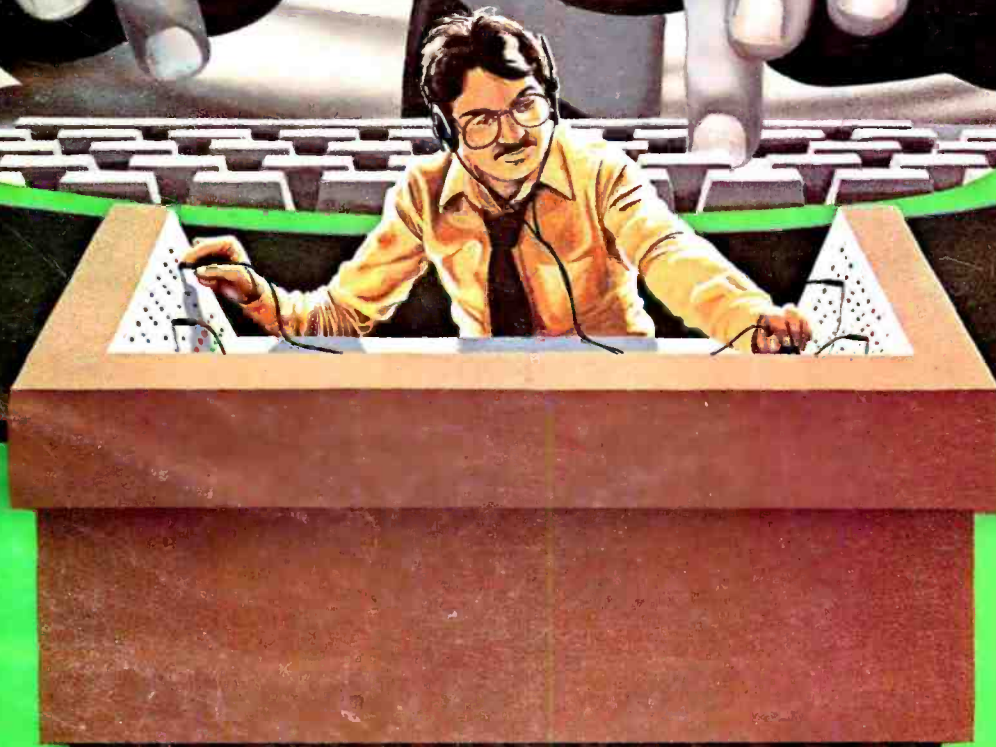


BYTE[®]

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OPERATING SYSTEMS



YOUR CHOICE-smart either way

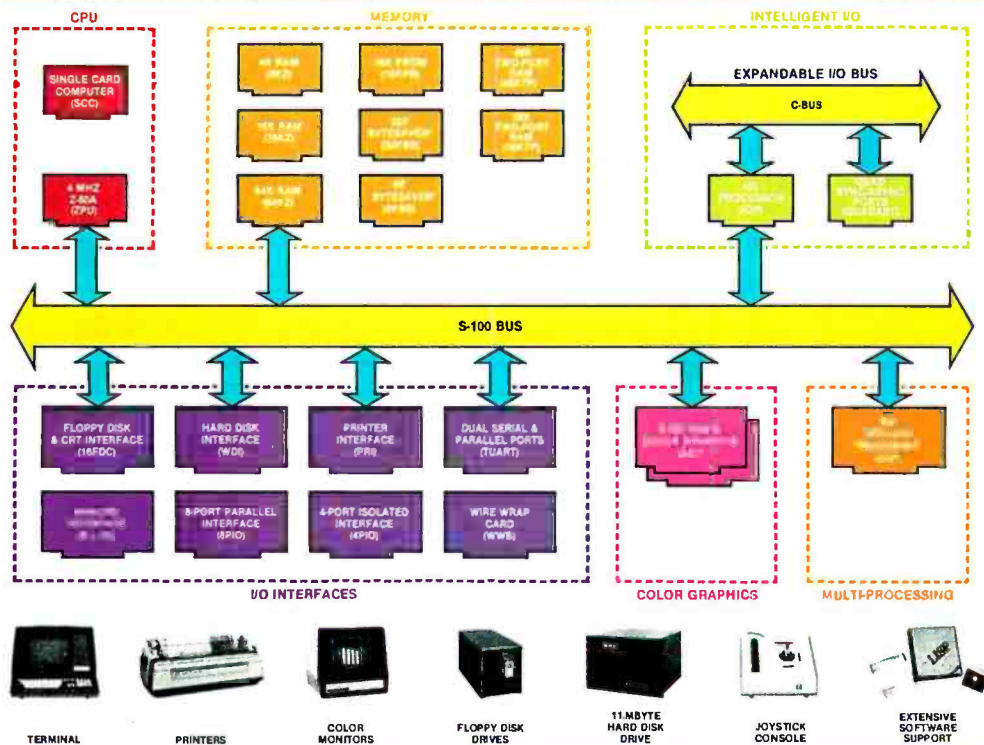
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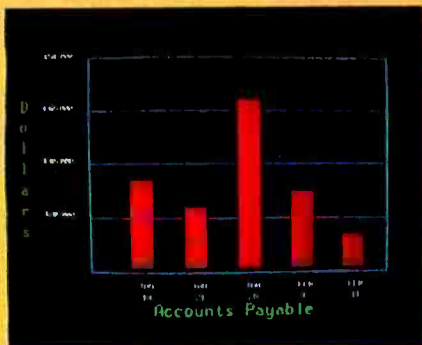


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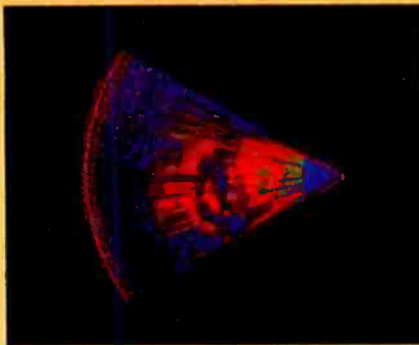
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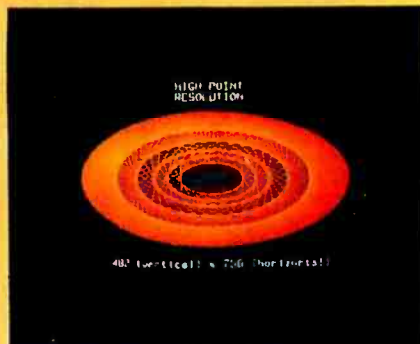
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Ultrasonic heart sector scan



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).

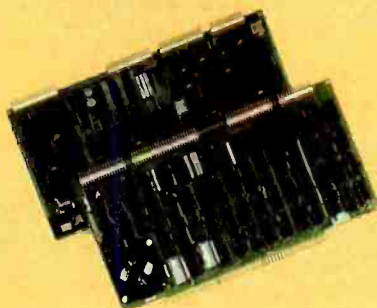
When we say the SDI results in a high-quality professional display, we mean **you can't get higher resolution than this system offers in an NTSC-conforming display.**

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).



Model SDI High-Resolution Color Graphics Interface



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

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.

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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.

*U.S. Pat. No. 4121283



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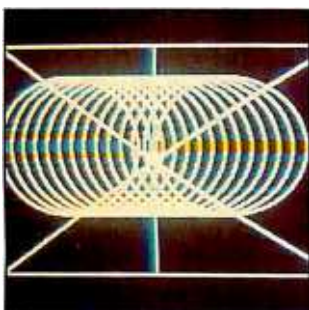
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In This Issue

It's the operating systems that turn a hunk of hardware into a clever machine. As Robert Tinney's cover drawing depicts, they are the brains behind the brawn of today's computing systems.

This month two articles analyze the most popular operating system, "CP/M: A Family of 8- and 16-Bit Operating Systems," by Gary Kildall, and James Larson's "The Ins and Outs of CP/M." If you can get by the title of Chris Morgan's editorial — "The New 16-Bit Operating Systems, or, the Search for Benutzerfreundlichkeit" — you'll discover what form the operating systems of the future may take. And Robert Greenberg presents what may be the next popular operating system in his article, "The UNIX Operating System and the XENIX Standard Operating Environment."

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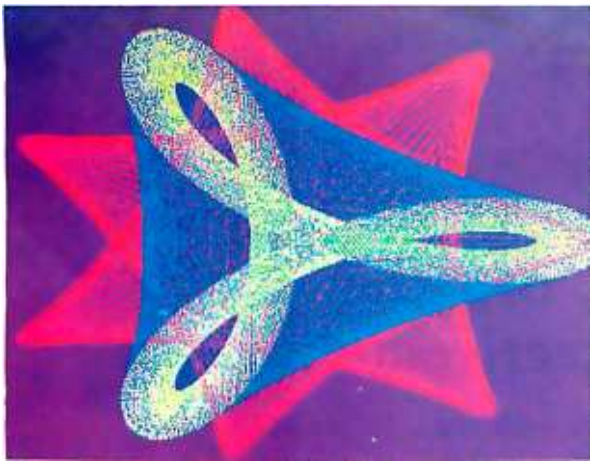
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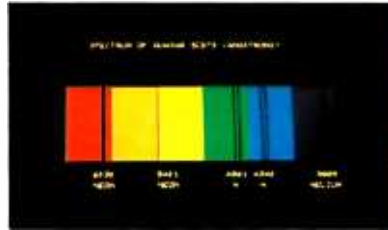
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1981 Technology Forecast

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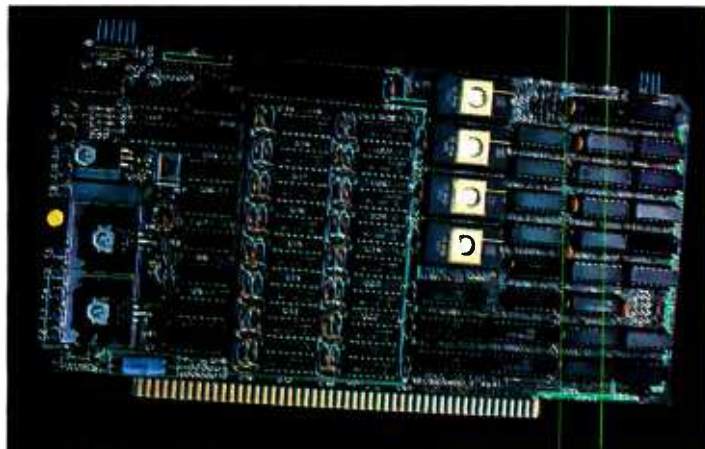
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Screenware™ Pak I

A 4K byte operating system resident in PROM on MicroAngelo™. Pak I emulates an 85 character by 40 line graphics terminal and provides over 40 graphics commands. Provisions exist for user defined character sets and directly callable user extensions to Screenware™ Pak I.

