The Model 6300 comes with two 8-inch double-density floppy-disk drives. Several hard-disk options are available. The complete system is available with the IBM 3101 video terminal and Texas Instruments 820 RO or optional letter-quality printer. The single-user system is priced at $5195.

Circle 472 on inquiry card.

Single-Board Bubble-Memory System

The RMS family of single-board bubble-memory systems includes the controller, all electronics, and the bubble-memory devices. The four modules with 32 K-byte-thru 256 K-byte-capacity systems interface with the Rockwell AIM-65 microcomputer, System 65 development system, and the Motorola EXORciser and Micromodule family. The average data rate for an accessed block is 22 K bytes per second. Depending upon block location, the access time ranges from 20 μs to 20 ms. The RMS includes checksum-error detection, redundancy control, and power-fail memory-protect circuitry. Prices range from $1800 for a 32 K-byte system to $5350 for a 256 K-byte system with a 1-megabyte bubble-memory device. For information, contact Bubble Memory Products, Electronic Devices Division, Rockwell International, POB 3669 RC55, Anaheim CA 92803, (714) 632-3729

Circle 473 on inquiry card.

6802 Single-Board Computer with 2 K-Byte EPROM

The Model SBC-02 computer from Star-Kits, POB 209, Mt Kisco NY 10549, is a single-board computer that features a 6802 processor with 128 bytes of programmable memory, a 2 K-byte EPROM (erasable programmable read-only memory), and parallel or serial I/O. A wire-wrap area is provided for custom interfacing and expansion. The board costs $25 with instructions, $75 for a parallel I/O kit, or $150 when wired and tested. An optional machine-level monitor can be installed to provide program entry and control, single-stepping, breakpoints, and other front-panel functions from a serial terminal. It is supplied separately in an EPROM for $40 (included at no charge in the kit and wired verisons).

Circle 474 on inquiry card.

Single-Board 6809 Computer

The ADS 6809 S-100 single-board computer features provisions for 2 K bytes of programmable memory, 4 to 16 K bytes of EPROM, RS-232 serial communication with selectable data rates, parallel I/O ports, and simulated 8080-type I/O. ADSMON, a 2 K-byte monitor, allows users to examine and change memory and registers, test memory, calculate relative offsets, load and punch tape files, and more. The ADS 6809 is sold as a printed-circuit board with a manual for $69.95 from Ackerman Digital Systems, 110 N York Rd, Suite 208, Elmhurst IL 60126, (312) 530-8992.

Circle 475 on inquiry card.

What's New?

SOFTWARE

Graftrax Graphics for the TX-80 Printer

Graftrax is a high-resolution bit-plot graphics capability for the Epson TX-80 dot-matrix printer. The bit-plot mode allows individual bit control of the print wires. Graftrax enables the printer to perform programmable universal form-handling functions. The length of a line feed is software definable in 255 steps of 0.007 inches each. The skip-over-perforation function allows the size of the print field to be adjusted from one line to a full page. Graftrax counts the dots being printed in the high-density graphics mode so that Graftrax slows the printer down if a safe duty cycle is exceeded. Graftrax is built into a PROM (programmable read-only memory). For more information, contact Epson America Inc, 23844 Hawthorne Blvd, Torrance CA 90505, (213) 378-2220.

Circle 476 on inquiry card.

Apple II Cassette Pascal

Dynasoft Pascal is a p-code implementation of a Pascal subset intended for use with cassette-based microcomputer systems that cannot support full-scale systems such as UCSD Pascal. It includes the control structures of standard Pascal and supports integer, char, boolean, scalar, subrange, pointer, and array data types. A linkage to machine-language subroutines is also provided. The one-pass compiler produces a position-independent program that is run with a 2 K-byte interpreter. The package, including the compiler, interpreter, and a line-oriented editor, requires 8 K bytes of memory space and will run on a 16 K-byte Apple II or Apple II Plus. Support is provided for low- and high-resolution graphics. This cassette system costs $50. For more details, contact Dr Allan Jost, c/o Dynasoft Systems Ltd, POB 51, Windsor Junction, Nova Scotia, Canada, B0N 2V0, (902) 861-2202.

Circle 477 on inquiry card.

TRS-80 Disk BASIC Compiler

ACCEL2, a TRS-80 Disk BASIC compiler, is being marketed by Allen Gelder Software, POB 11721, Main Post Office, San Francisco CA 94101. The compiler produces compact machine-code translations of selected Disk BASIC statements and functions in integer, single- and double-precision, and string variable types. Subset compilation minimizes output code expansion with little loss of execution speed. Six diagnostic messages and a set of local/global compilation options increase compatibility with subject programs and control output code growth. The compile-time routines are self-relocating and occupy 5120 bytes; the run-time component takes 1 K bytes, making the compilation process available to 16 K-byte non-disk-drive machines. ACCEL2 comes on cassette tape with a manual for $88.95

Circle 478 on inquiry card.

TRS-80 Payroll System Uses TRSDOS 1.2

PR is a payroll system for the TRS-80 Model II. It requires TRSDOS 1.2, a 132-column printer, a dual-disk drive, and 64 K bytes of memory. PR calculates the payroll for all employees as it maintains monthly, quarterly, and yearly totals for reporting purposes. It can produce paychecks, 941 forms, W-2 forms, paycheck registers, monthly summaries, general-ledger transaction registers, employee file lists, and more. Priced at $129, PR comes with a manual, an installation guide, twelve programs, and sample data files on an 8-inch floppy disk. Contact Micro Architect Inc, 96 Dothan St, Arlington MA 02174, (617) 643-4713.

Circle 479 on inquiry card.

TRS-80 Text Editor

Textan is a text editor for the TRS-80 using Level II BASIC. It is a machine-language editor requiring at least 16 K bytes of memory. It is a video editor designed to read tapes written in Level II BASIC. Upon completion of the edit function, it returns to BASIC with the program loaded. Textan includes 32 command functions and 26 reserved-word keys. The command functions allow for top, bottom, and center of screen; end of and first of line; character, word, to end of line, and line delete; previous screen; automatic line numbering; line and character insert; and more. The reserved-word keys will automatically enter AND, GOSUB, CHR$, DIM, ELSE, FOR, GOTO, and most of the other command words. Contact Southeastern Software, 512 Conway Ln, Birmingham AL 35210, (205) 956-2389.

Circle 480 on inquiry card.

Alpha Micro Computer FORTH

FORTH is available on the Alpha Micro Microsystems AM-100 computer. Based on the model by FIG (FORTH Interest Group), AM-FORTH runs under the AMOS operating system and includes FORTH, an interface to the AMOS file structure, and a FORTH text editor. AM-FORTH has facilities to permit processing data using AMOS sequential files. Memory is controlled so that the program uses only enough for the dictionary with the application routines and file I/O (input/output) buffers. An AMS or STD format disk is available with documentation and the FORTH program for $40. Contact George Young, c/o Sierra Computer Company, 617 Mark NE, Albuquerque NM 87123, (505) 296-8085.

Circle 481 on inquiry card.

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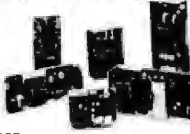
JUST HOT STUFF

POWER SUPPLIES



If you can beat these prices we will be truly amazed. OEM's at 500 lot pay more than this. Call or write for full spec. sheets.

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PRIAM–SHUGART–CENTURY–MICROPOLIS				
+5V @ 9A	–5V @ .8A	+24V @ 7A	US-384	89.00
SHUGART – SIEMANS – MPI 5¼"				
+5V @ .5A	+12V @ .9A		US-340	33.50
+5V @ 2A	+12V @ 4A		US-323	56.25
SHUGART – SIEMANS – CDC 8"				
+5V @ 1A	–5V @ .5A	+24V @ 1.5A	US-205	52.50
+5V @ 2A	–5V @ .5A	+24V @ 3A	US-206	69.00
+5V @ 3A	–5V @ .6A	+24V @ 5A	US-162	89.00
+5V @ 1.7A	–5V @ 1.5A	+24V @ 2A	US-272	69.00
+5V @ 2A	+12V @ .4A	–12V @ .4A	US-HTAA	37.50

TELEVIDEO 912C

SOROC IQ120– $675.00
Televideo 912C– 665.00
ADDS R-25 – 710.00

Also have 920C, SOROC, HAZELTINE, etc. What we don't have is room on this page. Call Toll Free 800 number for prices.

C-ITOH PRINTER

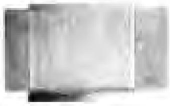
$499.00

Look closely at the photo and see other adds in this rag at $995.00. Perfect units, warranteed. Only 500 pcs. Same story, manufacturerer had too many.

S-100 CARD EXTENDER

$12.50

(Gold Contacts)



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5¼"	SOFT	$2.65 ea.
5¼"	HARD 10	2.65 ea.
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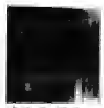
SPECIAL OF THE QUARTER

12 SLOT MOTHER



We have connectors and power supply too. Start your system with quality components. Terminated.
CONNECTORS $3.50 ea. $22.50

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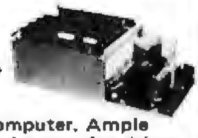
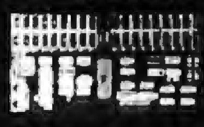
$239.00 MADE IN USA



Complete S-100 12 Slot Computer. Ample system power with regulated power for drives. Excellent for Subsystem or Hobby use. 4 hours to build. (6 conn. incl., less fans)

EXPANDABLE RAM
★SPECIAL★SPECIAL★SPECIAL★

This is the best all around 64K board you can buy. If after you see it, you don't agree return for full refund. Bank Select by extended address lines or I.O. 40H.



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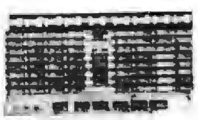
32K STATIC (KIT)

You have seen this well known board around for years. We bought 500 of them and plan on cornering the market! Bank Select on extended address lines.



$388.00

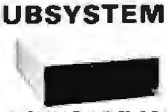
Z-80 CPU (KIT)

The first time this world popular CPU offered in Kit, 2 serial, 3 parallel, CTC, EProm Z-80 at 4 mhz. Software buad rate, etc.(less Prom)

$212.00

DUAL DRIVE SUBSYSTEM

$995.00



2 SHUGART 801R POWER SUPPLY

If this looks like a Lobo Drive System, don't be fooled. Just because it looks like one, works like one, smells like one, and tastes like one (?) doesn't mean it has to cost like one!

FANS $14.95

These are brand new, in the box fans. Not noisey bearing pullouts. Never again at these low prices!

3-1/8"

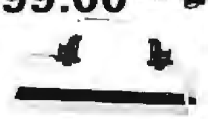
4-5/8"

SPECIALS OF THE MONTH

4116s
200 NS
Expansion 16K Dynamic RAMs for Apple, TRS-80 S-100 systems. T.I., Mostek Intel, Call for manufacturer. $4.25

DIP-80 $399.00

Don't be mislead by this LOW price. This is a rugged 100% Duty Cycle 7 by 7 Dot Matrix Printer. Brand new, factory warr.



• RS-232 ADD $65.00
• TRACTOR FEED ADD $70.00

2114s $3.45

One of the world's two most popular STATIC RAMs. Factory prime tested units. Sold in lots of 8 only. FUJITSU, HITACHI, etc. 200 NS

TMS-4044
MM-5257
INTEL 2147
$4.25
250 NS

The other of the world's most popular STATIC RAMs. This one is 4K by 1 organization. Don't buy Gold, buy these, the price won't last!

2716s $13.50 (450 NS)
2708s $6.95 (450 NS)

Remember when 2716s were $50.00 and hard to get? These units are so beautiful it's hard to part with them. But we will, for a small price. Guaranteed!

SHUGART DRIVE

8" 851R $585.00

8" 801R
$395.00

Manufacturer had too many, buys at 1000 piece rate, sales dropped, so we got'em. Fantastic buy, get them while they last! Full warranty.

5¼" MINI

$265.00

Now is the time to expand that Trash-80 or Rotton Apple (no offense!) These go so fast. Quantities limited to those on hand. Hurry! No Junkers! Factory warranty.

SHUGART / SIEMANS / MPI

What's New?

SOFTWARE

Timeclok

Timeclok/Billing is a time-management and billing program for businesses and professional offices chiefly concerned with projects or cases. It maintains client and overhead expenses by time and disbursement charges. Up to thirty employees can charge time and billing-rate units, such as per hour, per day, and miles traveled. One hundred work and overhead codes can be user-defined. The program can handle 100 clients on a single floppy disk. Timeclok generates reports on employee contribution, cash receipts, charges per client, charges per case or project, and billing statements. Reports can be assembled for a month or all months to date. Reports on individual clients, projects, and staff members can also be obtained. Client accounting balances are maintained for fourteen months. Timeclok requires the North Star disk operating system, 48 K bytes of memory, twin floppy-disk drives, a 24-line by 80-character video terminal, and a 132-column printer. Contact Ladco Development Company Inc, POB 464, Olean NY 14760, (716) 372-0168.

Circle 465 on inquiry card.

Enhanced NEWDOS/80 for the TRS-80 Model I

NEWDOS/80 is an enhancement of Apparat's NEWDOS 2.1 disk operating system for the TRS-80 Model I. NEWDOS/80 can mix or match disk drives and support track counts from 18 thru 80. It contains new editing commands and an improved RENUMBER command, plus it can route data to displays and printers simultaneously. Also included are Superzap/80, print spooling, and specifiable system options (SYSGEN). The price of NEWDOS/80 on a floppy disk with documentation is $149 from Apparat Inc, 4401 S Tamarac Pky, Denver CO 80237, (303) 741-1778.

Circle 466 on inquiry card.

FORTH for the 6502

This version of FORTH is available for the 6502-based KIM-1, SYM-1, AIM-65, and Apple II microcomputers. This version of FORTH contains a built-in 6502 assembler, a text editor, and a cassette file-management system. Information on interfacing FORTH to a floppy disk is provided, as well as several extensions to the language. 6502 FORTH sells for $90, which includes a manual, source listing, and the cassette containing the object code. Contact Eric C Rehnke, Tech Services, 1067 Jadestone Ln, Corona CA 91720, (714) 371-4548.

Circle 467 on inquiry card.

CP/M-86 Operating System from Digital Research

Digital Research, the originator of the CP/M operating system, has introduced CP/M-86 for Intel 8086/8088-based microcomputers. This is a single-user system. The file format of CP/M, release 2, has been retained. CP/M-86 can also function as a slave node in a CP/NET network. For details, contact Digital Research, POB 579, 801 Lighthouse Ave, Pacific Grove CA 93950, (408) 649-3896.

Circle 468 on inquiry card.

Monty Plays Monopoly

The Ritam Corporation, Fairfield, Iowa, has developed a "computer-opponent" program for the Apple II and the TRS-80 Model I Level II computers that plays Parker Brothers' popular board game, Monopoly. This program, called Monty Plays Monopoly, uses the standard Monopoly playing board and pieces, and plays the game according to the official rules. Monty is an entertaining opponent because he performs musical and graphics diversions for you while waiting for his turn to play. When it is Monty's turn, he appears on the video screen and proceeds to wheel and deal as any other Monopoly player. The program is priced at $29.95 for 16 K-byte cassette systems and $34.95 for 32 K-byte floppy-disk systems. Monty Plays Monopoly is distributed by Personal Software, 1330 Bordeaux Dr Sunnyvale CA 94086, (408) 745-7841.