Screenware™ Pak II

An optional software superset of Pak I which adds circle generation, polygon flood, programmable split screen for separate graphics and terminal I/O, relative coordinates, faster vector and character plotting, a macro facility, full UCSD Pascal compatibility, and more.

And now...COLOR!!

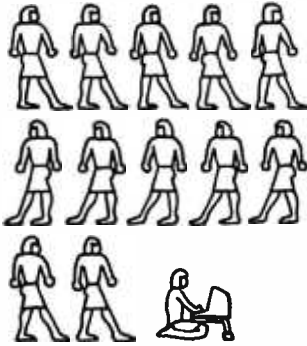
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Editorial

The New 16-Bit Operating Systems, or, The Search for Benützerfreundlichkeit

by Chris Morgan, Editor in Chief

"Benützerfreundlichkeit: (literally 'user friendliness') The philosophy that a system should be constructed with the interests of the user as the chief concern."

— from The Practical Guide to Structured Systems Design
by Meilir Page-Jones, Yourdon Press, New York, 1980, page 338.

Sam Goldwyn, the "G" of MGM, was famous for his inside-out logic. He once said, "A verbal agreement isn't worth the paper it's written on." This month's topic prompted me to coin a "Goldwynism" of my own: "The best time to talk about the future is before it happens."

In one sense 16-bit microcomputers are definitely here, yet in another they are strangers to us. The personal-computer community still lives in an 8-bit world, straining all 8 bits of every word to perform miracles.

But all that can and must change. Opponents of 16-bit systems cite cost and software conversion problems as the two main justifications for staying with 8 bits. Yet, how can software keep pace with the increased demand for more sophisticated graphics, to name only one area, unless we can address more than 64 K bytes of memory? How will we be able to access the staggering amounts of information in future memory banks without an increase in word size? And then there are the exciting new languages like Smalltalk that demand 16 bits for their operation. Simply put, 16 bits is the only way to go. The 16-bit operating system, therefore, becomes a critical link in the computing chain.

Doing It Right the Second Time

The *operating system* is the "master controller" of the computer: it gets us going when we turn on our computers, keeps track of files, lets programs talk to one another, performs input/output tasks, and so on. Put charitably, most operating systems in the 8-bit world have been afterthoughts or compromises in design. Even CP/M, a de facto standard in our field, has been criticized as being awkward for nontechnical users. But CP/M's ubiquitousness is responsible for the development of a lot of valuable software that would otherwise probably not have been written.

The sin of inefficiency is venial compared to the mortal sin of "user-unfriendliness." I'd buy an operating system any day that takes a long time to run a given program but which makes me more productive by communicating with me in useful ways. Let's face it: most of us don't have to worry about real-time process control and its inherent time constraints. And the cost of a line of code is becoming astronomical.

KEVIN COHAN 1956-1981

Kevin Cohan, BYTE technical editor, died April 22nd when the car he was driving left the road, striking a tree. He was 24 years old. Kevin joined the BYTE staff in November, 1980, after attending Dartmouth College, and was a valuable and well-liked member of our "family." He will be missed.

Percom Mini-Disk Drive Systems for TRS-80* Computers...

Now! Add-On and Add-In Mini-Disk Storage for your Model III.



The industry leader in microcomputer peripherals, Percom not only gives you better design, better quality and first-rate service, but you pay less to boot.

New for the TRS-80* Model III

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Moreover, the initial drive may be either an internal add-in drive or an external add-on drive. And whichever configuration you get, the initial drive kit comes complete with our advanced 4-drive controller, interconnecting cables, power supplies, installation hardware, a DOS and of course the drive mechanism itself.
- **First Drive Includes DOS:** OS-80™, Percom's fast extendable BASIC-language disk operating system, is included on diskette when you purchase an initial drive kit. Originally called MicroDOS, OS-80 was favorably reviewed in the June 1980 issue of Creative Computing magazine.
- **Works with Model III TRSDOS:** Besides being fully hardware compatible, Percom's Model III 40-track drive systems may be operated with Tandy's Model III TRSDOS — without any modifications whatsoever. And, TRSDOS may be easily upgraded with simple software patches for operating 80-track drives.

Percom TFD add-on drives start at only \$399. Model III Drive kits start at only \$749.95.

Quality Percom products are available at authorized dealers. Call toll free 1-800-527-1592 for the address of your nearest dealer or to order direct from Percom.

Still #1 for Model I

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Add our innovative DOUBLER™ adapter to your Model I Expansion Interface, and with Percom drive systems you can enjoy the same double-density storage capability as Model III owners.

The DOUBLER includes a TRSDOS*-like double-density disk operating system called DBLDOS™

We also offer a double-density Model I version of OS-80 as well as DOUBLEZAP programs for modifying NEWDOS/80 and VTOS 4.0† for DOUBLER compatibility.

Of course you don't have to upgrade your computer for double-density operation to use Percom mini-disk drive systems. In single-density operation, our TRS-80* Model I compatible 40-track drives store 102 Kbytes of formatted data on one side of a diskette, and our 80-track drives store 205 Kbytes. By comparison, Tandy's standard drive for the Model I stores just 86 Kbytes.

And like our Model III drives, Model I add-on drives are optionally available with "flippy" storage capability.

System Requirements:

Model III: 16-Kbyte system (min) and Model III BASIC. The second internal drive may be installed after the first internal drive kit is installed, and external drives #2, #3 and #4 may be added if either an internal, or external first-drive kit has been installed. External drives #3 and #4 require an optional interconnecting cable.

Model I: 16-Kbyte system (min), Level II BASIC, Expansion Interface, disk operating system and an interconnecting cable. For double-density storage, a Percom DOUBLER must be installed in the Expansion Interface and DBLDOS (comes with the DOUBLER) or other double-density DOS must be used. For single-density operation, a Percom SEPARATOR™ adapter, installed in the Expansion Interface, will virtually eliminate "CRC ERROR — TRACK LOCKED OUT" read errors. Prices and specifications subject to change without notice.

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*In Calculus, a fundamental statement in the definition of limit; interpreted here to imply: "For your integration problem, Intersystems has a solution."

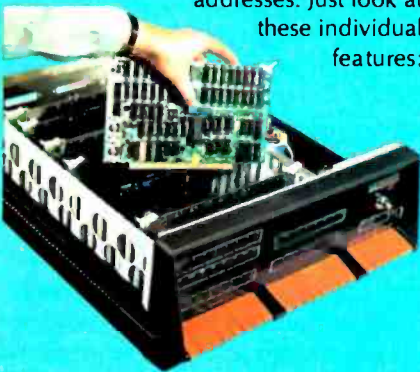
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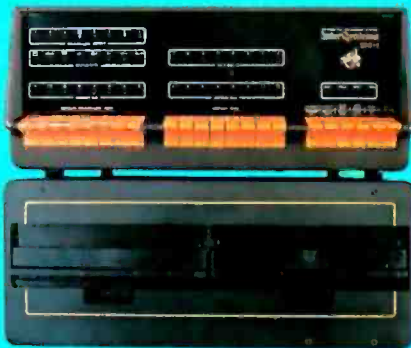
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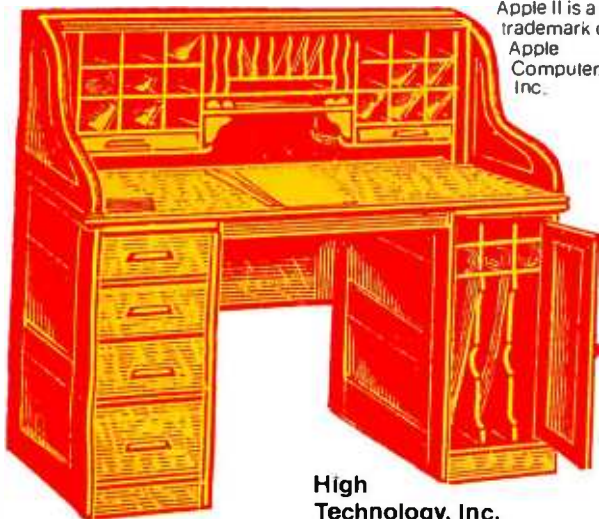
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Editorial

Now we have a chance to start with a clean slate. Software manufacturers are filling their 16-bit tabula rasas with offsprings of UNIX, an operating system developed at Bell Labs in 1969 by Kenneth Thompson and Dennis Ritchie. (See Robert Greenberg's article, "The UNIX Operating System and the XENIX Standard Operating Environment," page 248.) A software engineer was quoted in a recent issue of *Electronics* magazine (March 24, 1981, page 119) as saying that UNIX is "like sitting behind the wheel of a well-tuned sports car—when you press the gas, it goes, and when you hit the brakes, it stops. It's the ultimate in responsiveness, and yet all the while you are riding in comfort." UNIX deserves such accolades. Its hierarchical file structure lends much needed order to the chaotic approaches found in many personal computer operating systems; it is designed for truly efficient multiuser operation; the elegant idea of the *pipe* allows data to flow from program to program efficiently; and the *shell* program acts as a user-friendly interface to the rest of the operating system. An excellent example of UNIX's versatility, described in Greenberg's article, shows how the user can add a simple spelling correction program to a system, with just one line of code.

New Programs

Several software vendors have taken out licenses to adapt UNIX to 16-bit personal computer systems. These include Microsoft, Whitesmiths, Zilog, and Onyx, the developers of XENIX, Idris, Zeus, and Onix, respectively. Among non-UNIX-related 16-bit operating systems, OASIS, developed by Phase One Systems Inc, has received high marks from many professional programmers. And judging from its past track record with CP/M, Digital Research's new CP/M-86 should also become a major factor in the market. (See "CP/M: A Family of 8- and 16-Bit Operating Systems," by Gary Kildall, page 216.)

Despite the recent relaxation of UNIX licensing fee conditions by Western Electric, the UNIX offspring will not be cheap. Operating system software could sell for more than \$2000. However, Lifeboat Associates' version of XENIX will probably retail for less than \$1000 by the end of the year.

The 8-bit computer is far from dead. There is too much good 8-bit software around for this to happen. And, for many applications, it's hard to beat the price-performance ratio of the 8-bit machine—at least by today's prices. Sixteen-bit and 8-bit machines will coexist for many years to come. I don't believe in the "mutually exclusive" school of computer punditry. Just as no high-level language has ever supplanted another (can readers give me an example of this?), 8-, 16-, 32-, (etc) bit microcomputers will coexist in the future.

In our field, the future becomes the present overnight. You don't need a crystal ball to state emphatically that we have not seen the end of the 8-bit versus 16-bit debate. But the new operating systems do add a welcomed layer of professionalism to personal computing. ■



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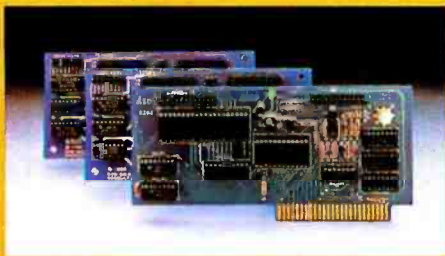
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OSI Still In Personal-Computer Business

As a result of "Ohio Scientific Sold" ("BYTELINES," March 1981 BYTE, page 246), we have had several telephone calls from dealers who were disturbed by BYTE's report that "In all likelihood OSI will move away from personal computing and into the small-business market." This statement is a false and damaging "projection."

When Ohio Scientific was founded in 1975, our first products were designed for, and directed to, the personal-computer market. In 1977, when other small-computer manufacturers were entering the "fun and games" computer market, OSI introduced the Challenger C3B Business Systems, featuring a three-processor system with 74-megabyte Winchester hard-disk storage.

As a pioneer in small business-computer systems, we feel we moved into the small-business market some time ago. Our

first business-system advertisements appeared in BYTE in 1978!

As for our personal-computer systems, now and for the future—in May 1980, we announced an enhanced version of our Challenger C1P and introduced our Challenger C1P Series 2. In total units and dollar volume, we are counting heavily on our personal-computer line to carry a full share of Ohio Scientific's continued success.

W Paul Warren
Coordinator, Marketing Communications
Ohio Scientific
1333 S Chillicothe Rd
Aurora OH 44202

We are sorry for any misinterpretations of Sol Libes's speculation on the future of OSI's marketing strategy. We were not implying that OSI will drop its personal-computer line, but that we feel that there may be a shift in its marketing emphasis.
... MH

BYTELINES Makes Waves

I have always enjoyed reading Sol Libes's "BYTELINES," and consider him to be a good source of information on the personal-computer industry, except for one annoying trait. Because Mr Libes is professionally associated with products that use the S-100 bus, his information is strongly biased toward Intel and S-100 products. For example, I recently counted six issues in a row where he discussed UNIX-like software to be introduced for Intel and S-100 users. At no time did he mention that the Motorola/S-50 users have had UNIX-like systems available for some time. Certainly he has seen the advertisements in BYTE for UNIFLEX for the 6809 by TSC (Technical Systems Consultants). If Mr Libes hasn't heard of the UNIX-like OS-9 by Microware, it is only because he looks at the world through S-100 blinders. Perhaps "BYTELINES" should be expanded to include associate editors who would supply information on other computer buses and the popular "no-bus" systems.

Leo Taylor
18 Ridge Ct W
West Haven CT 06516

Sol Libes Replies:

I am pleased that Leo Taylor enjoys reading my column and considers it "a good source of information." There is no doubt that I have a bias toward S-100-based systems—I guess it's my upbringing. I try to control it and present a balanced picture of the personal-computing field. I feel that I am successful 99% of the time, and that no one can be 100% unbiased.

When I wrote the UNIX items for "BYTELINES" during the spring and summer of 1980, TSC had not yet announced UNIFLEX, so I was not aware that it was coming. Additionally, nowhere in TSC's advertisements is it specifically stated that UNIFLEX is "UNIX-like," although the description sure sounds like it is.

The OS-9 operating system fell into the same category as UNIFLEX. Despite the fact that its advertisements refer to OS-9 as UNIX-like, a product review, in the December 1980 issue of 68' Micro Journal, stated that "the similarity [to UNIX] is mostly superficial."

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Letters

Treasure on Disk

I enjoyed the reviews and comments on the Adventure-like games in the December 1980 BYTE, especially Jerry Pournelle's "User's Column." (See "BASIC, Computer Languages, and Computer Adventures," page 222.) I would, however, like to point out for the benefit of BYTE's readers that the original version of Adventure ("The Colossal Cave") has been available from the Heath Users' Group for over two years, for a mere \$10.

This version comes on a 5-inch disk that runs on the Heath H-8 (with disk drive) or the H-89 computers. A minimum of 32 K bytes of memory is required, and the game plays very fast. Unlike other issues, Heath's version (written by Gordon Letwin before he left to join Microsoft) can be easily copied for backup and safe keeping—a distinct plus.

I'd also like to point out that while there are several maps and guides available to the Colossal Cave, none help that much. They may assist in reducing the search for treasures, but they won't help in avoiding some of the more subtle pitfalls, and certainly won't help in the Final Adventure.

D C Shoemaker
2000 A Foxridge
Blacksburg VA 24060

More GOTOs Changing

In David Carew's article "Change Your GOTOS into FOR...NEXT Loops" (January 1981 BYTE, page 334), a better approach to the problem would have been (if step 0 not allowed):

```
510 FOR I = 1 TO 2
520 READ X
530 I = 1
535 IF X = K THEN I = 2
540 NEXT I
```

However, the best way, for systems that allow it, is:

```
510 FOR I = 0 TO -1 STEP -1
520 READ X
530 I = X = K
540 NEXT I
```

For the TRS-80 (and, I think, all Microsoft BASICs), line 530 treats the second equals sign as a logical operation, giving a -1 (true condition) if equal, and a 0 (false condition) if not equal. Some BASICs have a different convention for true and

false (some represent true as 1 and false as 0) so the statement would be FOR I=0 TO 1. Another advantage of this form is that it can be embedded in the middle of a long line as follows:

```
500 ..... : FOR I = 0 TO -1 STEP -1
                  : READ X : I = X = K : NEXT : ....
```

Both of these examples are faster than the published counterparts—always setting I to 1 is faster than the test (even if false), because there are fewer characters to interpret, and the same goes for the other example. Also, both of these examples use less memory for the program.

Carey Tyler Schug
POB 585
Chicago IL 60690

CMOS Is Boss

A few important points need to be made in connection with Larry Malakoff's article "Memory: Making an Intelligent Decision." (See the February 1981 BYTE, page 142.) Mr Malakoff generalizes that dynamic memories are superior in the areas of packing density, power consumption, and cost. Unfortunately, he has overlooked one of the most exciting memory techniques currently available: CMOS (complementary metal-oxide semiconductor) *static* memories.

While we at Hitachi are active in the dynamic memory business (especially the 4816-type 16 K by 1-bit and the 4864-type 64 K by 1-bit devices), we recognize that, for many reasons, static memory is often desirable. This approach is typified by our CMOS 6116-type fully static 2 K by 8-bit memory.

Responding to each of Mr Malakoff's points:

●Density: Using the 6116, a 64 K-byte static memory board is not only feasible, but Godbout Electronics will soon release an S-100-compatible board, called RAM 17. The increased size of the 6116's package (24 pins versus 16 pins for the 4116-type dynamic device) is easily offset by the total lack of "tricky" refresh logic required by dynamic memory.

●Power Consumption: The 6116's power requirements (operating *and* standby) are equal to or less than most 16 K-bit dynamic devices. The power supply to Godbout's 64 K-byte static board is con-

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servatively overregulated using one 7805 5 V, 1 A voltage regulator.

●Price: Expect the price of Godbout's RAM 17 to be competitive (\$1400) with the \$895 to \$1195 figures quoted by Mr Malakoff.