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FORTH for OSI Systems

This FORTH language, based on the FIG (FORTH Interest Group) model language, runs under OSI's (Ohio Scientific's) OS65D-3.2 operating system. High-level FORTH disk-operating-system words are implemented in FORTH for full compatibility with FIG-standard extensions. A line editor and a 6502 assembler are included. Also featured are a programmable-memory dump, video graphics, data-disk initializer, a sample machine-code routine, and a system disk optimizer. Minimal requirements are 24 K bytes of programmable memory and one disk drive. The 5-inch floppy-disk version works on C2-4P and C4 models. The 8-inch version works on C2-8P, C8P, C2-OEM, and C3 models. Superboard, C1P, and C2 versions will also be available. The program and manual are available from Consumer Computers, 8907 La Mesa Blvd, La Mesa CA 92041, (714) 698-8088, for an introductory price of $69.95.

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74LS165	65
74LS170	1 75
74LS174	75
74LS175	75
74LS190	75
74LS193	95
74LS195	95
74LS196	85
74LS221	1 40
74LS240	1 65
74LS241	1 65
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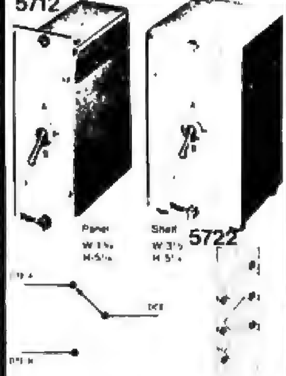

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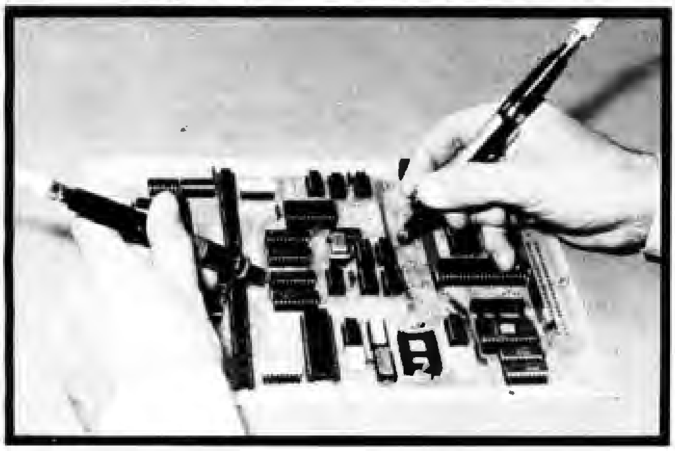

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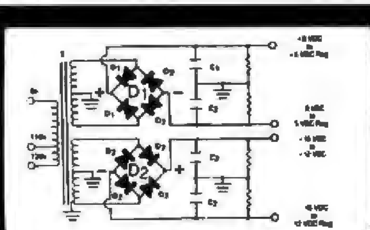

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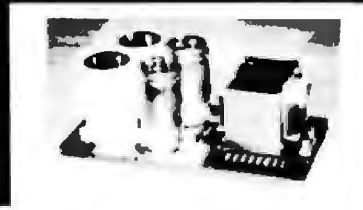

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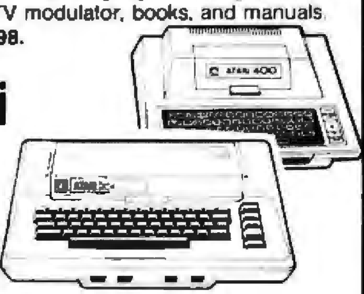

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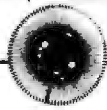

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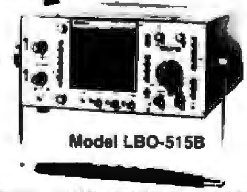
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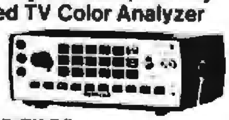

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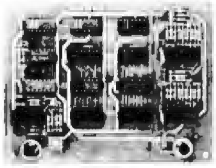
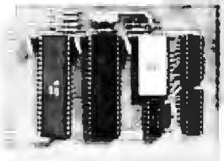
A-D & D-A CONVERTER



JBE A-D & D-A Converter can be used with any system having parallel ports • Interfaces with JBE Parallel I/O Card • D-A conversion time — 5 μs • A-D conversion time — 20 μs • Uses JBE 5V power supply • Parallel inputs & outputs include 8 data bits, strobe lines & latches • Analog inputs & outputs are medium impedance 0 to 5 volt range.

79-287 — ASSM. $79.95
Bare Board $29.95 — Kit $59.95

6502 MICROCOMPUTER



This control computer has: • 1024 bytes RAM (two 2114s) • 2048 bytes EPROM (2716) • Uses one 6522 VIA (comp. doc. Incl.) • Interfaces with JBE Solid State Switches & A-D & D-A Converter • Uses JBE 5V power supply • 2716 EPROM available separately (2716 can be programmed with an Apple II & JBE EPROM Programmer & Parallel Interface) • 50 pin connector included in kit & assm.

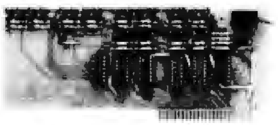
80-153 — ASSM. $110.95
Bare Board $24.95 — Kit $ 89.95

SOLID STATE SWITCH

Your computer can control power to your printer, lights, stereo & any 120VAC appliances up to 720 watts (6 amps at 120VAC). Input 3 to 15VDC • 2-14MA TTL compatible • Isolation — 1500V • Non zero crossing • Comes in 1 or 4 channel version • Includes doc. for interfacing with Dimmer Control.

79-282-1 — ASSM. $13.95
Bare Board $6.95 — Kit $10.95
79-282-4 — ASSM. $49.95
Bare Board $24.95 — Kit $39.95

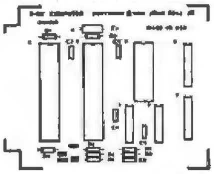
APPLE II DISPLAY BOARD



• Has run-stop, single step switch • Has 16 address LEDs, 8 data LEDs & 1 RDY LED • All lines are buffered.

80-144 — ASSM. $49.95
Bare Board $25.95 — Kit $42.95

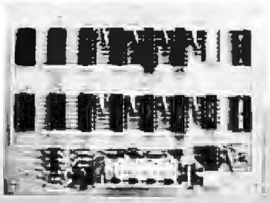
Z80 MICROCOMPUTER



JBE is announcing a single board dedicated computer designed for control functions. It features: • A Z80 Microprocessor software compatible with the Z80, 8080 & 8085 Microprocessors • Uses a Z80 PIO chip for I/O which has 2 independent 8 bit bidirectional peripheral interface ports with handshake & data transfer control • Uses one 2716 EPROM (2K) & two 2114 RAM memories (1K) • Single 5V power supply at 300MA req. • Clock frequency is 2MHz, RC controlled • Board comes with complete doc. • 50 pin connector is included • 2716 EPROM available separately.

80-280 — ASSM. $129.95
Bare Board $29.95 — Kit $119.95

DIMMER CONTROL



JBE Dimmer Control features: • 4 channels • 256 brightness levels • On-board power supply • Four 8 bit parallel input ports • Interfaces with JBE Solid State Switch & Apple II Parallel Interface.

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Bare Board $25.95 — Kit $79.95

POWER SUPPLIES

• Use wall transformers for safety • Protected against short circuit and thermal breakdown.

5 VOLT POWER SUPPLY

Rated at 5V 500MA • Operates JBE A-D & D-A Converter, Z80 & 6502 Microcomputers, 8085 & 8088 Microcomputers.

80-160 — ASSM. $20.95
Bare Board $8.95 — Kit $16.95

± 12 VOLT POWER SUPPLY

Rated at ± 12V 120MA • Can be used as a single 24V power supply • Ideally suited to OP-AMP experiments.

80-161 — ASSM. $22.95
Bare Board $8.95 — Kit $18.95

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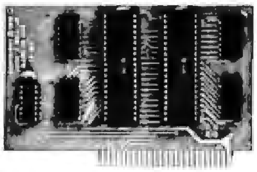
6502	$9.95
6522	$9.95
Z80	$9.95
Z80 PIO	$9.95
2716 5V	$19.95

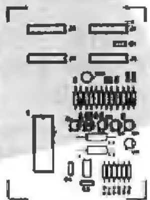
6522 APPLE II INTERFACE



• Interfaces printers, synthesizers, keyboards, JBE A-D & D-A Converter & Solid State Switches • Has handshaking logic, two 6522 VIAs & a 74LS74 for timing. Inputs & outputs are TTL compatible.

79-295 — ASSM. $69.95
Bare Board $22.95 — Kit $59.95

2716 EPROM PROGRAMMER



JBE 2716 EPROM Programmer was designed to program 5V 2716 EPROMS • It can also read 2716s. It interfaces to the Apple II using JBE Parallel I/O Card & four ribbon cable connectors • An LED indicates when power is being applied to the EPROM • A textool zero insertion force socket is used for the EPROM • Comes with complete doc. for writing and reading in the Apple II or Apple II+ • Cables available separately.

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An 8086 family microcomputer system using an 8088 CPU, 8284, 8155, 8755A & an 8185.

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This intelligent CRT Controller is based on an 8085A Microprocessor & an 8275 Integrated CRT Controller. It features: • 25 lines, 80 characters/line • 5x7 dot matrix • Upper case only • Two 2716s • Serial Interface RS232 & TTL • Baud rates of 110, 150, 300, 600, 1200, 2400, 4800 & 9600 • Keyboard scanning system • Req's. unencoded keyboard • Uses +5V & ± 12V power supplies.

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MPU-B SBC 8085 CPU — Complete 8085 based CPU including: serial RS-232 port, parallel I/O port 3 MHz operation, 256 bytes memory, ROM monitor, 3 timers, and more.
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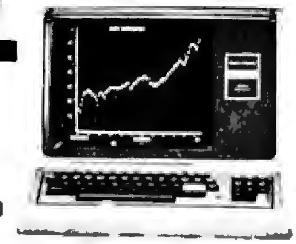

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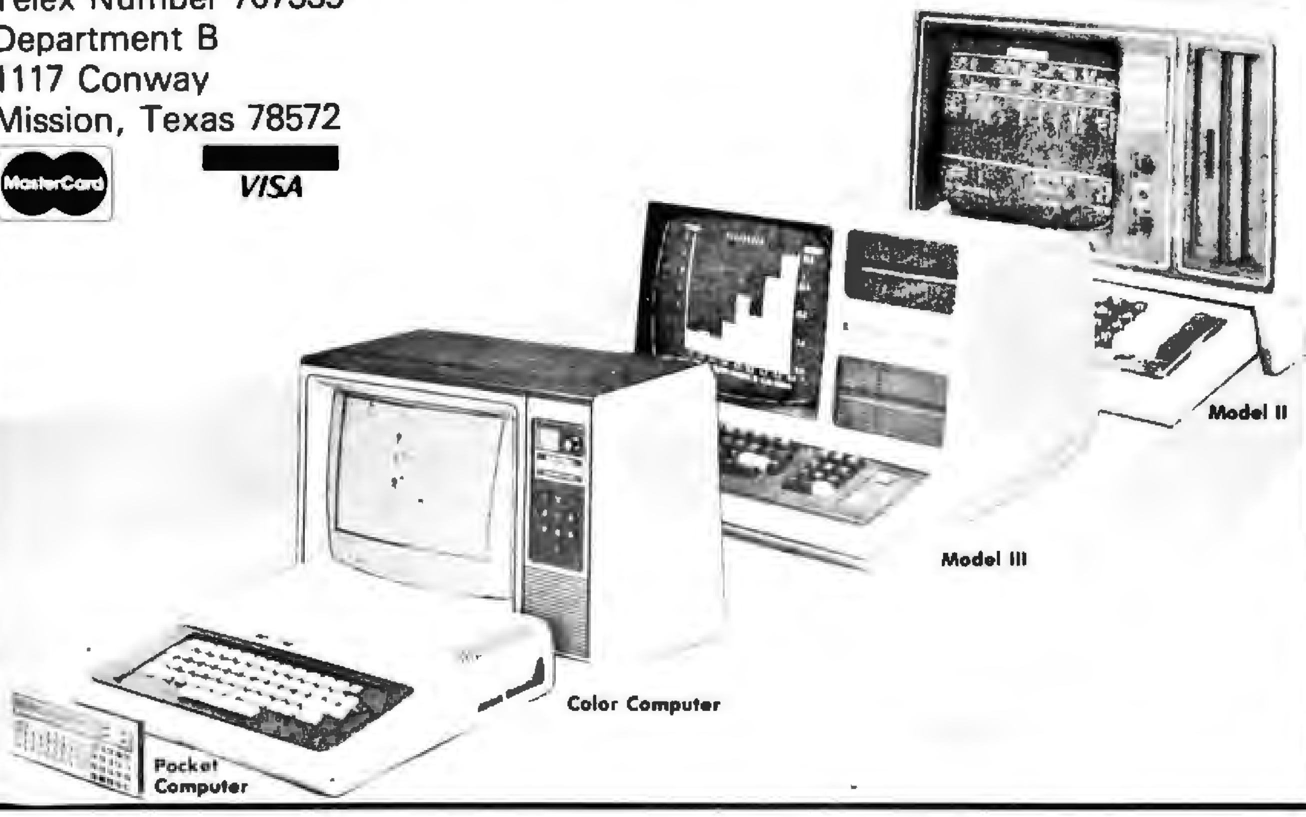

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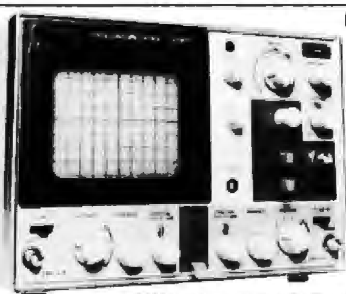

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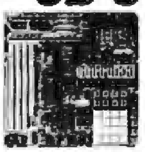

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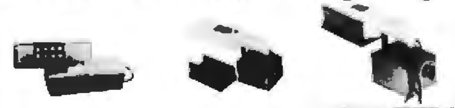

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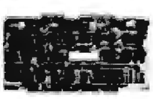

27002 assem/T ... $250
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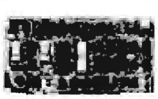

38013 assem/T ... $470

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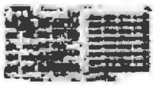

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4070	50/100 Imsai/Crom.	.250	$3.85ea.	$3.65ea.	$3.15ea.
4090	50/100 Imsai W/W	.250	4.30ea.	3.85ea.	3.45ea.
BRAND: SULLINS: U.L Reg.					
120865	50/100 Solder Eye	.140	6.00ea.	6.10ea.	5.45ea.
129878	50/100 S/T Imsai	.250	4.60ea.	4.10ea.	3.70
129876	50/100 W/W Imsai	.250	5.25	4.75	4.20
120865	50/100 S/T Altair	.140	4.85	4.45	3.85
129880	50/100 S/T Cromem.	.250	4.75	4.25	3.80
OTHER .126" CONTACT CTR CONNECTORS:					
12385	22/44 S/E No Ears	.140	4.15	3.75	3.35
12760	36/72 S/T	.140	5.40	4.85	4.35
12790	40/80 W/W	.250	6.30	5.65	6.00
.100" CONTACT CTR CONNECTORS:					
10048	13/26 S/E No Ears	.140	3.40	3.05	2.15
10280	25/50 S/E TRS 80	.140	4.60	4.06	3.60
10175	20/40 S/E TRS 80	.140	5.85	5.35	4.75
10188	20/40 W/W TRS 80	.200	3.30	3.00	2.15
10190	20/40 S/T TRS 80	.140	3.20	2.80	2.55
10486	36/72 S/E Vector	.140	5.50	4.80	4.40
10490	36/72 W/E Vector	.200	5.80	5.25	4.85
10500	36/72 S/T Vector	.140	5.70	4.20	4.80
10535	40/80 S/E PET	.140	5.85	5.35	4.75
10540	40/80 W/W PET	.200	6.00	5.40	4.80
10550	40/80 S/T PET	.140	5.80	5.25	4.85
10585	43/86 S/E COS/ELF	.140	8.95	8.25	5.55
10605	43/86 S/T COS/ELF	.140	8.60	5.85	5.30
10606	43/86 W/W COS/ELF	.200	8.90	8.20	5.85
10615	43/86 S/T COS/ELF	.200	8.80	8.10	5.40