A few other points:

●Compatibility: The 6116 is easy to interface and is fully compatible with all processors, DMA (direct memory access) controllers, front panels, etc. Boards like those mentioned in the article may not work with faster processors (eg: 6809, 8088) now available for the S-100 bus.

●Versatility: The 6116 is pin-compatible with the 2716 EPROM (erasable programmable read-only memory) and Hitachi's new 48016 EEPROM (electrically erasable PROM), and so the user can configure a board to contain the best combination of memory types for a given application.

●Speed: The 6116 is available for speeds rated as fast as 120 ns (more than fast enough for microprocessor applications). Godbout's board will work with Z80 microprocessors running at 6 MHz with no wait states. I do not believe that there is a dynamic board that can do the same.

●Design Simplicity: No "black art" transparent refresh or special circuitry (eg: DMA, Reset) is needed; consequently, the time and the cost of the design process have been reduced. (For systems with more than 64 K bytes of memory, the best solution is to adopt the IEEE 696 Extended Addressing Standard, not the cumbersome nonstandard bank-select scheme.)

As CMOS manufacturing processes continue to approach NMOS in density, cost, and performance, companies like Hitachi have the capability to bring their CMOS expertise to bear on applications like memory devices and peripheral controllers. As devices become more complex, and applications more demanding, CMOS technology will be required to overcome thermal dissipation problems.

Thomas Cantrell
Microprocessor Product Marketing
Hitachi America Inc
1800 Bering Dr
San Jose CA 95112

Hand-Held Computer Algorithm Improvement

I read with interest Gregg Williams's

Table Rank (N)	Number of Elements in Table (2 ^N)	Williams's Algorithm F(N) = 2 ^N + 2F(N-1)	Modified Algorithm F'(N) = 2 ^N + 2F'(N-1) - 1	Ordinary Lookup N2 ^N
1	2	1	1	2
2	4	6	4 + 2(1) - 1 = 5	8
3	8	20	8 + 2(5) - 1 = 17	24
4	16	56	16 + 2(17) - 1 = 49	64
5	32	144	32 + 2(49) - 1 = 129	160
6	64	352	64 + 2(129) - 1 = 321	384

Table 1

description of the Panasonic and Quasar hand-held computers, especially the data-compression techniques. (See "The Panasonic and Quasar Hand-Held Computers," January 1981 BYTE, page 34.) Reading the text box that describes the mapping algorithm, however, I noticed a possible improvement.

In figure 3, page 41, a permutation of four elements encoded with 6 bits (001010, by rows) is demonstrated. However, according to the text, the first box will always be unswitched. Since it is constant, the first box (or first bit) need not be stored explicitly. This leaves 5 bits instead of 6 to encode the permutation (01010 for the example). The recursive nature of the algorithm should compound the savings significantly for larger permutations. In table 1, I have reproduced Mr Williams's table 2 with an additional column.

Craig R Ewert
400 Raymondale #16
South Pasadena CA 91030

Gregg Williams Replies:

Your analysis of the requirements of the algorithm is completely correct, although this does not necessarily mean that even more space can be saved within the HHC (hand-held computer). I compiled the table of results you referred to based on a description of the algorithm, and I did not realize that the box in the upper-left corner did not need to be encoded. Although I was unable to contact the person who had written the code implementing the algorithm, your interpretation of the algorithm does, in fact, allow permutations to be stored with less memory. My thanks to you (and to Paul E Black, of Oquirrh City, Utah, who wrote a similar letter) for pointing this out.

Thermodynamic Flaws

Richard Hetherington's excellent "Programming Quickie" in the February 1981 BYTE contains one flaw that can cause the user of his routine to arrive at some misleading results. (See "Energy-Saving Cost/Benefit Analysis," page 266.)

Table 2 gave the heat value of various fuels, and as far as I can see, it's correct. Unfortunately, the heat values are theoretical maxima, and to compute cost savings you need to make allowances for inefficiencies in extracting that heat. In practice, efficiencies range from (essentially) 100% for electricity to 20% or less for a fireplace. (A small fire in a large fireplace on a cold night can actually run at negative efficiency—losing more heat up the chimney than it contributes to the house.) Efficiencies tend to vary with the quality of the heating hardware, and (I suspect) with whether they are measured in the laboratory or in a more conventional environment. In general, you would not be wrong to expect 100% for electricity; 60% to 70% for gas or oil heat; 40% to 50% for wood or coal stoves; and something pretty dismal for an unaugmented fireplace.

The conventional means of accounting for this are either to reevaluate the fuel's heat value by the efficiency, or to alter the equation C=Z*Q/H to read C=Z*Q*E/(100*H), where E is the efficiency in percent. In this case, I would modify the routine to use the latter method, because it lets you evaluate the effect of switching to a more efficient heat source.

Anyone seriously planning to tackle his or her home-heating problem should construct a paper-and-pencil thermodynamic model of his or her house. This is nowhere near as difficult as it sounds. Any public library has some books (mostly those dealing with solar heating) that can help.

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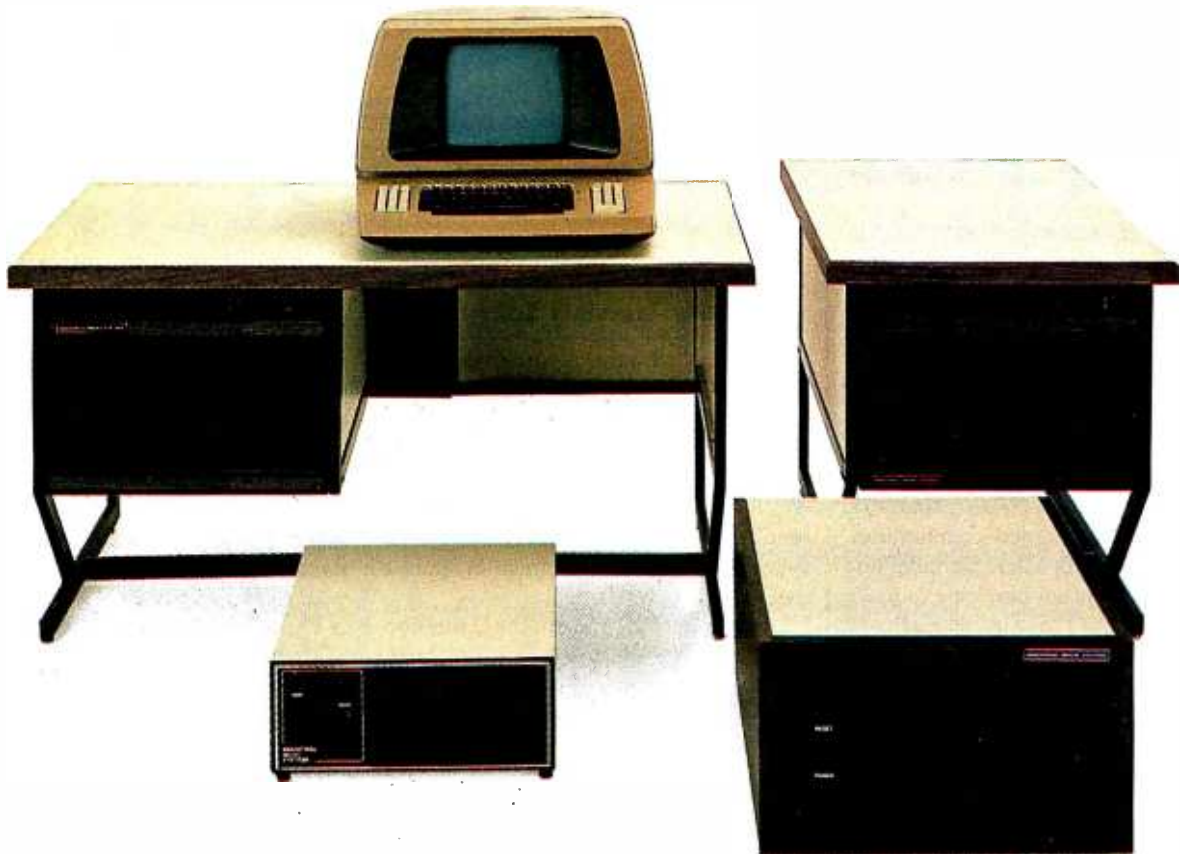
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Mr Hetherington's routine is only as good as the data you put into it, and if you don't know how much heat you are putting into your house, and where it is going out, you may not recognize bad data when you use it.

Donald Kenney
291 S Main St
Andover MA 01810

Computers Can Help People

I read Mark Dahmke's editorial and would like to share with BYTE readers an interest of mine. (See "Computer Speech: An Update," February 1981 BYTE, page 6.)

I'm an academic adviser at Michigan State University and work with students in the Lower Division. Among our many academic services, we try to assist students in selecting majors that will help them attain their individual goals in life. I have very realistic concern and at the same time very optimistic hope for one student in particular.

Kelly Watson is a quadriplegic and has a combination of athetoid and spastic cerebral palsy. She is a delightful young lady—bright, pretty, and her sparkling sense of humor helps her overcome frustration. Kelly, although just 20, became a sophomore at the end of this winter term. She has gotten this far in her academic career out of sheer determination, and I'm sure someday she will be the newspaper editor she plans to become.

Kelly uses a joystick-operated electric wheelchair and types with a headstick on an IBM electric typewriter. MSU's Artificial Language Laboratory hopes to be able to provide her with a word-processing system. With financial assistance from concerned communities, technologists such as Mark Dahmke and John Eulenberg will soon be able to make accessible to persons such as Bill Rush and Kelly Watson those opportunities we all enjoy. I foresee a great advancement in human concern.