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15110	6/12 S/T PET/MSC	.140	1.85	1.65	1.50
15137	6/12 S/T PET/MSC	.200	1.80	1.64	1.45
15175	6/- S/E Sgle Row	- -	1.70	1.50	1.30
15270	10/20 S/E	.140	2.15	1.95	1.70
15275	10/20 S/T	.140	2.00	1.85	1.80
15436	12/24 S/E PET	.140	2.80	2.35	2.10
15440	12/24 S/T PET	.140	2.85	2.40	2.15
15445	12/24 S/T PET	.200	2.75	2.50	2.20
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15515	15/30 W/W GRI Key	.200	2.80	2.35	2.10
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15610	18/36 S/T	.140	3.00	2.70	2.40
15615	18/36 W/W	.200	3.80	3.20	2.90
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15880	25/50 S/T	.140	4.55	4.10	3.65
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DB	25S	Female	3.80ea.	3.40ea.	3.20ea.
DB	51212-1	1 pc. Grey Hood	1.50ea.	1.30ea.	1.10ea.
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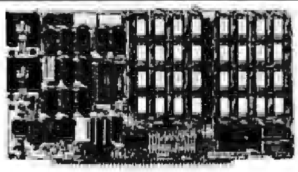

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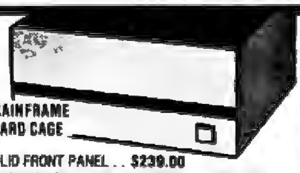

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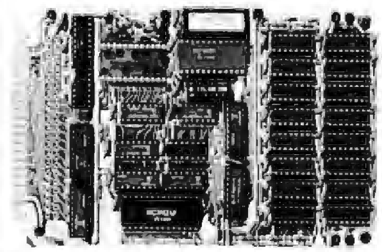

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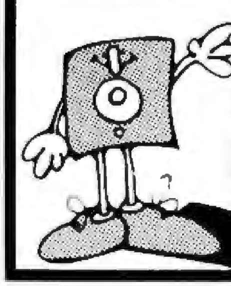

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Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

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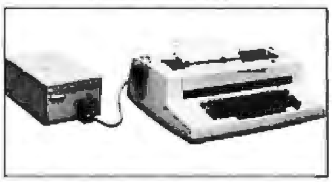

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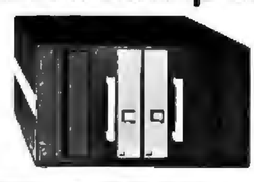

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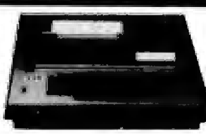

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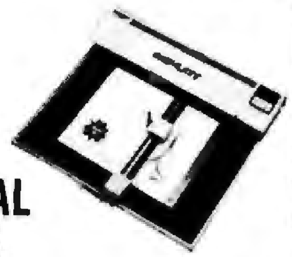

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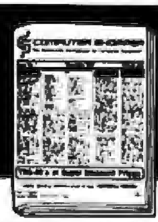

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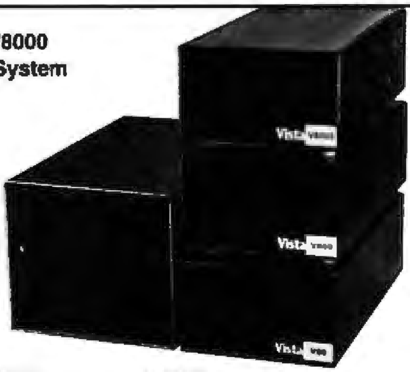

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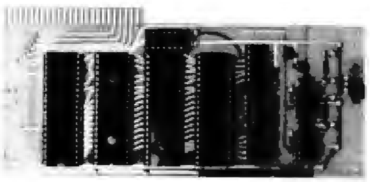

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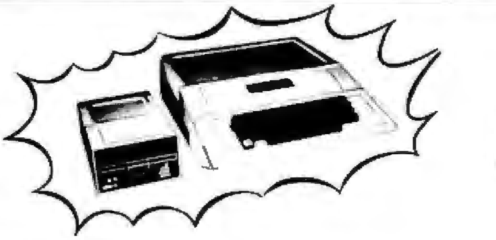

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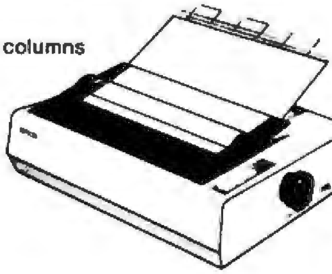

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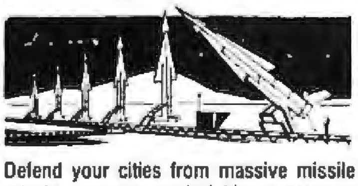

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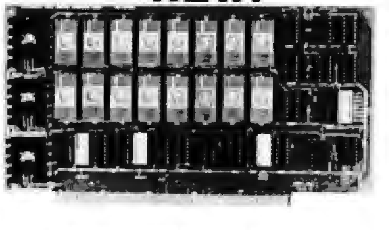

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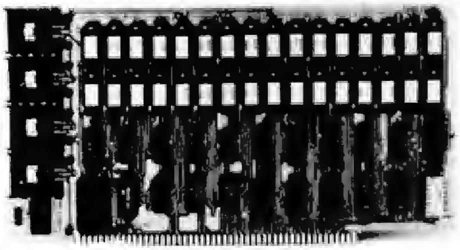

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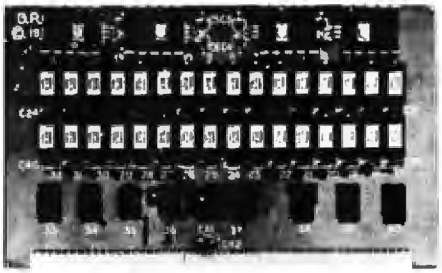

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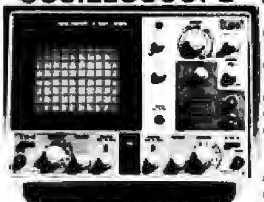

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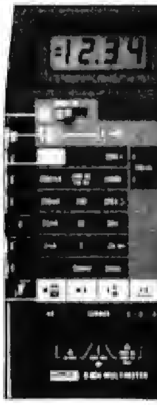

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Terms: Visa, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6% sales tax. Minimum order $15.00 Prepaid U.S. orders less than $75.00 include 5% shipping and handling. MINIMUM $2.50. Excess refunded. Just in case ... please include your phone no. Prices subject to change without notice. We will do our best to maintain prices thru January 1981.
*SOCKET and CONNECTOR prices based on GOLD, not exceeding $700 per oz.

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DETACH OUR CATALOG FROM THE NOV. BYTE

ORDER TOLL FREE (800) 423-5633

DISK DRIVES, etc.

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Shugart
SA801R SALE

SHU-SA801R $410.00

2 OR MORE $395.00 ea.

Capacity	Single Density	Double Density
Unformatted		
Per Disk	3.2 megabits	6.4 megabits
Per Track	41.7 kilobits	83.4 kilobits
IBM Format		
Per Disk	2.0 megabits	n/a
Per Track	26.6 kilobits	n/a
Transfer Rate	250 kilobits/sec.	500 kilobits/sec.
Latency (average)	83 ms	83 ms
Access Time		
Track to Track	8 ms	8 ms
Average	260 ms	260 ms
Setting Time	8 ms	8 ms
Head Load Time	35 ms	35 ms

CP/M
version 2.2

California Computer Systems

CCS2422
FLOPPY DISK CONTROLLER
WITH CP/M VERSION 2.2

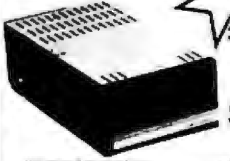
SALE $375.00

IEE S-100 COMPATIBLE SINGLE/DOUBLE DENSITY
5¼"/8" DISK DRIVES
SINGLE/DOUBLE HEADED
ASSEMBLED & TESTED
LIST $400.00

Verbatim

Part No.	Sectoring	Application	Box of 10
VRB-MD 525-01	Soft Sector	TRS-80 Apple	$29.95
VRB-MD 525-10	Hard 10 Sector	North Star	$29.95
VRB-MD 525-16	Hard 16 Sector	Micropolis	$29.95
VRB-MD 577-01	Soft Sector	77 Track Cert	$48.00
VRB-MD 577-16	Hard 16 Sector	77 Track Cert	$48.00
VRB-FD32-1000	Hard Sector	Shugart 801R	$37.00
VRB-FD34-1000	Soft Sector	IBM 3740	$37.00

MICROPOLIS™



35 TRACK ADD-ON FOR THE TRS-80
LIST $545.00

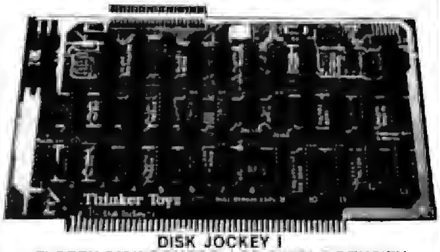
SALE $279.00

MCP1027M1

MISCROPOLIS OVERSTOCK LIST

MODEL	DESCRIPTION	LIST	SALE PRICE
S-100 SUB-SYSTEMS			
MCP-1053-2	630 KB DUAL	$1895 00	$995.00
MCP-1043-2	315 KB SINGLE	$1145 00	$695.00
MCP-1041-2	315 KB SINGLE, NO PS	$1045 00	$639.00
MCP-1042-1	143 KB SINGLE	$795 00	$625.00
MCP-1041-1	143-KB SINGLE, NO PS	$695.00	$595.00
COMPLETE W/S-100 CONTROLLER, CABLES, MANUALS AND MICROPOLIS MDOS AND BASIC			
ADD-ON DRIVES			
MCP-1033-2	630 KB DUAL	$1395.00	$895.00
MCP-1023-2	315 KB SINGLE	$645.00	495.00
MCP-1021-2	315 KB SINGLE, NO PS	$545.00	$475.00
MCP-1002-1	143 KB SINGLE	$545.00	$375.00
MCP-1021-1	143 KB SINGLE, NO PS	$445.00	$360.00
REQUIRES ACCESSORY ADD-ON CABLES			
TRS-80® DISK DRIVES			
MCP-1027-1	35 TRACK SINGLE	$545.00	$299.95
MCP-1037-1	35 TRACK DUAL	$1195 00	$695.00
MCP-1027-2	77 TRACK SINGLE	$645.00	$439.00
MCP-1037-2	77 TRACK DUAL	$1395.00	$795.00
ACCESSORIES			
APP 395M	NEW DOS/80 TRS-80® 35 thru 77 TRACK OPERATING SYSTEM	SUPPLIED 35 TRACK $149.00	ON 77 TRACK $159.00
PR1-34CEEE-2	Two Drive Data Cable		$29.95
PR1-34CEEE-4	Four Drive Data Cable		$39.95

Thinker Toys™



DISK JOCKEY I
FLOPPY DISK CONTROLLER-SINGLE DENSITY

		List Price	SALE
THT-DJ1K	KIT		$179.00
THT-DJ1A	A&T	$229.00	$219.00

DISK JOCKEY 2D
FLOPPY DISK CONTROLLER-DOUBLE DENSITY

		List Price	SALE
THT-DJ2DK	KIT		$379.00
THT-DJ2DA	A&T	$429.00	$409.00

Thinker Toys™

DISCUS/2D™
DOUBLE DENSITY DISK SYSTEM

Why not go all the way to the professional/industrial standard of 600K byte/side disk memory with your S-100 system? The new DISCUS/2D™ full-size, double-density floppy disk system is actually less expensive than many mini-floppy systems.

And Thinker Toys™ hasn't just made full-size, double-density disk memory affordable...we've made it more functional.

Thinker Toys™ has developed BASIC-V,™ a virtual disk BASIC that lets you address all 600K bytes (expandable to 1 megabyte) as if were main memory. The data format is soft-sectored and compatible with IBM's new System 34. And DISCUS/2D™ accepts both single-density and double-density disks for complete flexibility in data storage

And DISCUS/2D™ is even more attractive because it's priced and delivered as a truly complete system. It's complete with all hardware. It's complete with all necessary software. And it's completely assembled, tested and warranted.

Specifications:
- CP/M V2.2 standard
- Plug compatible with Shugart, Remex and Siemens single- or double-sided drives
- Double/single-density capability utilizing MFM and FM data formats
- Western Digital 1791 LSI floppy disk controller chip
- Uses 2K of S-100 address space:
  - —1K PROM with built-in disk drive and I/O utility subroutines incorporating memory mapped I/O
  - —1K 2114-3L 300 ns access time RAM for disk data offering and general purpose use
- Starting address of memory space is 340:000 (E000 hex) for compatibility with other popular ROM based systems
- Phase-locked data separator and crystal controlled disk data write precompensation capability to insure the highest standards of data integrity in double density mode.
- Compatible with all 2 MHz and 4 MHz systems which conform with the proposed IEEE standard for the S-100 bus
- 1602 UART with crystal-controlled baud-rate generator
- Sixteen switch selectable baud rates from 50 to 19,200 bits/second
- TTY current loop and industry standard RS232C serial interface
- Power-on jump circuitry for automatic bootstrap loading from the disk drive
- Power supply requirements: + 8V @ 1200 ma; + 16V @ 150 ma; −16V @ 70 ma.

	List Price	SALE
THT-D2DS Single Drive	$1199..00	$ 998.00
THT-D2DD Double Drive	$1994.00	$1649.00
THT-D22S Single Drive	$1545.00	$1298 00
THT-D22D Double Drive	$2740.00	$2295.00

DISCUS 1
FULL-SIZE, SINGLE-DENSITY
DISK MEMORY SYSTEM

Specifications:
Data Specifications and Formats
- 250,000 byte capacity per standard 8" floppy diskette
- Soft-sectored IBM-compatible format: 77 tracks/26 sectors per track/128 bytes per sector
- Includes Disk/ATE™ disk operating system with integral monitor, assembler and text editor & BASIC-V advanced virtual disk BASIC capable of addressing up to 1 megabyte
- Software customized for SOL and Exidy available
- Patches for CP/M* included
- Optional CP/M* Microsoft BASIC, and FORTRAN available.

	List Price	Our Price
THT-D1S Single Drive	$995.00	$950.00
THT-D1D Dual Drive	$1790.00	$1595.00

DISCUS HD 26 MEGABYTES	List Price	SALE
THT-M26S Subsystem	$4995.00	$4095.00
THT-M26A Add-on hard disk drive	$4995.00	$3995.00
THT-M26HDC Hard disk controller		$ 695.00
Shipping Weight: THT-M26S&A		50 lbs.
Shipping Weight: THT-M26HDC		3 lbs.

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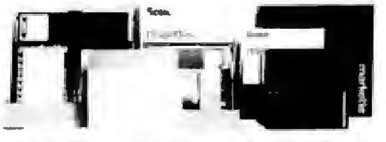


DISKETTES

FREE PLASTIC LIBRARY CASE INCLUDED WITH THE PURCHASE OF EVERY BOX OF DISKETTES

[illegible] labeled for California Digital by one of [illegible] producers of magnetic media. [illegible] is certified double density at [illegible] to insure extended media life each diskette manufactured with a reinforced hub-hole. And [illegible] course, a plastic library case is included with every box of diskettes. [illegible] specify computer or required sectors.

$24.95 BOX

Ten boxes $22.75 One hundred boxes $21.50

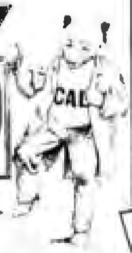
MINIDISKETTES	box	10 boxes		box	10 boxes
[illegible] 3601	$27.00	$25.00	Scotch 744[illegible](10)	$31.00	$30.00
Verbatim [illegible](10)	29.00	27.00	Dysan	[illegible]	[illegible]

EIGHT INCH	[illegible]	box	10 bx.	Dysan	box	10 bx.	[illegible]	box	10 bx.
single side/single den.	740-0	$35.	$3[illegible]	3740/1	$40.	$47.	3060	[illegible]	[illegible]
single side/double [illegible]	741-0	45.	[illegible]	3740/1d	75.	72.	3010	7.	[illegible]
Single side/32 sector	740-32	[illegible]	[illegible]	na.			na.		
Double [illegible] double D.	743-0	[illegible]	55.	na.			3115	49.	45.

SCOTCH [illegible] head cleaning kit. $24.[illegible] [illegible] please specify [illegible]

[illegible] available on request for [illegible] diskpack, [illegible]

MEMORY



TRS-80 APPLE II $29

16k memory (8) 4116's

Installation is simple. Anyone who has ever changed a spark plug should be able to up-grade his microcomputer.

How can California Digital offer these memory up-grade sets at 25% below our competition? Simple, we buy in volume, wholesale to dealers and sell the balance directly to owners of personal microsystems. These 16K dynamic memory circuits are factory prime and unconditionally guaranteed for one full year. NOW, before you change your mind, pick up the telephone and order your up-grade memory from California Digital. Add $3 for TRS80 jumpers.

STATIC	1-31	32-99	100-5C	-999	1K+
21L02 450nS.	1.10	.99	.95	.90	.85
21L02 250nS.	1.49	1.39	1.25		*
2114 1Kx4 450	5.95	5.50	5.25	4.7[illegible]	4.50
2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.25	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	5.95	5.50	5.00	4.80	4.60

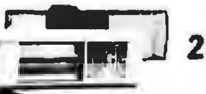
2716 EPROM SALE $9.95

We have slashed price in an effort to reduce our over stocked inventory. These are single five volt EPROMs manufactured by one of the Worlds largest producers of semiconductors. All are first quality prime devices. Ceramic 450nS.

FREE

Ultra-Violet Products UVS 11-E

UV EPROM ERASER



With purchase of FORTY 2716 EPROM's

$79 value

NEW from *Shugart Technology* 5 Megabyte Hard Disk Drive

Packaged in the same physical size as the industry standard 5 1/4" minifloppy disk drive. The micro-Winchester stores thirty times as much data (6.38 megabytes unformatted), accesses data twice as fast (170 milliseconds) and transfers data twenty times faster (5.0 megabits per second.)

The ST506 is factory sealed to protect the media from environmental contaminates. Requires only DC voltage.

Dual California Digital 5 1/4" enclosure, ST506 drive and power supply. **$1500**

Shugart Associates SA400 removable media disk drive for above package. add: **$300**

S-100 & Apple controller scheduled for spring release.

Shugart Associates

$385

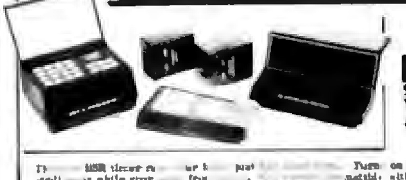
801/ R Disk Drive 15 lbs.

Shugart 801/R with CP206 power supply, muffin exhaust fan, complete in dual enclosure with all the necessary harnessing cables. Documentation included. [illegible] pounds. MSD-1001 **$795**

[illegible] as above but with [illegible] Shugart 801R disk drives [illegible] pounds. MSD-2001 **$1195**

Disk drive cable, 6 feet [illegible] with [illegible] card connector at both ends. MCA-4105 [illegible]

E[illegible] drives. 2201 [illegible] $0.00 per disk drive.



BSR SYSTEM X-10

Th[illegible] BSR timer [illegible] part [illegible]. Turn on lamps and appliances while your [illegible] from [illegible] compatible with your existing system. X-10 devices.

BSR Timer single chan[illegible]	[illegible].00	Appliance Module [illegible] W.	$14.95
Master control console	[illegible]	Lamp Module 300 Watt	12.95
Ultrasonic Controller	[illegible]	W.W. full control wall switch	14.50

TI-810

$1495

List $1895

CONNECTORS

GOLD EDGE CONNECTOR

S-100 .125" centers	[illegible]	10+
Imsai solder .250" [illegible]	[illegible]	$2.50
Imsai wire wrap (TI)	[illegible]	[illegible]
Sullins Hi-Rel. [illegible]	[illegible]	4.[illegible]
Sullins Hi-Rel. [illegible]	[illegible]	4.[illegible]
Sullins / Altair .140	5.[illegible]	[illegible]

[illegible] Center ([illegible])		
22/44 Kim Eyelet	[illegible]0	[illegible]
36/72 Digital Group	[illegible]	[illegible]
36/72 Digital Group W[illegible]	4.60	[illegible]
43/86 Motorola 6800 S/T	5.60	[illegible]
43/86 Moto. 6800 W/W	[illegible]0	

INTEGRATED CIRCUIT SOCKET

	Low Profile each	100+	Wire Wrap	100+
8 pin	$.10	[illegible]	[illegible]	.[illegible]
14 pin	.10	.09	.[illegible]	.[illegible]
16 pin	.12	.11	[illegible]	.[illegible]
18 pin	.15	.1[illegible]	.[illegible]	.[illegible]
24 pin	.25	.2[illegible]	[illegible]	.[illegible]
40 pin	.42	.40	1.40	1.[illegible]

D Type		[illegible]	[illegible]
[illegible]	[illegible]	$1.[illegible]	$1.[illegible]
DE[illegible]	[illegible]	2.00	1.06
DE [illegible]	1.[illegible]	1.45	1.20
DA[illegible]	[illegible]	[illegible]	[illegible]
DA [illegible]	[illegible]	1.[illegible]	[illegible]
DA [illegible]	[illegible]	1.[illegible]	[illegible]
[illegible]	2.[illegible]	[illegible]	[illegible]
DB25 [illegible]	1.[illegible]	1.1	[illegible]
DB [illegible]	1.[illegible]	1.1	[illegible]0
[illegible]	4.2[illegible]	4.00	3.30
[illegible]	[illegible]	5.75	3.50
[illegible]	[illegible]	[illegible]	3.75
[illegible]	[illegible]	5.10	4.75
DD 05 [illegible]	5.[illegible]	[illegible]	6.00
DD 0 [illegible]	3.00	[illegible]	3.10

CENTRONICS

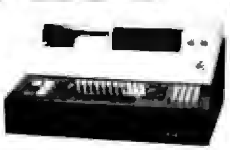
57-30360	[illegible]	[illegible]	5.[illegible]

RIBBON CABLE CONNECTORS

17/34 5" disk [illegible]	[illegible]	[illegible]	2.95
20/40 TRS-[illegible]	[illegible]	[illegible]	4.70
[illegible]	[illegible]	[illegible]	1.90

SURPLUS

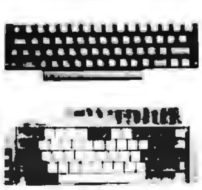
IBM 2980 SELECTRIC BANK TERMINAL



$250

The IBM 2980 terminal was designed to be located at each tellers [illegible] in a branch bank. Information entered into the terminal would [illegible] the customers account at the computer. A record of [illegible] posted into the customers passbook and simultaneously recorded [illegible] 40 column paper roll located within the terminal. USED

Each unit is supplied with print ball, ribbon and [illegible]

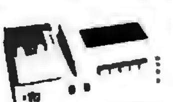


KEY-BOARDS $24.95

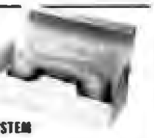
62 key [illegible] New surplus purchased from [illegible] inventory of the Altair [illegible]

50 key Micro-Switch brand Hall Effect keyboard. (USED). Ten bit TTL level output. Requires +5 volt. KEY-[illegible] [illegible] Same unit with ASCII encoder. Add $15.00

Also available Maxi-switch [illegible] keyboard. [illegible] TTL [illegible]



$139.50



PORTABLE DATA ENTRY SYSTEM

[illegible] designed for retail store order entry [illegible] control number, merchandise on [illegible] data has been entered, the [illegible] in the acoustic coupler on all the [illegible] master computer.

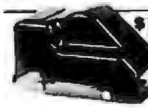
[illegible] includes: [illegible] drive unit; Removable [illegible] with LED [illegible] Gould "D" [illegible] with charger; Acoustical coupler [illegible] cable.

All units removed from service in [illegible] condition. Original [illegible]

Regulated Power Supply 5 VOLT 5 AMP

$9.95

[illegible] USED surplus power supply [illegible] Pass transistor regulation outputs five volts at [illegible] Suitable for TTL hobby application [illegible] SPC-[illegible]



$59 Sankyo Magnetic Card Transport

[illegible]

ATARI RF MODULATOR

[illegible] Apple [illegible]

$9.95

DATA INPUT TERMINAL

This Keystation terminal [illegible] acquired from the C[illegible] division of [illegible] Corporation. The unit was originally [illegible] for inputing data directly onto magnetic tape.

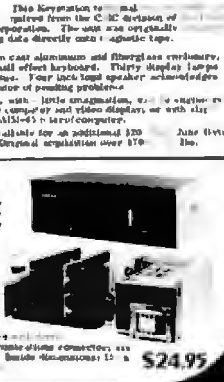
The system is comprised of a premium cast aluminum and fiberglass enclosure, along with a Honeywell / Microswitch hall effect keyboard. Thirty display lamps advise the operator of the systems status. Four inch loud speaker acknowledges acceptance of data and alerts the operator of pending problems.

But most of all this USED terminal, with a little imagination, [illegible] to make the perfect home for an S-100 computer and video display, or with slight modification will accept the Rockwell AIM-65 microcomputer.

Five volt regulated power supply is available for an additional $20 [illegible] lbs.

All units are in excellent condition. Original acquisition over $70[illegible]

WESTERN UNION ENCLOSURE



These enclosures were manufactured for Western Union by Universal Technology. The exact purpose of the product is still a mystery but the enclosure is ideally suited for an S-100 motherboard with shielded power supply. Removable hood and plexiglass front make this enclosure an attractive home for any hobby project. New surplus in factory boxes supplied with [illegible] 22/44 edge connectors, DB25 [illegible] connectors, six foot grounded power cord and more. Inside dimensions: 15 x 10 1/2 x 6 7/8. Shipping weight 6 lbs.

$24.95

VISA

master charge

All merchandise sold by California Digital is premium grade.
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Foreign orders 10% shipping. Excess will be refunded.
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4320 KEYBOARD MODELS
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Friction 80 RS232 AAL 1195
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EPSON MX-80 $495
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Quiet Buss
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IMSAI
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Expandable + with 32K
Monitor For Serial Terminal
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Q.T. Price **$425.00**

Q.T. BD SET #2 (KIT) — **FOR HOBBYISTS**
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FDCII Dbl Den Controller A&T
Monitor For Serial Terminal
Our Normal Retail $1050.00
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Versafloppy I
Monitor For Serial Terminal
BIOS for 8" or 5¼" Drives
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Q.T. Price **$850.00**

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Versafloppy II
Monitor For Serial Terminal
BIOS for Disk Drives
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Q.T. Price **$1000.00**

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TRS-80 • APPLE • EXIDY

4116 200 ns ...... **8 for $35.00**
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2114L 300 ns ..... **8 for $40.00**
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CEN-737-1 737-1 .... **$899.00**

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NOVATION CAT
300 baud, auto answer/originate acoustic modem
NOV-CAT **$149.00**

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SINGLE BOARD COMPUTER
4 MHz Z80A CPU, dbl den Controller (5¼" or 8" simultaneously), CP/M® compatible, on-bd EPROM/RAM/ROM, two serial & two parallel ports, real time clk, std 2K monitor & disk routine on ROM, one year warranty.
SPECIAL PRICE THIS MONTH
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DOUBLE DENSITY CONTROLLER
Controls up to 4 mini or 4 maxi drives simultaneously, IBM diskette format, works with sgl or dbl sided drives, 1K RAM data buffer, works with any CPU regardless of clock speed, CP/M® 2.2 furnished for 5¼" or 8", Oasis compatible.
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QT MINI-SYSTEMS

• (4 MHz) Z80A CPU • Dbl Den Controller • Two serial & two parallel ports • Real time clock • 2K Monitor on ROM • 48K Memory board • Mainframe with 6 slot mother board • DOS on 5¼" disk w/manuals.
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(Just add terminal & compute)

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1 Male DB-25, 1 Female DB-25, 1 Cover
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8035 .... $20.00
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8085A $20.00
8086-4 .... $60.00
8088 .... $60.00
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TMS 9900 JL .. $29.95

8080A SUPPORT
8212 .... $ 3.50
8214 .... $ 4.50
8216 .... $ 2.95
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8238 .... $ 6.00
8243 .... $ 5.00
8251 .... $ 7.00
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2716 (5V) $13.50
2716 (5 & 12V) $13.50
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N8T26 .... $ 2.50
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1488 .... $ 1.25
1489 .... $ 1.25
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P3404 .... $ 6.75
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2513 .... $10.95
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2513 .... $10.95
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2513 .... $10.95
LWR CASE (5V)

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6840P $18.25
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• Typewriter keyboard • Microprocessor controls • Upper/lower case • Adjustable baud rates (75-9600 baud) • Special function keys
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VER-525-16 16 sector $27.95
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VER-34-1000 Soft sector $33.95
8" sgl sided dbl den box of 10
VER-34-8000 Soft sector $55.95
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VER-34-4000 Soft sector $57.95

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Protect your valuable software from spindle damage
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FSI-HDA 8" Applicator .... $ 5.25
FSI-HHM Pkg of 50 for 5¼" $10.75
FSI-HMA 5¼" Applicator .... $ 5.00

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CCS-2200AT A&T $349.95
QT 8" Disk Mainframe
Dual 8" drive cutouts with 6 slot motherboard
QTC-MF-DD6 with 30 amp p.s. $625.00
5¼" Disk Mainframes with 18A
QTC-MF-MD12 (12 slot M/B) $500.00
QTC-MF-MD6 (6 slot M/B) $450.00
QTC-MF-MD w/o M/B $400.00
Mainframe - T.E.I.
TEI-MCS-112 (12 slot M/B) $575.00
TEI-MCS-122 (22 slot M/B) $695.00