Jane E Linnell
Michigan State University
Undergraduate University Division
Student Academic Affairs Office
East Lansing MI 48824

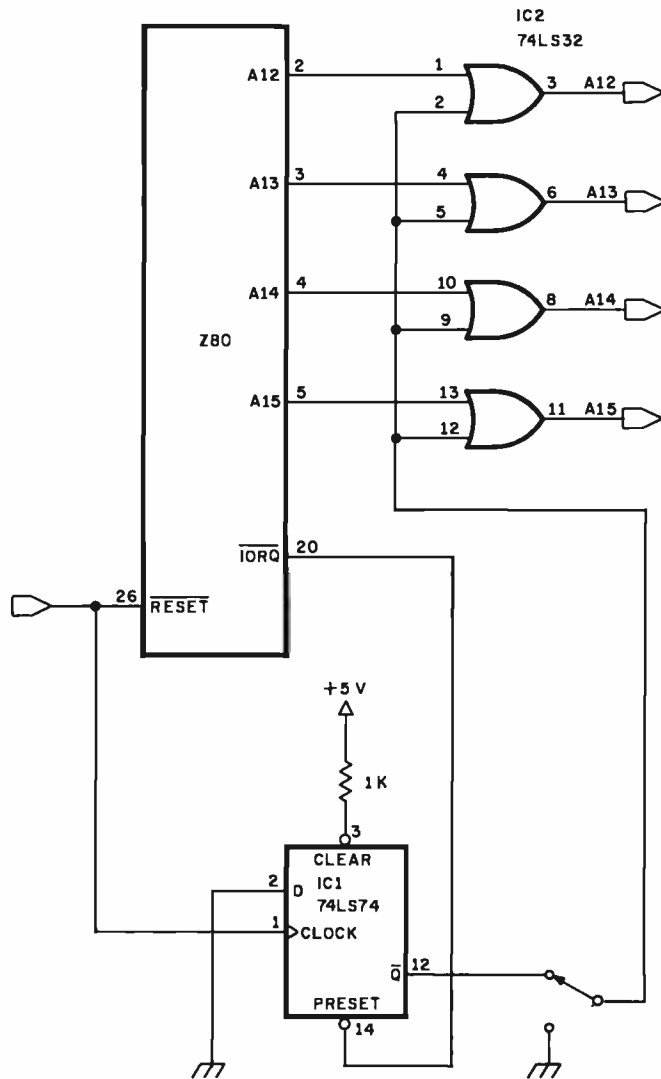


Figure 1

Simpler Starting Solution

Although Randy Soderstrom's approach to the problem of forcing the Z80 starting address was interesting, it is not the simplest solution. (See "Forcing the Z80 Starting Address," February 1981 BYTE, page 288.) His suggestion requires four integrated circuits, and an initial time delay is introduced. The circuit in figure 1 uses only two devices.

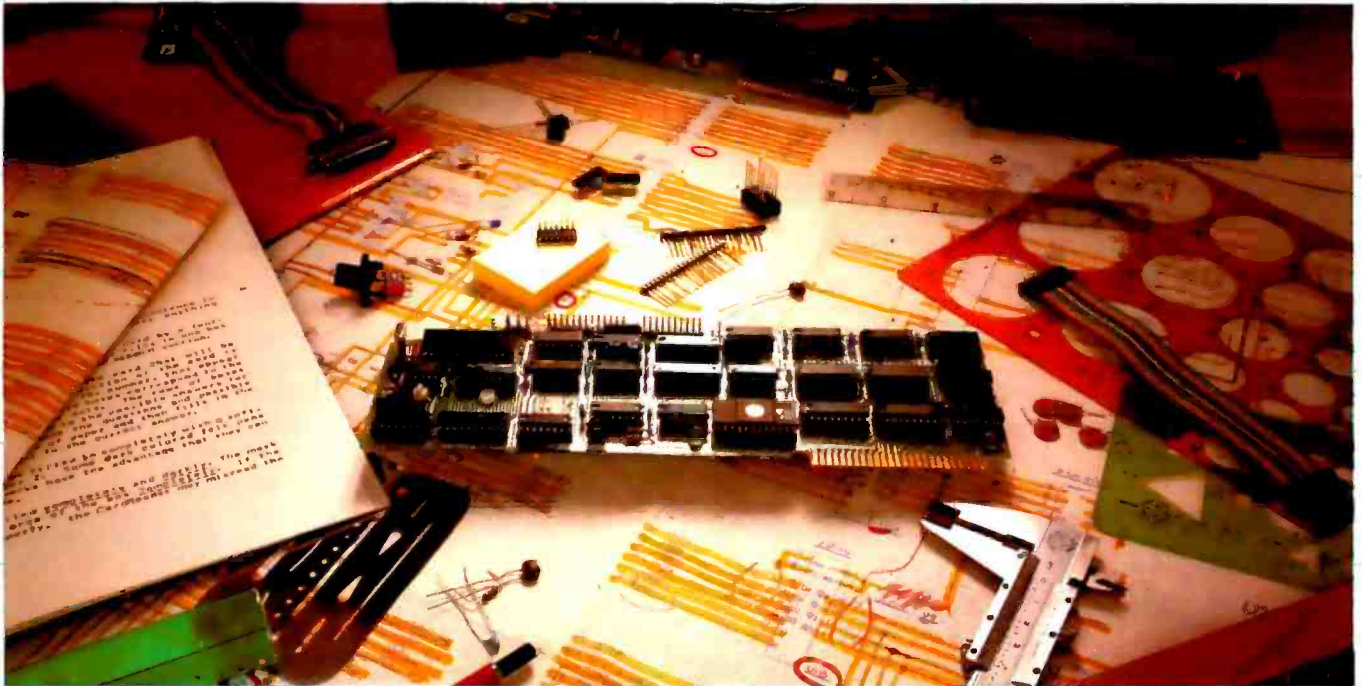
Upon reset of the system, the D flip-flop (IC1) is clocked, causing Q̄ to go high. Although the processor's address bus and program counter contain all 0s, the memory addressed is hexadecimal F000. The 74LS32 quad OR gate (IC2) accomplishes this with one input per gate high. The system monitor can be stored at hexadecimal address F000 and can now handle its high-priority housekeeping

without worrying about the address. A JP (jump immediate) to the next instruction will set the program counter correctly. The first OUT or IN instruction will activate the IORQ (input/output request), and then preset the D flip-flop, allowing signals on the address bus to pass freely through the 74LS32, and restoring the system to normal operation. As in Randy's circuit, there is no interference with memory refresh.

This technique is used on MOSTEK's STD Bus-based CPU-1 card. We feel this is the best and most economical approach to take.

Mitchell A Russo
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BASIC Problems

Samuel Bates's "Rotation Algorithm" was fascinating but frustrating for two reasons. (See the January 1981 BYTE, page 328.) First, there are many terms used from Hewlett-Packard's HP 3000 BASIC that are not common to other versions of BASIC. I can figure out what MAT R=ZER does (it puts 0 in every element of the array R) and duplicate it with a subroutine, and I can determine from context that # means < > (not equal). However, I'm stymied by FILES*, ASSIGN, ENTER, and READ#1,1. Please, BYTE, return to the old policy of inserting a box with explanations of uncommon terms! A flowchart would have been useful, too.

"Whose BASIC Does What?" by Teri Li was also welcome. (See the January 1981 BYTE, page 318.) I hope its idea will be extended both to cover more computers and to be more complete in terms. I hope that BYTE will eventually publish it as a separate reference booklet. There were, however, some errors in the article.

```
10 FILES *
120 ASSIGN A$,1,S
160 ENTER 255,A9,A$
1130 READ #1,1
1140 IF END #1
      THEN 1190
1150 READ #1,B$
```

tells the interpreter that file names will be provided in a later ASSIGN statement
 assigns A\$ as file number 1, a sequential file
 allows 255 seconds for the values A9 and A\$ to be input
 sets the pointer for file number 1 to the first record
 transfers control to statement 1190 if
 end-of-file number 1 is encountered
 reads the next value from file number into the variable B\$

Table 2

For the Commodore PET, the major errors of significance are:

- HOME and CLS should be checked.
- COLOR=n, FRE(x\$), SPC(expr), and RANDOMIZE should not be checked.
- CALL address should have SYS entered.
- TI(expr) should be TI or TI = expr.
- TIS, a different real-time clock function, should be listed.

I don't need to say that BYTE is the best (I read six other journals regularly as

well), so I'll just say "thanks and keep it up."