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QT DISK PACKAGE
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Dbl Den Drives in Cabinet Only
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Highly reliable floppy disk drives sgl sided dbl den
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Pkg of two .... $ 549.00 ea.
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Dbl Sided Dbl Den
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Sgl Sided Sgl Dbl Den

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QTC-6 Slot K kit $39.95
QTC-6 Slot AT A&T $49.95
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QTC-12 Slot K kit $69.95
QTC-12 Slot AT A&T $89.95
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QTC-18 Slot K kit .... $ 99.95
QTC-18 Slot AT A&T $139.95

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Buy 4 Sets for $35.00
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5¼" or 8" disk controller with free CP/M 2.2
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SBC-100-SD Systems
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SDS-SBC100K Kit $269.95
SDS-SBC100AT A&T $339.95
SBC-200 - SD Systems
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SDS-SBC200AT A&T $375.00
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2 or 4 MHz switchable Z80 CPU with RAM, ROM & I/O
SSM-CB2K Kit $239.95
SSM-CB2AT A&T $299.95
2810 Z-80 CPU - Cal Comp Sys
2 or 4 MHz Z80A CPU w/serial I/O port
CCS-2810 A&T $275.00
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2.5 MHz RAM board expandable from 16K to 64K
SDS-RAM16K 16K kit $245.00
SDS-RAM16AT 16K A&T $295.00
SDS-RAM32K 32K kit $275.00
SDS-RAM32AT 32K A&T $325.00
SDS-RAM48K 48K kit $305.00
SDS-RAM48AT 48K A&T $355.00
SDS-RAM64K 64K kit $335.00
SDS-RAM64AT 64K A&T $385.00
ExpandoRAM II - SD Systems
4 MHz RAM board expandable from 16K to 256K
SDS-RAM216K 16K kit $249.95
SDS-RAM216AT 16K A&T $299.95

SDS-RAM232K 32K kit $289.95
SDS-RAM232AT 32K A&T $339.95
SDS-RAM248K 48K kit $324.95
SDS-RAM248AT 48K A&T $374.95
SDS-RAM264K 64K kit $359.95
SDS-RAM264AT 64K A&T $409.95
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2 or 4 MHz 16K static RAM - a real memory bargain
CCS-2016B 16K 2 MHz A&T $279.00
CCS-2016BCK 16K 4 MHz A&T $309.00
PB-1 - S.S.M.
2708, 2716 EPROM board with built-in programmer
SSM-PB1K kit $159.95
SSM-PB1AT A&T $239.95
PROM-100 - SD Systems
2708, 2716, 2732, 2758 & 2516 EPROM programmer
SDS-PROM-100K kit $175.00
SDS-PROM-100AT A&T $225.00
I/O-4 - S.S.M.
2 serial I/O ports plus 2 parallel I/O ports
SSM-IO4K kit $179.95
SSM-IO4AT A&T $259.95
SSM-IO4BB Bare board .... $ 35.00
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15 Hz to 25K Hz music synthesizer for S-100
SSM-SB1K kit $239.95
SSM-SB1AT A&T $299.95
S-100 Extender - Cal Comp Sys
Puts problem boards within easy reach
CCS-2520A A&T .... $ 24.95

Versafloppy I - SD Systems
Versatile floppy disk controller for 8" or 5¼"
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SDS-VF2K kit $309.95
SDS-VF2AT A&T $369.95
VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O
SDS-VDBK kit $339.95
SDS-VDBAT A&T $399.95
VB3 - S.S.M.
80 x 24 x 48 memory mapped with graphics
SSM-VB3-4mhzK kit, 4 MHz $399.95
SSM-VB3-4mhzAT A&T, 4 MHz $464.95
SSM-VB3-4mhzUPG 80 x 48 upgrade, 4 MHz .... $ 89.00
VIDEO BOARD - Ithaca Audio
64 x 16 assembled & tested S-100 video board
IIS-VBDAT A&T $99.95
T1 Active Terminator
SSM-T1K kit .... $ 34.00
SSM-T1AT A & T .... $ 64.00
VB2 I/O Mapped Video Interface
SSM-VB2K kit $160.00
SSM-VB2AT A & T $210.00
XB1 Extender Board
SSM-XB1K kit (with Connector) .... $ 22.00
SSM-XB1AT A & T .... $ 30.00
Z-80 STARTER KIT - SD Systems
Z-80 computer with RAM, ROM, I/O & keyboard
SDS-Z80K kit $319.95
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QT COMPUTER SYSTEMS INC.
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Circle 332 on inquiry card.

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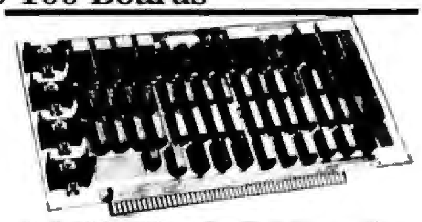
S-100 Boards



64K RAM Board - Cal Comp Sys
4 MHz, bank selectable, IEEE standard

MEM-64565A *A & T* $449.95

Memory Bank - Jade
4 MHz, IEEE S-100, bank selectable, 8 or 16 bit

MEM-99730K *Kit, no RAM* $219.95
MEM-16730K *16K kit* $249.95
MEM-16730A *16K A & T* $299.95
MEM-32731K *32K kit* $289.95
MEM-32731A *32K A & T* $339.95
MEM-48732K *48K kit* $324.95
MEM-48732A *48K A & T* $374.95
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MEM-64733A *64K A & T* $409.95
MEM-99730B *Bare board* $55.00

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MEM-32631K *32K kit* $329.95
MEM-32631A *32K Jade A & T* $379.95
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MEM-48631A *48K Jade A & T* $419.95
MEM-64633K *64K kit* $409.95
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32K STATIC RAM - Jade
2 or 4 MHz expandable static RAM board uses 2114L's

MEM-16151K *16K 4 MHz kit* $169.95
MEM-16151A *16K 4 MHz A & T* ... $224.95
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MEM-32151A *32K 4 MHz A & T* ... $349.95

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MEM-16160A *16K 2 MHz A & T* ... $279.00
MEM-16162A *16K 4 MHz A & T* ... $309.00
MEM-16160B *Bare board* $29.95

THE BIG Z* - Jade
2 or 4 MHz switchable Z-80 CPU with serial I/O*

CPU-30201K *Kit* $145.00
CPU-30201A *A & T* $199.00
CPU-30200B *Bare board* $35.00

SBC-100 - SD Systems
2.5 MHz Z-80 CPU with serial & parallel I/O ports*

CPC-30100K *Kit* $299.95
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SBC-200 - SD Systems
4 MHz Z-80 CPU with serial & parallel I/O ports*

CPC-30200K *Kit* $339.95
CPC-30200A *Jade A & T* $499.95

CB2 - S.S.M.
2 or 4 MHz switchable Z-80 CPU with RAM, ROM, & I/O*

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CPC-30300A *A & T* $299.95

2810 Z-80* CPU - Cal Comp Sys
2/4 MHz Z-80A CPU w/serial I/O port*

CPU-30400A *A & T* $275.00

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Double density controller with the inside track

IOD-1200K *Kit* $299.95
IOD-1200A *8" A & T* $389.95
IOD-1205A *5¼" A & T* $389.95
IOD-1200B *Bare board* $65.00

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5¼" or 8" disk controller with free CP/M 2.2

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VERSAFLOPPY II - SD Systems
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IOD-1160K *Kit* $379.95
IOD-1160A *Jade A & T* $439.95

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IOI-1046K *4 CTC's, 2 SIO's, 1 PIO* .. $259.00
IOI-1046A *A & T* $319.00
IOI-1045B *Bare board w/ manual* ... $59.95
IOI-1045D *Manual only* $20.00

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2 serial I/O ports plus 2 parallel I/O ports

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IOI-1010A *A & T* $259.95
IOI-1010B *Bare board* $35.00

100K DAY CLOCK - Mtn Hardware
Crystal controlled S-100 clock with NiCad backup

IOK-1400A *A & T* $329.95

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15 Hz to 25K Hz music synthesizer for S-100

IOS-1005K *Kit* $239.95
IOS-1005A *A & T* $299.95

TB-4 - Mullen
Extremely versatile extender board with logic probe

TSX-180K *Kit* $55.00
TSX-180A *A & T* $75.00

S-100 EXTENDER - Cal Comp Sys
Puts problem boards within easy reach

TSX-160A *A & T* $24.95

VIDEO BOARD - Jade
64 x 16 assembled & tested S-100 video board

IOV-1050B *Bare board* $25.00
IOV-1050K *Kit* $99.95
IOV-1050A *A & T sale price* $139.95

VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O

IOV-1020K *Kit* $399.95
IOV-1020A *Jade A & T* $459.95

VB3 - S.S.M.
80 x 24 or 80 x 48 memory mapped with graphics

IOV-1095K *Kit, 4 MHz* $399.95
IOV-1095A *A & T, 4 MHz* $464.95
IOV-1096K *80 x 48 upgrade, 4 MHz* . $89.00

PB-1 - S.S.M.
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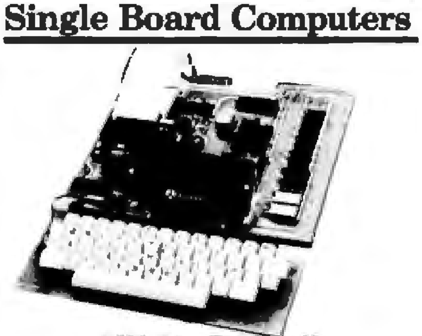
MEM-99510K *Kit* $159.95
MEM-99510A *A & T* $239.95

PROM-100 - SD Systems
2708, 2716, 2732, 2758, & 2516 EPROM programmer

MEM-99520K *Kit* $219.95
MEM-99520A *Jade A & T* $269.95

Single Board Computers



AIM-65 - Rockwell
6502 computer with printer, display, & keyboard

CPK-50165 *1K AIM* $374.95
CPK-50465 *4K AIM* $449.95
SFK-74600008E *8K BASIC ROM* ... $99.95
SFK-64600004E *4K assembler ROM* $84.95
PSX-030A *Power supply* $64.95
ENX-000002 *Enclosure* $49.95
4K AIM, 8K BASIC, power supply, & enclosure
Special package price $625.00

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Z-80 computer with RAM, ROM, I/O, & keyboard*

CPS-30010K *Kit* $369.95
CPS-30010A *Jade A & T* $459.95

Motherboards

ISO-BUS - Jade
Silent, simple, and on sale - a better motherboard

6 Slot (5¼" x 8¾")

MBS-061B *Bare board* $19.95
MBS-061K *Kit* $39.95
MBS-061A *A & T* $49.95

12 Slot (9¾" x 8¾")

MBS-121B *Bare board* $29.95
MBS-121K *Kit* $69.95
MBS-121A *A & T* $89.95

18 Slot (14¼" x 8¾")

MBS-181B *Bare board* $49.95
MBS-181K *Kit* $99.95
MBS-181A *A & T* $139.95

Mainframes

MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply

ENC-112105 *Kit* $309.95
ENC-112106 *A & T* $349.95

DISK MAINFRAME - NNC
Dual 8" drive cutouts with 8 slot motherboard

ENS-112320 *with 30 amp p.s.* $699.95

Video Monitors

9" B & W MONITOR - A.P.F.
High quality, high resolution video monitor

VDM-750900 *9" monitor* $149.95

13" COLOR MONITOR - Zenith
The hi res color you've been promising yourself

VDC-201301 .... $449.00

12" GREEN SCREEN - NEC
20 MHz, P31 phosphor video monitor with audio

VDM-651200 *12" monitor* $249.95

SUP'R'MOD II - M & R Assoc
Color or B & W TV interface recommended for Apple

IOR-5050A *A & T* $29.95

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MEX-16100K *TRS-80 kit* $39.95
MEX-16101K *Apple kit* $39.95
MEX-16102K *Exidy kit* $39.95

DISK DRIVE for APPLE
5¼" disk drive with controller for your Apple
MSM-12310C *with controller* $475.00
MSM-123101 *w/out controller* $375.00

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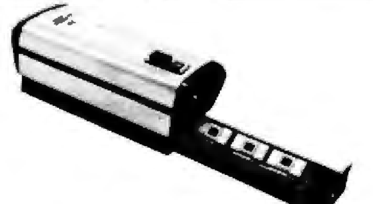

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7400

SN7400N	19	SN74123N	59
SN7401N	22	SN74125N	39
SN7402N	22	SN74126N	44
SN7403N	22	SN74128N	59
SN7404N	22	SN74132N	69
SN7405N	23	SN74136N	95
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	69
SN7408N	26	SN74142N	2 95
SN7409N	23	SN74143N	2 95
SN7410N	22	SN74144N	2 95
SN7411N	29	SN74145N	62
SN7412N	29	SN74147N	1 95
SN7413N	39	SN74148N	1 20
SN7414N	59	SN74150N	99
SN7416N	29	SN74151N	67
SN7417N	29	SN74152N	67
SN7420N	22	SN74153N	67
SN7421N	35	SN74154N	1 19
SN7422N	29	SN74155N	82
SN7423N	29	SN74156N	89
SN7425N	29	SN74157N	69
SN7426N	29	SN74158N	1 65
SN7427N	29	SN74160N	95
SN7429N	45	SN74161N	95
SN7430N	23	SN74162N	95
SN7432N	29	SN74163N	87
SN7437N	29	SN74164N	97
SN7438N	29	SN74165N	97
SN7439N	29	SN74166N	1 20
SN7440N	29	SN74167N	1 95
SN7441N	79	SN74170N	1 69
SN7442N	57	SN74172N	5 95
SN7443N	79	SN74173N	79
SN7444N	79	SN74174N	89
SN7445N	79	SN74175N	89
SN7446N	79	SN74176N	85
SN7447N	59	SN74177N	85
SN7448N	79	SN74179N	1 80
SN7450N	23	SN74180N	75
SN7451N	23	SN74181N	1 75
SN7453N	23	SN74182N	75
SN7454N	23	SN74184N	1 95
SN7459N	29	SN74185N	1 95
SN7460N	23	SN74186N	9 95
SN7470N	39	SN74188N	3 90
SN7472N	34	SN74190N	1 15
SN7473N	38	SN74191N	1 15
SN7474N	36	SN74192N	85
SN7475N	38	SN74193N	85
SN7476N	36	SN74194N	85
SN7479N	4 60	SN74195N	85
SN7480N	59	SN74196N	85
SN7481N	1 10	SN74197N	85
SN7482N	1 10	SN74198N	1 39
SN7483N	55	SN74199N	1 39
SN7485N	65	SN74221N	1 39
SN7486N	39	SN74251N	1 39
SN7489N	1 75	SN74273N	1 05
SN7490N	39	SN74279N	89
SN7491N	65	SN74283N	2 15
SN7492N	52	SN74284N	3 90
SN7493N	49	SN74285N	3 90
SN7494N	72	SN74290N	1 25
SN7495N	65	SN74298N	95
SN7496N	72	SN74365N	68
SN7497N	3 10	SN74366N	68
SN74100N	99	SN74367N	.79
SN74107N	32	SN74368N	79
SN74109N	53	SN74390N	1 90
SN74116N	1 95	SN74393N	1 90
SN74121N	.29	SN74490N	1 90
SN74122N	.39		