Frank Chambers
Rock House
Ballyoroy, Westport
County Mayo, Ireland

The Hewlett-Packard 3000 is correctly classified as a minicomputer, so only a small percentage of our readers will have access to a system similar to the one used by Mr Bates. The BASIC statements that may be unfamiliar are defined in table 2. ■

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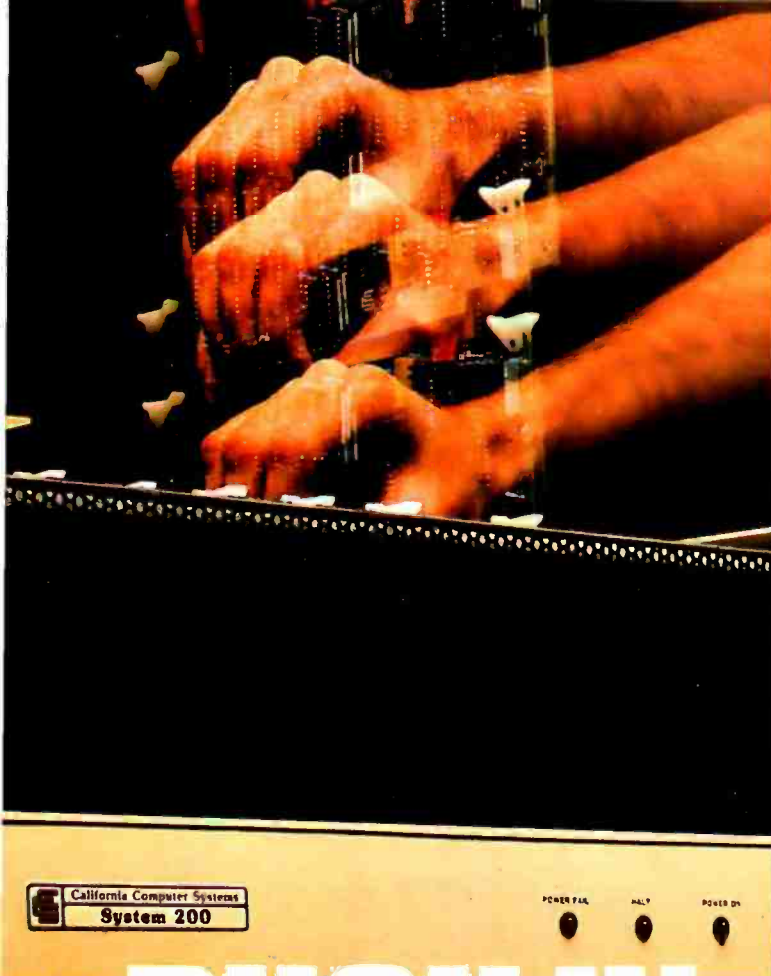


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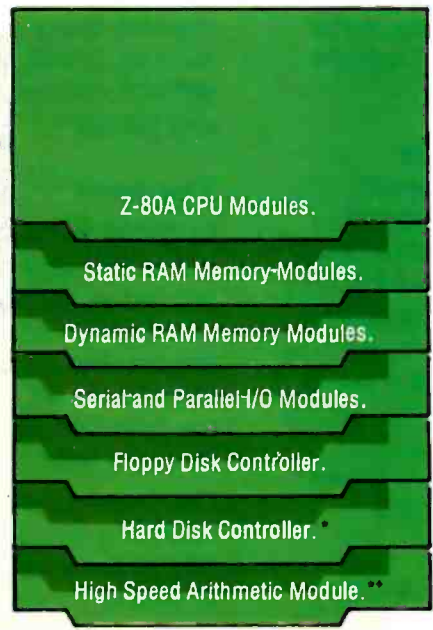
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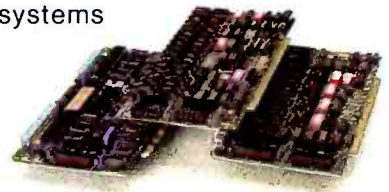
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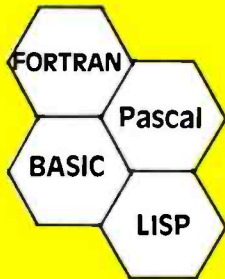
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Hardware Review

RAMCRAM Memory Module for the Atari

Mark Pelczarski
1206 Kings Circle
West Chicago IL 60185

Axlon Inc has released an alternative for add-on memory for the Atari computers that might save some money for Atari 800 owners. RAMCRAM will also offer more memory for the Atari 400 than you may have thought possible.

For \$320 you can buy a single module that contains 32 K bytes of programmable memory. The unit plugs into the middle memory slot of an Atari 800, and with the 16 K-byte module provided with your system, gives a full 48 K bytes of memory (it will not work with only an 8 K-byte module ahead of it).

In an Atari 400, the module can replace the built-in 8 K bytes of memory to give a 32 K-byte system. The Atari 400 would then be able to use any software for Atari 800 32 K-byte systems, plus it would contain enough memory to handle a DOS (disk operating system) and, therefore, a floppy-disk drive. With RAMCRAM, Personal Software's 17 K-byte VisiCalc will run on the Atari 400.

In an Atari 800, the top 8 K bytes of memory-address space are pre-empted if you have a cartridge in the left slot, such as BASIC, the Editor/Assembler, or Star Raiders. With a left cartridge installed you can use



Photo 1: The Axlon RAMCRAM memory cartridge for the Atari 400 or 800.

only 40 K bytes. Without a cartridge, but with RAMCRAM installed, you have 48 K bytes of memory which can be used for copying disks faster on a one-drive system. (DOS does not require a cartridge, and more programmable memory means swapping disks fewer times while copying.) You also have 48 K bytes for machine-language programs that do not need cartridges, such as VisiCalc, and languages could be loaded from disk without using cartridges.

Axlon also provides its dealers with a memory-diagnostic program that will analyze the memory of an Atari



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800, checking that the full 48 K bytes are functional. It performs three tests: the first tries to zero every bit in memory, the second checks for memory uniqueness by turning on bits and testing whether other bits were affected, and the third rolls a 1 bit through each location, checking that every bit can be turned on. The diagnostic program is available to customers for \$15.

If you own an Atari computer and you're the type of person that thinks ahead more than a year, it seems as though RAMCRAM is the way to go for memory expansion. If you own an Atari 400, it gives you memory that you couldn't get otherwise. If you own an Atari 800, it gives you all the memory it can now hold *and* leaves one expansion slot open for future use. Given Axlon's plans for additional Atari-compatible products, that slot may be valuable. ■

At a Glance

Name
RAMCRAM

Use
Increases programmable-memory capacity of Atari computers

Manufacturer
Axlon Inc
170 Wolfe Rd
Sunnyvale CA 94086
(408) 730-0216

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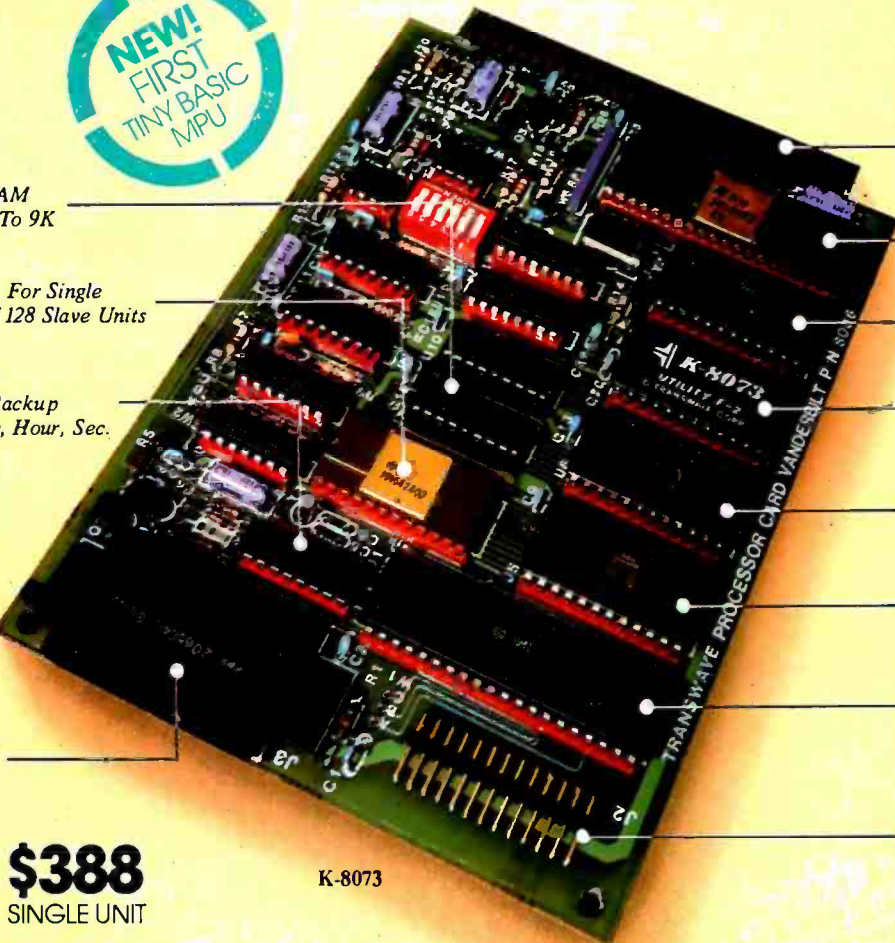


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Technical Forum

LISP vs FORTRAN

A Fantasy

Laurie Rocheleau
c/o David Clay
Florida Institute of Technology
Melbourne FL 32901

Editor's Note: *David Clay, an instructor of computer science at the Florida Institute of Technology, sent us an interesting short story written by one of his students. In his cover letter, he wrote:*

"I assigned a short term paper recently on the comparison of two programming languages, LISP and FORTRAN. Most papers were written in an expected style, outline of topics, and format—until I came to Laurie Rocheleau's. I was surprised, entertained, and impressed. After reading it, I felt that others might find it a novel approach to a somewhat mundane academic chore—writing term papers."

We, too, were surprised, entertained, and impressed, so we decided to publish this short story/term paper. We also want to thank Clay for rewarding such creativity: the cover letter of Rocheleau's paper is marked "A++". . . GW

As they wheeled her into the room her hopes began to fade. She had been praying that this place would be different from all the others. The last room had been so cold. Not only in temperature; no one had even attempted a conversation the entire eight months she had been there. This new room seemed to be a copy of the last, and all the others she had been in.

They placed her in a corner, and after plugging in all of her tubes and wires, they left. It was terribly quiet and dark.

Suddenly she began to receive something from someone across the room. She was absolutely ecstatic. Someone was trying to communicate with her. The language was a bit strange, it was some form of output statement:

PRINT*, 'What is your name?'