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CD4000	.35	CD4093	99
CD4001	.35	CD4094	2 95
CD4002	.35	CD4098	2 49
CD4006	1 39	CD4099	2 25
CD4007	29	MC14408	12 95
CD4008	1 39	MC14409	12 95
CD4009	49	MC14410	12 95
CD4010	49	MC14412	12 95
CD4011	.35	MC14415	8 95
CD4012	29	MC14419	4 95
CD4013	49	CD4501	39
CD4014	1 39	CD4502	1 65
CD4015	1 15	CD4503	69
CD4016	59	CD4505	8 95
CD4017	1 19	CD4506	75
CD4018	99	CD4507	95
CD4019	49	CD4508	3 95
CD4020	1 19	CD4510	1 39
CD4021	1 19	CD4511	1 39
CD4022	1 15	CD4512	1 39
CD4023	38	CD4515	3 95
CD4024	79	CD4516	1 69
CD4025	38	CD4518	1 39
CD4027	.45	CD4520	1 39
CD4028	85	CD4555	4 95
CD4029	1 29	CD4556	99
CD4030	45	CD4566	2 25
CD4031	3 25	74C00	39
CD4032	2 15	74C02	39
CD4034	3 25	74C04	39
CD4035	85	74C08	49
CD4037	1 95	74C10	49
CD4040	1 29	74C14	1 65
CD4041	1 25	74C20	39
CD4042	95	74C30	39
CD4043	85	74C32	99
CD4044	85	74C42	1 85
CD4046	1 75	74C48	2 39
CD4047	1 25	74C73	65
CD4048	99	74C74	85
CD4049	60	74C85	2 49
CD4050	69	74C89	4 95
CD4051	1 10	74C90	1 85
CD4052	1 10	74C93	1 85
CD4053	1 10	74C95	1 85
CD4055	3 95	74C107	1 19
CD4056	2 95	74C151	2 49
CD4059	9 95	74C154	3 50
CD4060	1 39	74C157	2 10
CD4066	75	74C160	2 39
CD4069	35	74C161	2 39
CD4070	49	74C163	2 39
CD4071	35	74C164	2 39
CD4072	35	74C173	2 59
CD4073	35	74C174	2 75
CD4075	35	74C175	2 75
CD4076	1 29	74C192	2 39
CD4077	35	74C193	2 39
CD4078	35	74C195	2 39
CD4081	35	74C922	7 95
CD4082	35	74C923	6 95
CD4085	1 95	MM80C95	1 50
CD4089	2 95	MM80C97	1 25

74LS00

74LS00N	35	74LS164N	1 19
74LS01N	28	74LS165N	89
74LS02N	28	74LS166N	2 48
74LS03N	28	74LS168N	1 89
74LS04N	39	74LS169N	1 89
74LS05N	28	74LS170N	1 99
74LS08N	39	74LS173N	89
74LS09N	39	74LS174N	99
74LS10N	28	74LS175N	99
74LS11N	39	74LS181N	2 20
74LS12N	39	74LS190N	1 15
74LS13N	47	74LS191N	1 15
74LS14N	1 25	74LS192N	98
74LS15N	39	74LS193N	98
74LS20N	26	74LS194N	1 15
74LS21N	38	74LS195N	95
74LS22N	38	74LS196N	89
74LS26N	39	74LS197N	89
74LS27N	39	74LS221N	1 49
74LS28N	39	74LS240N	1 95
74LS30N	26	74LS241N	1 49
74LS32N	39	74LS242N	1 95
74LS37N	79	74LS243N	1 95
74LS38N	39	74LS244N	1 95
74LS40N	26	74LS245N	4 95
74LS42N	79	74LS247N	1 10
74LS47N	79	74LS248N	1 10
74LS48N	79	74LS249N	1 69
74LS51N	26	74LS251N	1 79
74LS54N	35	74LS253N	98
74LS55N	35	74LS257N	98
74LS73N	45	74LS258N	98
74LS74N	59	74LS259N	2 95
74LS75N	68	74LS260N	69
74LS76N	45	74LS261N	2 49
74LS78N	65	74LS266N	59
74LS83AN	99	74LS273N	1 75
74LS85N	1 19	74LS275N	4 40
74LS86N	45	74LS279N	59
74LS90N	79	74LS283N	1 10
74LS92N	75	74LS290N	1 29
74LS93N	75	74LS293N	1 95
74LS95N	88	74LS295N	1 10
74LS96N	98	74LS298N	1 29
74LS107N	45	74LS324N	1 75
74LS109N	45	74LS347N	1 95
74LS112N	49	74LS348N	1 95
74LS113N	49	74LS352N	1 65
74LS114N	55	74LS353N	1 65
74LS122N	55	74LS363N	1 49
74LS123N	1 19	74LS365N	99
74LS124N	1 35	74LS366N	99
74LS125N	89	74LS367N	73
74LS126N	89	74LS368N	73
74LS132N	79	74LS373N	2 75
74LS136N	59	74LS374N	2 75
74LS138N	89	74LS375N	69
74LS139N	89	74LS377N	1 95
74LS145N	1 25	74LS385N	1 95
74LS148N	1 40	74LS386N	65
74LS151N	79	74LS390N	1 95
74LS153N	79	74LS393N	1 95
74LS154N	2 49	74LS395N	1 70
74LS155N	1 19	74LS399N	2 95
74LS156N	99	74LS424N	2 95
74LS157N	99	74LS668N	1 75
74LS158N	75	74LS670N	2 29
74LS160N	99	81LS95N	1 99
74LS161N	1 15	81LS96N	1 99
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78M06	1 49	LM1458CN/N	49
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LM108AH	2 95	LM1496N	89
LM300H	79	LM1556N	1 50
LM301CN/H	.35	LM1800N	79
LM304H	99	LM1820N	95
LM305H	89	LM1850N	95
LM306H	3 25	LM1889N	3 95
LM307CN/H	29	LM2111N	1 75
LM308CN/H	98	LM2900N	99
LM309K	1 49	LM2901N	2 50
LM310CN	1 25	LM2917N	2 95
LM311D/CN/H	98	CA3013T	2 29
LM312H	1 75	CA3018T	1 99
LM317T	2 75	CA3021T	3 49
LM318CN/H	1 49	CA3023T	2 99
LM319N/H	1 25	CA3035T	2 75
LM320K-XX*	1 49	CA3039T	1 49
LM320T-XX*	1 25	CA3046T	1 29
LM320H-XX*	1 25	LM3053N	1.49
LM323K	4 95	CA3059N	3.25
LM324N	1 25	CA3060N	3 25
LM339N	.95	CA3062N	4 95
LM340K-XX*	1 49	LM3065N	1 49
LM340T-XX*	1 25	CA3080N	1 29
LM340H-XX*	1 25	CA3081N	1 69
LM344H	1 95	CA3082N	1 69
LM348N	1 65	CA3083N	1 99
LM358CN	98	CA3086N	1 29
LM360N	1 49	CA3089N	2 75
LM372N	1 95	CA3096N	2 49
LM376N	3 75	CA3097N	1 99
LM377N	3 75	CA3130T	2 49
LM380CN/N	1 25	CA3140T	2 49
LM381N	1 79	CA3146N	2 49
LM383T	1 95	CA3160T	1 49
LM386N	1 49	CA3190N	1 95
LM387N	1 49	CA3401N	69
LM390N	1 95	MC3423N	1 49
NE531V/T	3 75	MC3460N	3 95
NE555V	39	SG3524N	3 95
NE556N	98	CA3600N	3 50
NE561T	19 95	LM3900N	59
NE562B	7 95	LM3905N	1 49
NE565N/H	1 25	LM3909N	98
NE566N/V	1 75	RC4131N	2 95
NE567V/H	1 50	RC4136N	1 10
NE592N	2 75	RC4151N	4 50
LM702H	2 99	RC4194	4 95
LM709N/H	29	RC4195	4 40
LM710N/H	98	ULN2001	1 25
LM711N/H	39	ULN2003	1 50
LM715N	1 95	SN75450N	59
LM723N/H	75	SN75451N	49
LM733N/H	98	SN75452N	49
LM739N	1 15	SN75453N	49
LM741CN/H	.33	SN75454N	49
LM741CN-14	19	SN75491N	89
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Atari BASIC	52.00	Counseling Procedures	35.00	**Add-On Memory**	
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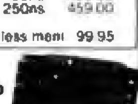

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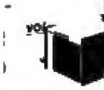

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SN7401N	.20			SN74157N	.69
SN7402N	.25	SN7472N	.29	SN74160N	.89
SN7403N	.25	SN7473N	.35	SN74161N	.89
SN7404N	.25	SN7474N	.35	SN74162N	.89
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SN7416N	.29	SN7491N	.59	SN74176N	.79
SN7417N	.29	SN7492N	.45	SN74177N	.79
SN7420N	.25	SN7493N	.45	SN74179N	1.49
SN7421N	.29	SN7494N	.69	SN74180N	.79
SN7422N	.45	SN7495N	.69	SN74181N	2.25
SN7423N	.29	SN7496N	.69	SN74182N	.79
SN7425N	.29	SN7497N	3.00	SN74184N	2.49
SN7426N	.29	SN74100N	1.49	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7429N	.39	SN74109N	.39	SN74191N	1.25
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SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
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SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.90
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29			74LS192	1.15
74LS01	.29	74LS92	.75	74LS193	1.15
74LS02	.29	74LS93	.75	74LS194	1.15
74LS03	.29	74LS95	.99	74LS195	1.15
74LS04	.35	74LS96	1.15	74LS197	1.19
74LS05	.35	74LS107	.45	74LS221	1.19
74LS08	.29	74LS109	.45	74LS240	1.95
74LS09	.35	74LS112	.45	74LS241	1.95
74LS10	.29	74LS113	.45	74LS242	1.95
74LS11	.35	74LS114	.49	74LS243	1.95
74LS12	.35	74LS122	.69	74LS244	1.95
74LS13	.69	74LS123	1.25	74LS245	2.95
74LS14	.99	74LS125	.89	74LS247	1.19
74LS15	.35	74LS126	.55	74LS248	1.19
74LS20	.29	74LS132	.99	74LS249	1.19
74LS21	.29	74LS133	.89	74LS251	1.19
74LS22	.35	74LS136	.59	74LS253	.89
74LS26	.35	74LS138	.89	74LS257	.89
74LS27	.35	74LS139	.89	74LS258	.99
74LS28	.35	74LS151	.89	74LS260	.69
74LS30	.29	74LS153	.89	74LS266	.69
74LS32	.35	74LS154	1.75	74LS273	1.95
74LS33	.59	74LS155	1.19	74LS279	.75
74LS37	.45	74LS156	1.19	74LS283	1.09
74LS38	.45	74LS157	.89	74LS290	.99
74LS40	.35	74LS158	.89	74LS293	.99
74LS42	.89	74LS160	1.15	74LS298	.99
74LS47	.89	74LS161	1.15	74LS352	1.25
74LS48	1.15	74LS162	1.15	74LS353	1.29
74LS49	1.15	74LS163	1.15	74LS365	.75
74LS51	.35	74LS164	1.15	74LS366	.75
74LS54	.35	74LS165	1.15	74LS367	.75
74LS55	.35	74LS166	1.95	74LS368	.75
74LS73	.45	74LS168	1.19	74LS373	1.95
74LS74	.45	74LS169	1.19	74LS374	1.95
74LS75	.59	74LS170	2.49	74LS375	.69
74LS76	.45	74LS173	1.19	74LS386	.69
74LS78	.49	74LS174	.99	74LS393	2.49
74LS83	.99	74LS175	.99	74LS395	2.49
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74LS86	.45	74LS190	1.25	81LS95	1.95
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74S02	.50			74S251	1.45
74S03	.50	74S133	.55	74S253	1.45
74S04	.55	74S134	.55	74S257	1.35
74S05	.55	74S135	1.19	74S258	1.35
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CD4012	.25	CD4046	1.79	CD4512	1.39
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CD4014	1.39	CD4048	1.35	CD4516	1.49
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CD4017	1.19	CD4051	1.19	CD4520	1.29
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CD4022	1.19	CD4060	1.49	CD4566	2.79
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CD4026	2.95	CD4070	.55	MC14409	14.95
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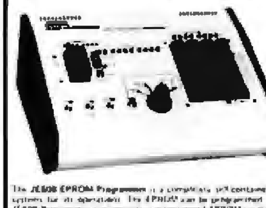
JE608 PROGRAMMER

2708 EPROM PROGRAMMER



- 3 separate Display Registers, 8 LED's for Hex Key entries, 16 LED's for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAM's from the EPROM Chip
- Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board
- Rapid checking verification of all programmed data changes
- User may move data from a master to RAM's or write into RAM's each keyboard location
- Allows manual stepping manipulation (up and down) of any address location
- Stand alone EPROM Programmer consisting of: A 19 key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a 110/Test Socket Panel Board assembly. The Test Socket is a zero force insertion type. Power requirements 115VAC, 60Hz, [illegible]
- Compact desk top enclosure. [illegible]

The JE608 EPROM Programmer is a completely self contained unit which is independent of computer control and requires no additional systems for its operation. The EPROMs can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program for a system prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that [illegible] the entire program will not be necessary. The JE608 Programmer contains a Programmer Board with 25 IC's and including power supplies of -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED Test Socket Panel Board are separate assemblies within the system.

JE608K KIT	$399.95
JE608A Assembled and tested	$499.95

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XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1	XC111G	.190"	green	4/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1	XC111Y	.190"	yellow	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1	XC111C	.190"	clear	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1				
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1				
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1				
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1				

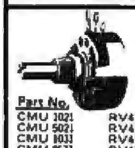
INFRA-RED LED
¼"x¼"x1/16" flat
IRL — 5/$1

DISPLAY LEDS

C.A. — Common Anode C.C. — Common Cathode

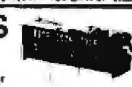
Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DL741	C.A.—red	.600	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL746	C.A.—red ± 1	.630	1.49
MAN 3	C.C.—red	.125	.25	DL747	C.A.—red	.600	1.49
MAN 52	C.A.—green	.300	1.25	DL750	C.C.—red	.600	1.49
MAN 54	C.C.—green	.300	1.25	DL338	C.C.—red	.110	.35
MAN 71	C.A.—red	.300	.75	FND358	C.C. ± 1	.357	.99
MAN 72	C.A.—red	.300	.75	FND359	C.C.	.357	.75
MAN 74	C.C.—red	.300	1.25	FND503	C.C. (FND500)	.500	.99
MAN 82	C.A.—yellow	.300	.49	FND507	C.A. (FND510)	.500	.99
MAN 84	C.C.—yellow	.300	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 3620	C.A.—orange	.300	.49	HDSP-3403	C.C.—red	.800	1.50
MAN 3630	C.A.—orange ± 1	.300	.99	5082-7613	C.C., R.H.D.—red	.300	1.25
MAN 3640	C.C.—orange	.300	.99	5082-7620	C.A., L.H.D.—yel.	.300	1.25
MAN 4610	C.A.—orange	.400	.99	5082-7623	C.C., R.H.D.—yel.	.300	1.25
MAN 6610	C.A.—orange—DD	.560	.99	5082-7730	C.A., L.H.D.—red	.300	.99
MAN 6630	C.A.—orange ± 1	.560	.99	5082-7731	C.A., R.H.D.—red	.300	1.25
MAN 6640	C.C.—orange—DD	.560	.99	5082-7750	C.A., L.H.D.—red	.430	1.75
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.75
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 sgl. dig. RHD	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7302	4x7 sgl. dig. LHD	.600	22.00
MAN 6780	C.C.—red	.560	.99	5082-7304	Overrange. char. (±1)	.600	19.95
DL704	C.C.—red	.300	1.25	4N28	Photo Xsistor Opto-isol.		.99
DL707	C.A.—red	.300	1.25	LIT-1	Photo Xsistor Opto-isol.		.69
DL728	C.C.—red	.500	1.49	MOC3010	Optically Isol. Triac Driver		1.25

POTENTIOMETERS



$2.95 each
2 Watt @ 70°C ± 10%
7/8" Slotted Shaft
Linear Taper
Meets Mil-R-94

Part No.		
CMU 1021	RV4NAY SD - 102A	1K
CMU 5021	RV4NAY SD - 502A	5K
CMU 1031	RV4NAY SD - 103A	10K
CMU 2531	RV4NAY SD - 253A	25K
CMU 5031	RV4NAY SD - 503A	50K
CMU 1041	RV4NAY SD - 104A	100K
CMU 1052	RV4NAY SD - 105A	1Meg



$1.35 each
3/4 Watt @ 70°C
15 turn pot. Linear taper. Printed circuit mount.