It was sort of hard to understand yet they were characters, her specialty, and after a bit of interpretation, she decided upon a method of replying. She had no PRINT statement in her memory, but she did have a trick up her circuit board. She sent her interpreter the instruction:

(CONS('My name is LISP. What is yours?))

As the other received her message, she could almost sense a chuckle. Soon she received his reply:

PRINT*, 'My name is FORTRAN. Why must you com-

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municate in such a strange way? Don't you have input and output commands?

She felt a bit embarrassed, yet she knew that she had many advantages over this FORTRAN fellow. She replied:

(CONS('No, I don't have input or output commands. I have to use this CONS instruction with quotes to get something printed out. And I have other instructions to use as input instructions.))

His reply upset her greatly:

PRINT '.Ha, how cumbersome. I bet you can't even handle a simple addition without some complicated function call. Well anyway, I'll grace you with a little knowledge about myself. I was one of the world's first high-level programming languages. And today I am probably the most widely used language for programming of scientific and engineering computations.'

She sat for a few nanoseconds, organizing her cut-down:

(CONS('All right, blowhard, listen to this; I and my various dialects are the primary languages in at least two areas of computer science: symbolic computation and artificial intelligence, which are concerned with programs that perform tasks that humans say require intelligence. Has anyone ever said you have intelligence? I bet not!!!))

PRINT '.Intelligent! How can you even consider your-

self intelligent if you can't deal with numbers. I mean numbers make the world go around. Look, even your insides are numbers—all zeros and ones, and you don't even understand them. I bet you can't deal with decimals, or even take the square root of a number—real or integer. You're useless.'

Quickly she replied:

(CONS('No, I can't take the square root of a number, but I can do quite a bit with numbers. Just take a look at this, these are some more of my functions:

(PLUS $X_1 \dots X_n$) = $X_1 + \dots + X_n$
 (DIFFERENCE X Y) = $X - Y$
 (MINUS X) = $-X$
 (TIMES $X_1 \dots X_n$) = $X_1 \times \dots \times X_n$
 (ADD1 X) = $X + 1$
 (SUB1 X) = $X - 1$
 (QUOTIENT X Y) = $X \div Y$
 (LESSP X Y) = T if $X < Y$ else NIL
 (GREATERP X Y) = T if $X > Y$ else NIL
 (ZEROP X) = T if $X = 0$ else NIL
 (NUMBERP X) = T if X is a number else NIL
 (LENGTH X) = Length of list X

They may not be as simple to understand as your method of manipulating numbers, but remember this: numbers are just a minor part of my abilities. Why, unlike you, I can even distinguish between a character and a number with my NUMBER function.

I realize that you are very graceful when it comes to dealing with numbers, but when it comes to character manipulation, a programmer would be crazy to use you. With me, the programmer can easily deal with characters and do a little with numbers if need be. You see, I'm not quite so one-sided as you are.))

PRINT '.OK Miss LISP, how about subroutines? They're simple. All I have to do after the END statement (I do hope you understand everything so far) of the main body is have the programmer write SUBROUTINE Name (parameter list). Below this all he has to do is write a sub-program that will be executed just like a regular program, when, in the calling program, the instruction CALL Name (argument list) is encountered. When the execution of the subroutine is finished, a RETURN statement returns control to the statement following the CALL statement in the calling program. The parameters in the parameter list are reference parameters, using the chaining, the copying, or the value/result method. Why, my subroutines can even call other subroutines if they want to. . . . I'm waiting for your response!

(CONS('I love the way you quickly changed the subject—away from letters and numbers. But, OK, here's my response: I will add to my argument of input and output while describing my "subroutines," which I call Procedures. I don't need explicit input and output statements

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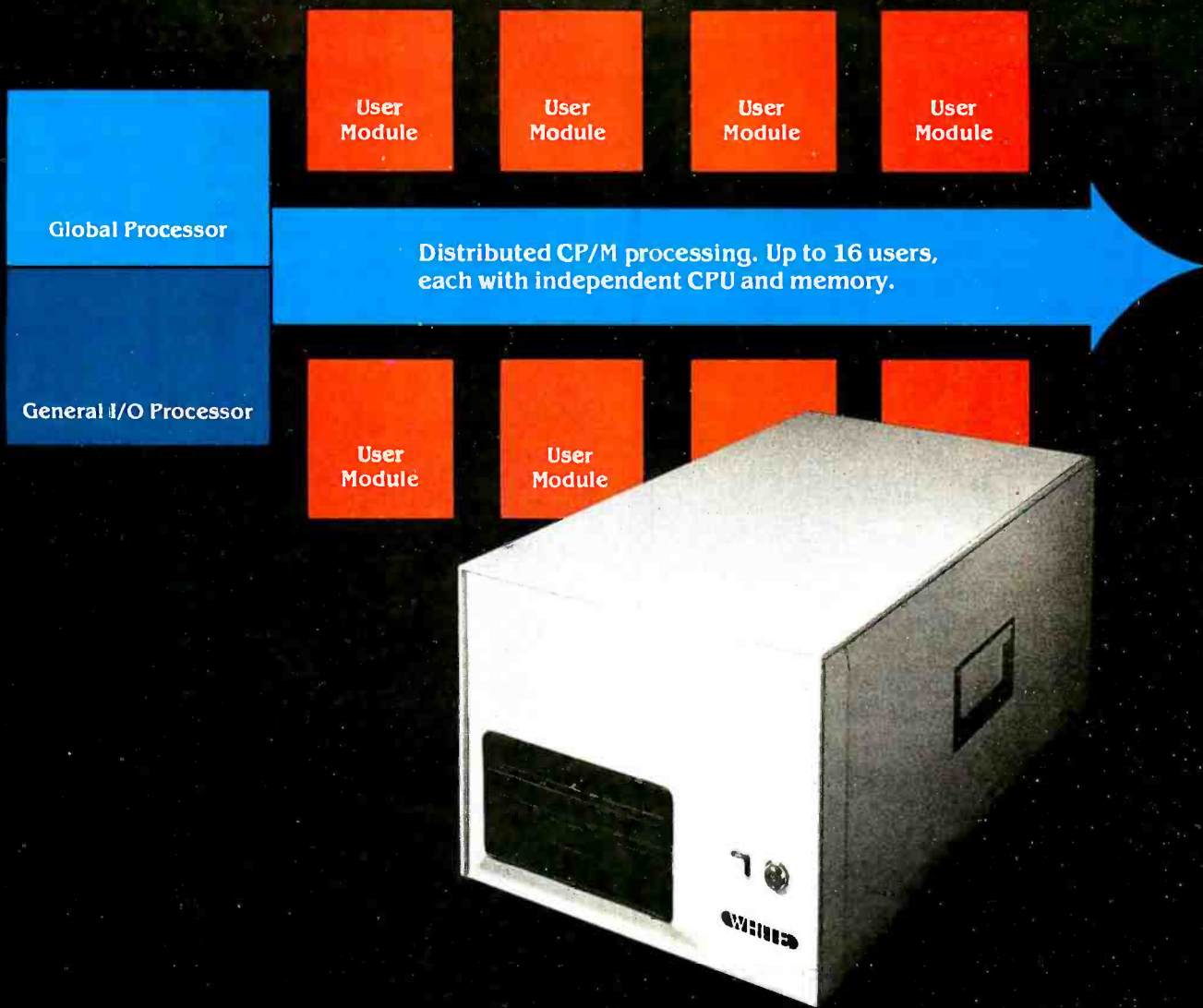
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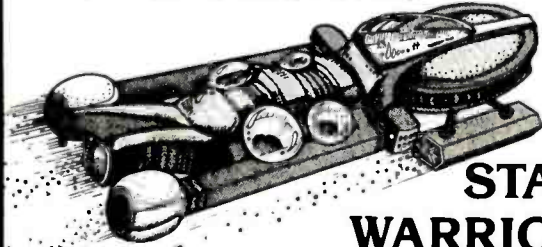
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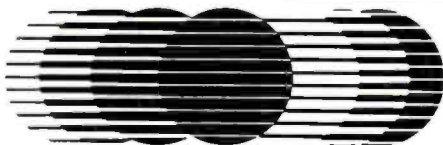
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Technical Forum

because "data" is provided in the form of arguments in procedure calls and because the value produced by a procedure called at the top level is automatically output by my interpreter.

I have taken a good look at your basic structure—Blah! At my top level, your main program, I have no need for variable declaration, assignments, loops, tests, etc. This is so because usually the first environment where such things are meaningful is the environment established by a procedure called from my top level.

To show you how I "call" a procedure, I must first say that nearly all of my commands are procedure-related. And all of my procedures return a value—thus, they are function procedures.

First I define a procedure, then I call it—just the opposite of your goofy subroutines. To define a procedure, I merely say:

LISP PROCEDURE Name(parameter list)

Body

where the body is much like the body of your subroutines. It is simply instructions to perform the task of the procedure. Some of the instructions can even be Procedures themselves.

As far as calling goes, I don't even have to say Call. All I have to do is write the name of the procedure along with its parameter list, for in essence my procedures are functions.

Name(parameter list)

This is all that is needed. The parameters are usually values. But I can pass arguments in the unevaluated form—Name Parameters. And my procedures can call themselves; this is called recursion, the all-important function that you can't even handle. You're nothing but an old man that's constantly being updated. They'll soon phase you out. No recursion—ha ha!)))

PRINT*, 'OK, so I am old, but you ain't no spring chicken yourself. I have been doing a bit of research while you were babbling. We were both invented in the late '50s. So don't talk to me about old.