Part No.	Part No.	Part No.
830P-50ohm	830P-5K	830P-100K
830P-100ohm	830P-10K	830P-200K
830P-500ohm	830P-20K	830P-500K
830P-1K	830P-50K	830P-1Meg
830P-2K		

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50pcs.	$1.95
ASST. 2	5ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50pcs.	$1.95
ASST. 3	5ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50pcs.	$1.95
ASST. 4	5ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50pcs.	$1.95
ASST. 5	5ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50pcs.	$1.95
ASST. 6	5ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50pcs.	$1.95
ASST. 7	5ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

$10.00 Min. Order — U.S. Funds Only
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Postage — Add 5% plus $1 Insurance

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PRICES SUBJECT TO CHANGE

1/81

INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	22.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	9.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	11.10
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	25.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.96
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	8.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.50
8212CPA	Volt Ref/Indicator	2.50

* INTERSIL'S EVALUATION KITS

74C

74C00	.39			74C195	1.59
74C02	.39			74C221	1.95
74C04	.39			74C240	2.25
74C08	.39	74C106	.75	74C244	2.25
74C10	.39	74C107	1.89	74C373	2.49
74C14	.75	74C151	2.95	74C374	2.59
74C20	.39	74C154	1.95	74C901	.89
74C30	.39	74C157	2.25	74C903	1.15
74C42	1.39	74C160	1.69	74C911	10.95
74C48	1.95	74C161	1.60	74C912	10.95
74C73	.79	74C162	1.49	74C915	1.69
74C74	.79	74C163	1.69	74C917	10.95
74C85	1.95	74C164	1.59	74C922	5.49
74C86	.99	74C173	1.39	74C923	5.75
74C89	6.95	74C174	1.39	74C925	7.50
74C90	1.29	74C175	1.29	74C926	7.50
74C93	1.29	74C192	1.69	80C95	.79
74C95	1.59	74C193	1.69	80C97	.79

LINEAR

LH0002CN	6.85			NE570N	4.95
LM310CLH	4.50			LM702H	.79
LM311CLH	4.75			LM703CN	.89
LH0070-0H	6.05	LM340T-5	1.25	LM709N	.29
TL071CP	.79	LM340T-12	1.25	LM710N	.79
TL072CP	1.39	LM340T-15	1.25	LM711N	.79
TL074CN	2.49	LM341P-5	.75	LM723N	.69
LH0082CD	35.80	LM341P-12	.75	LM733N	1.00
TL082CP	1.19	LM341P-15	.75	LM739N	1.19
TL084CN	2.19	LM342P-5	.69	LM741CN	.35
LH0094CD	35.80	LM342P-12	.69	MC1741SCG	3.00
LM300H	.99	LM342P-15	.69	LM747N	.79
LM301CN	.35	LM348N	1.25	LM748N	.59
LM302H	1.95	LM350K	5.75	LM1014N	2.75
LM304H	1.95	LF351N	.60	LM1310N	1.95
LM305H	.99	LF353N	1.00	LM1458CN	.59
LM307CN	.45	LF355N	1.10	LM1488N	1.25
LM308CN	1.00	LF356N	1.10	LM1489N	1.25
LM309H	1.95	LM358N	1.00	LM1496N	1.95
LM309K	1.25	LM359N	1.79	LM1556V	1.75
LM310CN	1.75	LM370N	4.49	LM1800N	2.95
LM311H	.90	LM373N	3.25	LM1877N-9	3.25
LM312H	2.49	LM377N	2.95	LM1889N	3.20
LM317MP	1.15	LM380N	1.25	LM1896N	1.75
LM317T	1.75	LM381N	1.95	LM2002T	1.49
LM317K	3.95	LM382N	1.79	LM2877P	2.05
LM318CN	1.95	LM384N	1.95	LM2878P	2.25
LM319N	1.95	LM386N-3	1.29	LM2896P-1	2.25
LM320K-5	1.35	LM387N	1.45	LM3189N	2.95
LM320K-12	1.35	LM389N	1.35	LM3900N	.69
LM320K-15	1.35	LM392N	.69	LM3905CN	1.25
LM320T-5	1.25	LF398N	4.00	LM3909N	1.15
LM320T-12	1.25	LM399H	5.00	LM3914N	3.95
LM320T-15	1.25	TL494CN	4.49	LM3915N	3.95
LM323K-5	5.95	TL496CP	1.75	LM3916N	3.95
LM324N	.99	NE510A	6.00	RC4136N	1.25
LM329DZ	.65	NE529A	4.95	RC4151NB	3.95
LM331N	3.95	NE531H	3.95	RC4194TK	5.95
LM334Z	1.30	NE536H	6.00	RC4195TK	5.49
LM335Z	1.40	NE540H	6.00	KB4428	4.25
LM336Z	1.75	NE544N	4.95	KB4429	5.95
LM337T	1.95	NE550A	1.30	LM4500A	3.25
LM337MP	1.15	NE555V	.39	ICL8038B	4.95
LM338K	6.95	LM556N	.99	LM13080N	1.29
LM339N	.99	NE564N	3.95	LM13600N	1.49
LM340K-5	1.35	LM565N	1.25	75138N	1.95
LM340K-12	1.35	LM566CN	1.95	75450N	.89
LM340K-15	1.35	LM567V	1.25	75451CN	.39

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.46	.34
.22/35V	.39	.34	.29	3.3/35V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.64	.56
.68/35V	.39	.34	.29	15/25V	1.39	1.23	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.16	.15	.11	1.0/25V	.16	.14	.13
10/25V	.16	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.14	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.21	10/25V	.16	.14	.13
100/25V	.28	.26	.22	10/50V	.17	.18	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.38	.38	.33	100/16V	.23	.17	.14
220/50V	.48	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.23	.19
2200/16V	.89	.79	.69	470/25V	.38	.32	.27

Circle 335 on inquiry card.

National Semiconductor Clock Modules

12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instruments.

Features: Bright 0.3" green display. Internal crystal time-base. ±0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

MA1023	.7" Low Cost Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Low Cost Digital LED Clock/Timer	6.95
MA1002	.5" LED Display Dig. Clock & Xformer	9.95

National Semiconductor RAM SALE

MM5290N-4 (MK4116/UPD416) .. **$4.95 each**
16K DYNAMIC RAM (250NS)
(8 EACH $39.95) (100 EACH $450.00/lot)

MM5290J-2 (MK4116/UPD416) .. **$6.95 each**
16K DYNAMIC RAM (150NS)
(8 EACH $49.95) (100 EACH $550.00/lot)

MM5298J-3A .... **$3.25 each**
8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS
(8 EACH $23.95) (100 EACH $250.00/lot)

MM2114-3 .... **$5.95 each**
4K STATIC RAM (300NS)
(8 EACH $43.95) (100 EACH $450.00/lot)

MM2114L-3 .... **$6.25 each**
4K STATIC RAM (LOW POWER 300NS)
(8 EACH $44.95) (100 EACH $475.00/lot)

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11E $79.50

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE747 .... $29.95

6-Digit Clock Kit

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 .... $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... $14.95

ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XFMR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	[illegible]
DP8212	8-Bit Input/Output	[illegible]
DP8214	Priority Interrupt Control	[illegible]
DP8216	Bi-Directional Bus Driver	[illegible]
DP8224	Clock Generator/Driver	[illegible]
DP8226	Bus Driver	[illegible]
DP8228	System Controller/Bus Driver	[illegible]
DP8238	System Controller	[illegible]
INS8243	I/O Expander for 48 Series	[illegible]
INS8250	Asynchronous Comm. Element	[illegible]
DP8251	Prog. Comm. I/O (USART)	[illegible]
DP8253	Prog. Interval Timer	[illegible]
DP8255	Prog. Peripheral I/O (PPI)	[illegible]
DP8257	Prog. DMA Control	[illegible]
DP8259	Prog. Interrupt Control	[illegible]
DP8275	Prog. CRT Controller	[illegible]
DP8279	Prog. Keyboard/Display Interface	[illegible]
DP8300	Octal Bus Receiver	[illegible]
DP8303	System Timing Element	[illegible]
DP8304	8-Bit Bi-Directional Receiver	[illegible]
DP8307	8-Bit Bi-Directional Receiver	[illegible]
DP8308	8-Bit Bi-Directional Receiver	[illegible]

6800/6800 SUPPORT DEVICES

MC6800	MPU	[illegible]
MC6802CP	MPU with Clock and RAM	[illegible]
MC6810AP1	128x8 Static RAM	[illegible]
MC6821	Peripheral Inter. Adapt (MC6820)	[illegible]
MC6828	Priority Interrupt Controller	[illegible]
MC6830L8	1024x8-Bit ROM (MC68A30-8)	[illegible]
MC6850	Asynchronous Comm. Adapter	[illegible]
MC6852	Synchronous Serial Data Adapter	[illegible]
MC6860	0-600bps Digital MODEM	[illegible]
MC6862	2400bps Modulator	[illegible]
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	[illegible]

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880-4) (2MHz)	[illegible]
Z80A (780-1)	CPU (MK3880-4) (4MHz)	[illegible]
CDP1802	CPU	[illegible]
2650	MPU	[illegible]
DM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	[illegible]
MC5460	MPU w/Clock (64 Bytes Memory)	[illegible]
INS8035N-6	MPU—8-Bit (6MHz)	[illegible]
[illegible]	[illegible]	[illegible]

DATA ACQUISITION (CONTINUED)

ADC0808CCN	8-Bit A/D Converter (8-Ch. Multi.)	[illegible]
ADC0816CCN	8-Bit A/D Converter (16-Ch. Multi.)	[illegible]
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	11.95
DAC1020LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	[illegible]
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	[illegible]
DAC1021LCN	10-Bit D/A Converter (0.10% Lin.)	[illegible]
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	[illegible]
CD4051N	8-Channel Multiplexer	[illegible]
AY-5-1013	30K BAUD UART	[illegible]

RAM'S

1101	256x1 Static	[illegible]
1103	1024x1 Dynamic	[illegible]
2101 (8101)	256x4 Static	[illegible]
2102	1024x1 Static	[illegible]
2102L	1024x1 Static	[illegible]
2111 (8111)	256x4 Static	[illegible]
2112	256x4 Static MOS	[illegible]
2114	1024x4 Static 450ns	[illegible]
2114L	1024x4 Static 450ns Low Power	[illegible]
2114-3	1024x4 Static 300ns	[illegible]
2114L-3	1024x4 Static 300ns Low Power	[illegible]
2117	16,384x1 Dynamic 350ns (housemarked)	[illegible]
4116 (UPD416)	16K Dynamic 300ns	[illegible]
[illegible]	[illegible] Fast 70ns	[illegible]
5101	256x4 Static	[illegible]
[illegible]	1024x1 Dynamic Fully Decoded	[illegible]
[illegible]	256x1 Dynamic	[illegible]
[illegible]	4096x1 Dynamic	[illegible]
[illegible]	16K Dynamic 300ns (UPD416)	[illegible]
[illegible]	8K Dyn. 300ns (lower ½ of MM5290J)	[illegible]
[illegible]	1Kx4 Static	[illegible]
[illegible]	4K Dynamic 16-pin	[illegible]
[illegible]	4K Static	[illegible]
[illegible]	1024x4 Static	[illegible]

PROMS/EPROMS

1702A	2K UV Erasable PROM	[illegible]
2708	8K EPROM	[illegible]
TMS2716	16K EPROM (-5V, +5V, +12V)	[illegible]
2716 (Intel)	16K EPROM (Single +5V)	[illegible]
2732 (Intel)	32K EPROM	[illegible]
2758	8K EPROM (450ns) (Single +5V)	[illegible]
[illegible]	2048 PROM	[illegible]
[illegible]	32x8 PROM (Open Collector)	[illegible]
[illegible]	[illegible]	[illegible]

SHIFT REGISTERS

[illegible]

DATA ACQUISITION

[illegible]

ROM'S

[illegible]

NMOS READ ONLY MEMORIES

[illegible]

MICROPROCESSOR MANUALS

[illegible]

SPECIAL FUNCTION

[illegible]

TELEPHONE/KEYBOARD CHIPS

[illegible]

DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures

- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.

Enclosure Model No.	Panel Width	PRICE
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DTE-11	10.65"	$32.95
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Ideal for use with clocks, games, power supplies or any other type of AC or DC application

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AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC 1000	117V/60Hz	12 VAC 1 amp	$5.95
DV9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
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UG1094/U	BNC Bulkhead Recp.	$1.29

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Expand your 4K TRS-80 System to 16K.
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★ Documentation for Conversion

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JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (as pictured above) ... **$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) ... **$ 79.95**
K62 62-Key Keyboard (Keyboard only) ... **$ 34.95**
DTE-AK (case only — 3½"Hx11"Wx8¾"D) **$ 49.95**

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FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8 bit latched output for microprocessor use. Three user define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16 pin IC connector. Only +5VDC required for operation. Size: 3½"H x 6¾"W x 8¾"D

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These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine.

FOR SALE: Southwest Technical Products Corp PR-40—40 character/line on 4-inch paper tape, 64 character ASCII; $200. Healthkit oscilloscope IO-4560—5 MHz triggered sweep; $75. Holden Caine, 1 Windsor Pl, Melville NY 11746, (516) 692-9512.

FOR SALE: Programmer's toolkit for old read-only memory PET. Perfect condition, with manual. Plugs onto right of PET. Commands: auto-automatic line numbering. Renumber-renumbers program. Find-lists occurrences of command or text in program. Help-alter error, list line; error is in reverse field. Append-merge saved programs. Other commands: trace, step, delete, dump. Costs about $100. Make me an offer. David Magill, 2001 Carling Ave, Apt 1709, Ottawa Ontario, K2A 3W5 Canada, (613) 722-3566.

FOR SALE: TI-59 programmable calculator with PC-100C printer cradle; both in excellent condition. Includes extra paper for printer, all manuals, and my own library of programs. $380 or best offer; I pay shipping. Mike Smith, 908 Murray Hill Rd, Binghamton NY 13903.

FOR SALE IN CANADA: 8 K and 16 K static-memory board for H-8 computer, both assembled and tested. Give me your offer. P Liem, 15 Ardell Grv, Nepean Ontario, K2G 4G5 Canada.

FOR SALE: Partially completed Heath Company digital computer with related tools. Additional information provided on request. Sale necessary to settle estate. Robert L Kennedy, Attorney at Law, POB 222, Colfax LA 71417.

FOR SALE: Xitan/TDL microcomputer disk system, software, and extras. 64 K memory, Xitan disk BASIC, INFO 2000 dual 8-inch floppy-disk drive (made by PerSci), CP/M operating system, twelve floppy disks, sorting and telecommunications software packages, spare 32 K memory board, equipment covers, and all documentation; $1500. V Roningen, 4707 9th St S, Arlington VA 22204, (703) 521-1451.

FOR SALE: Like-new 16 K Heathkit H-89 computer with H-77 floppy-disk drive, H-885 cassette interface, and HDOS. Used three months. $1800. Charles Leet, Jr, Box 517, Jelmore KS 67854, (316) 357-6531.

FOR SALE: 4116-type dynamic programmable memories from several manufacturers. Each 16 K circuit has been heat-tested and is guaranteed good. Speed is unknown. Price is $4 each postpaid. Steve Marley, 425 N Hickory #305, Escondido CA 92025, (714) 489-8293.

FOR TRADE: Two LSI-11 processor boards, two 4 K memory boards, and a serial-line unit. Will trade for H780H power supply, front panel for PDP-11/03/LSI-11, and H909C enclosure box. Robert McCown, 180 Farm St, Millis MA 02054.

FOR SALE: Heath ETA-3400 trainer accessory with full 4 K programmable memory. $175 or best offer. David Haas, 9 Marget Ann Ln, Suffern NY 10901, (914) 357-3447.

FOR SALE: I/O: OSI 8-slot chassis with fully populated 500 processor (read-only memory BASIC) 540 video with graphics; 430 with parallel, serial, dual D/A; fully socketed 24 K programmable-memory board with 2 K installed; video monitor; GRI keyboard; cassette recorder; graphics and music demonstration software; $800. Stephen P Smith, 106 E Clearview Ave, State College PA 16801.

FOR SALE: Apple serial I/O interface by Electronic Systems. Have three brand-new boards. Will sell with software and RS-232 connector; $52. I pay shipping. Dan Pole, 3105 Falkland, Carrollton TX 75007, (214) 492-2027 after 6:30 PM or on weekends.

FOR SALE: TRS-80, Model 1, Level 2, 16 K with expansion interface (RS-232C installed) plus Editor, Assembler, Micro Music, and blackjack programs. Excellent condition; $800 firm. RS-232C original carton; $55. Jerry Coyle, 11 Town Way, Hull MA 02045, (617) 925-1282.

FOR SALE: Changing systems, have LA 36 DECwriter. Two years old; in excellent condition. Will take best offer. Robert A Leverone, 279 Cambridge St, Burlington MA 01803.

FOR SALE: IMSAI cabinet and power supply for two minidiskette (5.25-inch) drives. Sturdy, with ample power. Have purchased a North Star Horizon. $800 or best offer. Ronald Subler, 25 First Parish Rd, Scituate MA 02066, (617) 545-6578.

FOR SALE: Heathkit ET-3400 assembled microprocessor trainer in excellent working condition. All additional components and manuals in good order. Asking $205 or $155 for trainer only. Also, new Base 2 Model MST impact printer with graphics for $650. Apple parallel interface available. Will ship via UPS. Jeff Sumey, 5 Nell St, Hopwood PA 15445, (412) 437-3021 evenings.

FOR SALE: Comprint 912 printer with TRS-80 interface. Works great. Price $425. Steven Wexler, 1634 Buck Hill Dr, Huntingdon Valley PA 19006, (205) 947-8236.

WANTED: SwTPC 6800 processor with MPA2 board. Depending on condition, will pay 70% of new cost. Bob Hanna, 7601 Wordham Dr, Austin TX 78749, (512) 441-9700 days.

WANTED: TRS-80 Level II programs to swap. Utilities, languages, games, and business. Send list, name, and address. Dennis Leong, 5910 N Washtenaw, Chicago IL 60659.

FOR SALE: I have upgraded my TRS-80 to 16 K and want to sell my old 4 K chip set. Used only twenty hours and is in prime condition. Will take best offer. (MCM 6604AC) Also, would like to swap Level II programs to increase library. Paper listing only. Will take cassette or listing. Mark Cruse, 3609 Stanolind, Midland TX 79703, (915) 694-4868.

FOR SALE: Ohio Scientific C1P with the 610 expander board installed. Features Microsoft 8 K BASIC in read-only memory, 16 K user memory easily expandable to 32 K by plugging in more memory, and minifloppy controller read-only memory with double-sided option. Original carton, documentation, and many programs included. Sell all for $600 plus $10 shipping. Charles F Allen, 9 Annabelle St, Carnegie PA 15106, (412) 276-8265.

FOR SALE: 12 V Reed relays; $0.50 each. All brand new, same as Electrol R4248-2. Also, a Power-One D24-4.8, 24 V power supply. M6800 software to trade. Send SASE with any offers. T Preston, 9274 Marinus Dr, Fenton MI 48430.

FOR SALE: IMSAI 8080, Tarbell floppy interface for two PerSci Model 70, IMSAI MIO, Processor Tech VDM-1, 8 K and 16 K programmable memory boards, Cromemco TUART, and more. All operational. Make offer or send SASE for detailed list. Tom Tai, POB 142, Eagleville PA 19408.

FOR SALE: Axiom 801 printer with six rolls of paper. Cable for hookup to PET or CBM computer. $280. Also, CAT modem and SOURCE program on disk and cassette for CBM. $150. Both for $400. Kurt Hesselden, 2201 E 11th, Farmington NM 87401, (505) 327-7682.

FOR SALE: Two 8085 microprocessor chips, fifteen 8155 static programmable memory chips, three 2716 eprom, and one 8212 I/O port. New/never used. Will not split up set. Cost $500. Will sell for $450 or best offer. Ted Poe, 28C Coolbrook Ct, East Amherst NY 14051.

FOR SALE: Shugart SA800; $375. SA900; $225. Pertec 8-inch floppy drive and 8-inch standard media; $225. Memorex 630 plug-compatible to IBM 2311 but has self-contained power supplies and uses modern voice coil-type positioning, 7.5 megabytes single density, and removable media; $500. Frank Bennett, 1242 Cottonwood St, Broomfield CO 80020, (303) 466-2621.

FOR SALE: 32 K ARTIC static programmable memory board for the S-100 bus, fully populated with 250 ns 4044 chips. Used, but in excellent working condition; $400. Cromemco BYTESAVER programmable read-only memory board. Programs 2704/2708s and has space for up to 8 K of programmable read-only memory. Used less than two hours and in excellent condition; $100. A E Caudel, 8003 Benaroya Ln, Apt C3, Huntsville AL 35802, (205) 883-7425 evenings.

FOR SALE: Integral Data Systems IDS-125 printer with printer control option. Needs mechanical adjustment. Over $800 new. Asking $400 or reasonable offer. Bill Krantz, 108 Hawthorne Dr, North Wales PA 19454, (215) 368-3697 evenings.

FOR SALE: Magnetic-tape Selectric typewriter (dual-tape model); $1200. Tapes; $4. Also, 80-track minifloppy with hardware switch to 35/40 track for TRS-80 Model I; $650. Arnold Vagts, 3713 S Parton St, Santa Ana CA 92707, (714) 549-7021.

WANTED: Texas Instruments SR-52 programmable calculator. Must be in excellent condition. Paul H White, 1539 Malcolm Ave, Los Angeles CA 90024, (213) 650-4001 days.

FOR SALE: Memorex 651 floppy-disk drive (new), thirty blank disks, controller board (old); $300. EVK 200 6800 development kit: 1 K programmable memory, 1/2 K erasable-programmable read-only memory, and read-only memory monitor; $170. Gordon Wilson, 819 San Lucas Ave, Mtn View CA 94043.

FOR SALE: Hazeltine 1520 intelligent terminal. Features 110 thru 19.2 K bps, cursor movement keys and numeric keypad, antiglare screen, full uppercase and lowercase ASCII character set, 80 by 24 dual-intensity readout, switch-selectable reverse video, and local screen editing. Almost new; with owner's manual. Asking $1150, will ship immediately UPS (insured) on receipt of certified check. Jeffrey J Nonken, 8 E Washington St, West Chester PA 19380, (215) 431-3513.

FOR SALE: Lear-Siegler ADM3A+ terminal, latest model, one-month old. $800. P Gleeson, 3470 19th St, San Francisco CA 94110, (415) 864-1967.

FOR SALE: Rockwell AIM-65, 1 K programmable memory with assembler read-only memory. Used only two hours. In factory box with all manuals. $350. Switching power supply, +5 V at 10 A, +24 V at 3 A, ±12 V at 1 A. $150. Bruce Warren, Box 784, Freeport TX 77541, (713) 233-3700 home, (713) 238-2547 office.

FOR SALE: 18-month-old Radio Shack TRS-80 Model I Level 2 computer in excellent condition; 32 K memory; expansion interface; 150 LPM Quick Printer; five rolls of paper; Data Dubber; light pen; two 6-plug isolator boxes; all manuals and a library of over fifty cassette programs. Original value over $2200; asking $1200. Michael Clark, 5967 Sullivan Trl, Nazareth PA 18064, (215) 759-6873.

FOR SALE: TI-25 and TI-30 calculators. Both in excellent condition. Will include documentation, batteries (TI-25 only), and the book *Great International Math on Keys* (TI-30 only) on request. Will sell any of the above separately. $40 for all of the above; best offer for separate units. May swap for TI-59 or TRS-80 (Level II) software. Joe Sewell, 6776 Sheridan Rd, Melbourne Village, Melbourne FL 32901.

FOR SALE: Ticker-tape Teletype. Full alphanumeric, five-level code. Excellent condition. Both transmit and receive work fine. 60 mA loop. $145. Chuck Gee, 1890 SW 3rd, Corvallis OR 97330, (503) 754-9422.

WANTED: Correspondents or exchange of Biotech Electronics (defunct) CGS-808B graphics software. Owners of firmware pack 2. Have firmware pack 1 source on CPM. Share with present group of four. Larry Snyder, S78 W17675 Canfield Dr, Muskego WI 53150, (414) 679-9706.

FOR SALE: ELF II with 4 K programmable memory, Giant board, ASCII keyboard, and documentation. Asking $400 or best offer. Kim Dixon, Box 33, Kenville Manitoba, R0L 0Z0 Canada, (204) 734-2411.

FOR SALE: Cromemco Z-2, 4FDC disk controller, plus a 32 K Dynabyte memory card. All are in perfect working condition. Runs at 4 MHz. Documentation is included, but no software. Asking $1600. Bill Dyche, 2812 Windemere Dr, Donelson TN 37214.

BOMB

BYTE's Ongoing Monitor Box

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October Winners: Sorting and Ciarcia

"Sorting with Binary Trees," by Bill Walker won first place in the BOMB for the October 1980 issue of BYTE, and Steve Ciarcia's "Make Liquid-Crystal Displays Work for You" came in second. Dr Walker's article, which is 2.1 standard scores above the mean, will net him an award of $100, while Steve Ciarcia's article, 0.85 standard scores above the mean, wins a $50 prize.

Other popular articles in this issue include "The 6502 Gets Microprogrammable Instructions," by Dennette Harrod, "Symbolic Math using BASIC," by David Stoutemyer, and "Machine Problem Solving, Part 2," by Peter Frey.

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The Brains of Men and Machines

by Ernest W. Kent

When the "Brains of Men and Machines" series of articles originally appeared in BYTE magazine, the response was immediate and enthusiastic. Now Ernest W. Kent has expanded his ideas about the brain into a full-length book.

As researchers begin to unravel the mysteries of the brain's chemical, electrical, and synaptic circuitry, their findings are becoming immediately applicable to advances in robotic behavior and computer design. **The Brains of Men and Machines** "dissects" the brain to provide new insights into computer design and artificial intelligence.

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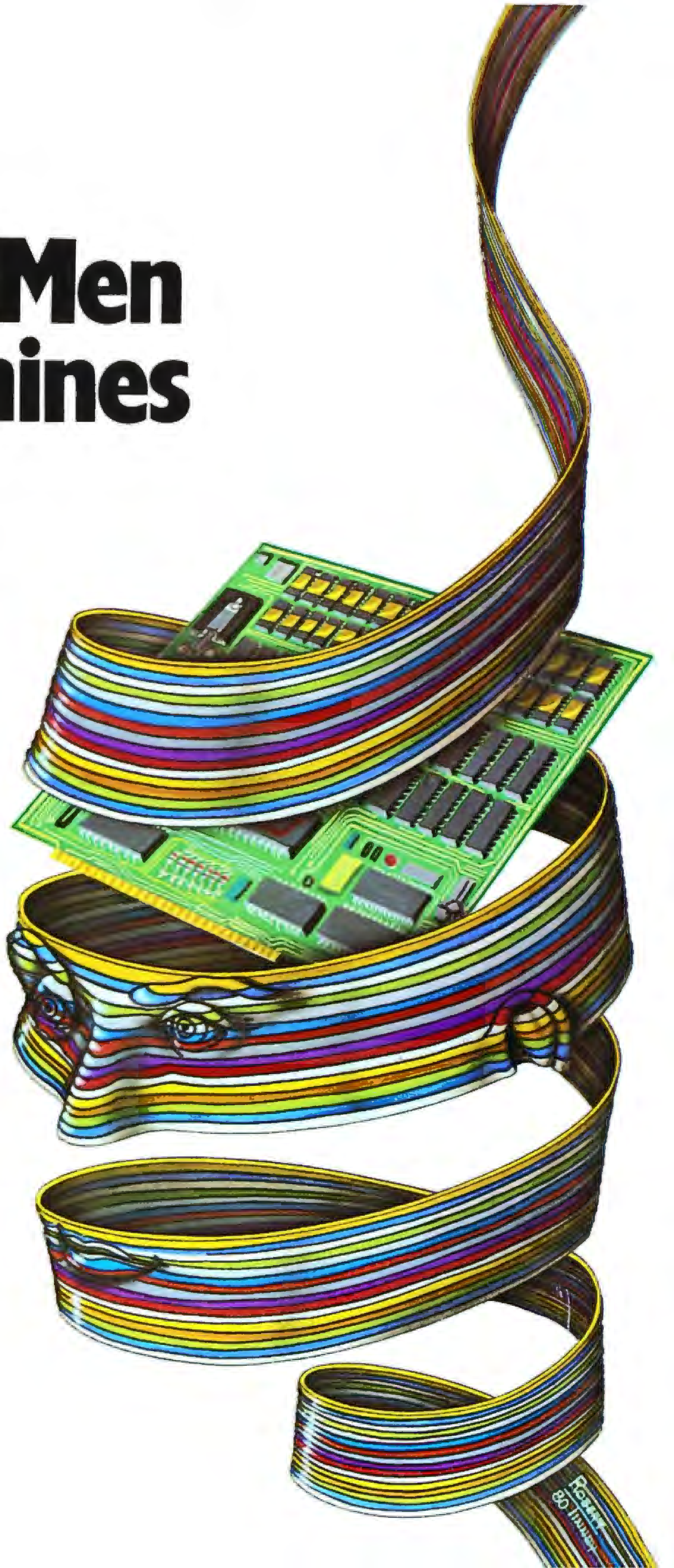

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  74 millisec worst case access
  38 millisec average
  10 millisec access on cylinder (215K user workspace)
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