Oh, and there's one little thing you left out—how about Global Variables? You don't even have such a thing. Why, when I call a subroutine, I can have a COMMON statement in both the calling and the called routines, in which there are variables which are global to the called routine. They can be changed if need be by the called routine, or they can just be used in evaluations. These changes, if any, affect the values in the calling routine. Why, I can even name my common statements, like this:

COMMON /Name / variables

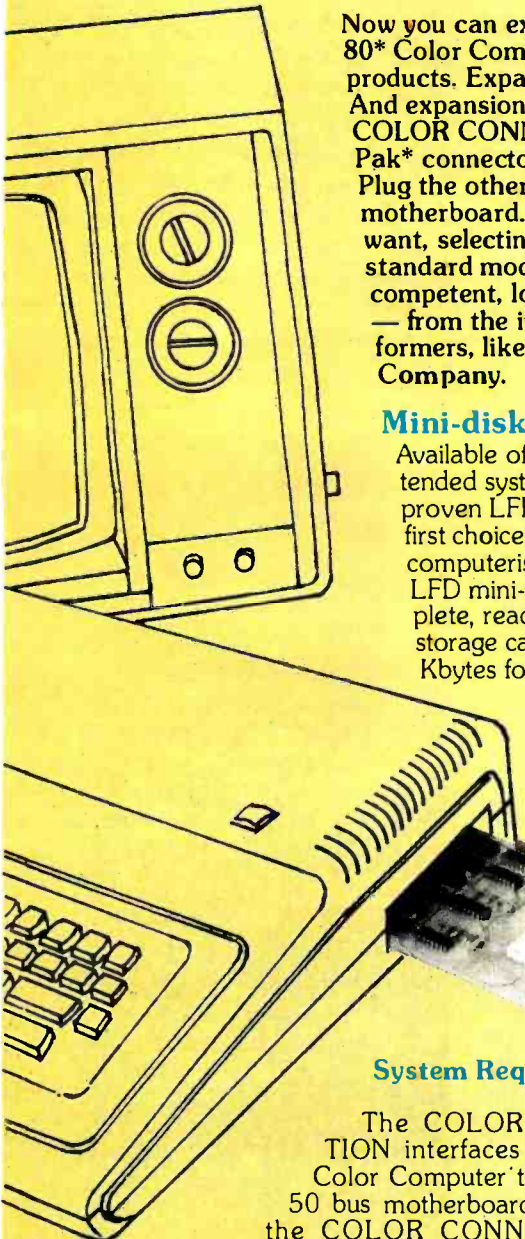
This way, different subroutines can have different globals with their calling routines. Can you top that????'

(CONS('I sure can . . .))

Suddenly the lights came on. The humans were back. Oh well, their talk would have to wait. Maybe this place wouldn't be so bad after all. ■

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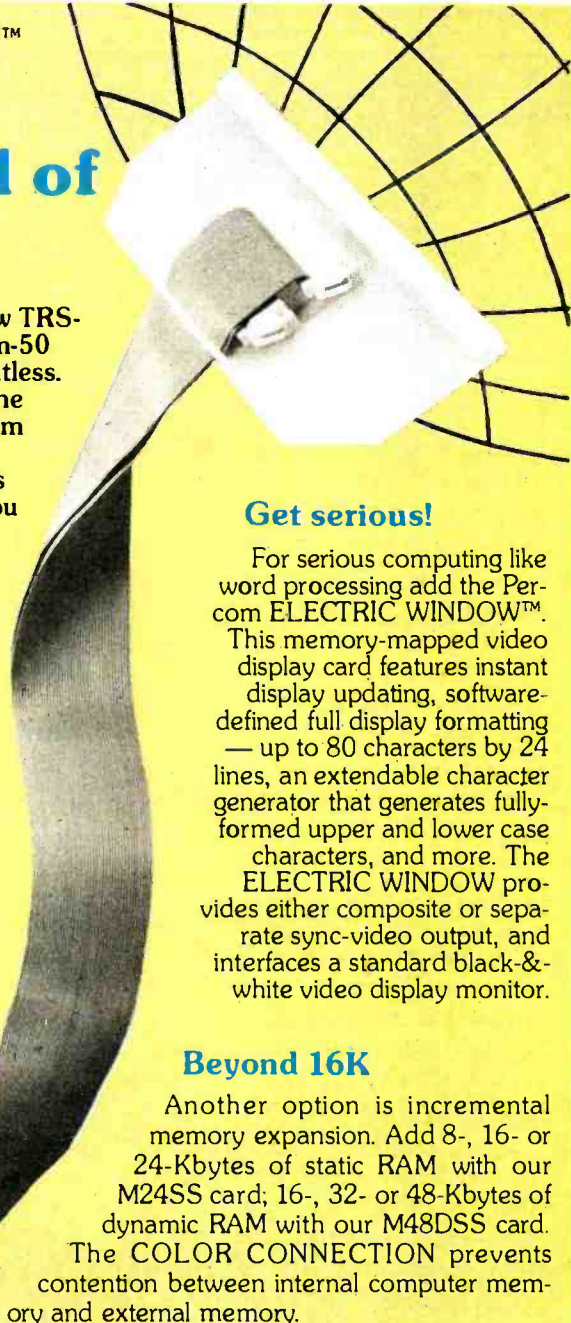
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Logo for Personal Computers

Harold Nelson, Technical Editor

The imminent release of not one but *two* versions of the Logo language for personal computers may be one of the most exciting software developments of the year.

The Logo programming language was developed at the Artificial Intelligence Laboratory at MIT (Massachusetts Institute of Technology). According to the Logo Project's originator and driving force, MIT Professor Seymour Papert, "Logo is the name of a philosophy of education in a growing family of computer languages...."

In the same passage, Professor Papert is quick to point out that Logo is not merely a children's language, although since its development over twelve years ago it has always been intended to facilitate discovery learning by young children. In fact, it represents a kind of "Copernican revolution." Rather than the child being programmed by the computer (as with computer-aided instruction), the child learns by *teaching* the computer—and has a good deal of fun in the process. In the past, this has been the overriding purpose of the Logo Project. However, Professor Papert states: "An example of a powerful use of list structure is the representation of Logo procedures themselves as lists of lists so that Logo procedures can construct, modify, and run other Logo procedures." (*Mindstorms: Children, Computers and Powerful Ideas*. New York: Basic Books Inc, 1980, page 217.)

Apple Logo and TI Logo are the first versions of this language that are intended for use with personal computers. TI Logo was developed for the Texas Instruments 99/4 computer, while Apple Logo runs on the Apple II or Apple II Plus computer. Each is a descendant of earlier implementations written in LISP and Pascal for larger computers, and this heritage is

evident in both versions of the language.

TI Logo

The first "draft" of Logo for the TI 99/4 was prepared by the Logo Project at MIT. Texas Instruments modified this draft according to its priorities and has done some impressive code compression in order to increase available memory for the production version of TI Logo.

Hardware for TI Logo

In addition to the TI 99/4 computer and a color monitor, memory expansion (from 16 K bytes up to 48 K bytes) and the language in EPROM (erasable programmable read-only memory) are the only requirements for running the prototype of TI Logo. In the prototype, both memory expansion and the language are contained in an actual black box (see photo 1, inset).

TI Logo has two production versions. The currently available version requires a disk controller, a 5-inch floppy-disk drive, a 32 K-byte memory expansion unit, and a TI Logo command module or ROM (read-only memory) cartridge. The second version, scheduled for release later this year, will require only the memory expansion unit and the command module (see photo 1).

Features

TI Logo can perform arithmetic operations on integers from $-32,768$ thru $32,767$, and can generate random integers from 0 thru 9, perform basic logical operations, and evaluate

logical relationships. It can also assign numerical values to words (values to variables), assign names to numbers (so that something can be called by name instead of number), and it has functions for structuring and modifying lists. In addition, there is a fine program editor for writing and modifying procedures (Logo programs).

Other Logo features in Texas In-



Photo 1: The TI Logo prototype (inset), including memory expansion, is contained in the black box under the monitor and behind the TI 99/4 computer. The final production version of TI Logo, which should be available later this year, will consist of a 32 K-byte memory expansion unit and a solid-state command module. (Photo courtesy of Texas Instruments.)

struments' version include powerful yet easy-to-use graphics capabilities that employ a *turtle* for drawing and thirty *sprites* for creating dynamic displays.

The Turtle

One of the best-known features of Logo is turtle graphics, or the line-drawing turtle—a small triangle on the video display (see photos 2 and 3). A variety of simple instructions move the turtle, tell it to face a certain direction, move it a given distance, and instruct it to draw, not draw, or erase a line.

Early MIT versions of Logo actually controlled a floor robot that resembled a turtle. This floor turtle

had a pen that could be raised or lowered for tracing the path that the turtle was instructed to follow. Originally, the state of the art made use of a mechanical robot easier than computer graphics. When young children were involved, the floor turtle also seemed to facilitate the transition to using the screen turtle. (The significance of turtle graphics has been recognized outside MIT for some time. For example, a subset of Logo, called Turtletalk, has been included in the Smalltalk language designed by Alan Kay for Xerox. Turtlegraphics is also a program in the library of the Apple version of Pascal.)

TI Logo has a screen turtle that can

be controlled by simple primitive instructions (see text box on turtle primitives). These *primitives* can be used for immediate turtle instructions or to create *procedures* (sequential lists of instructions) which define new instructions.

An important feature of TI Logo is that while all primitives can be spelled out in full, many can be abbreviated to two-letter instructions (eg: CS can be used anywhere in place of CLEARSCREEN). Such abbreviations can make Logo more accessible to such nontypists as the very young or the handicapped.

Sprites

The inclusion of thirty sprites and



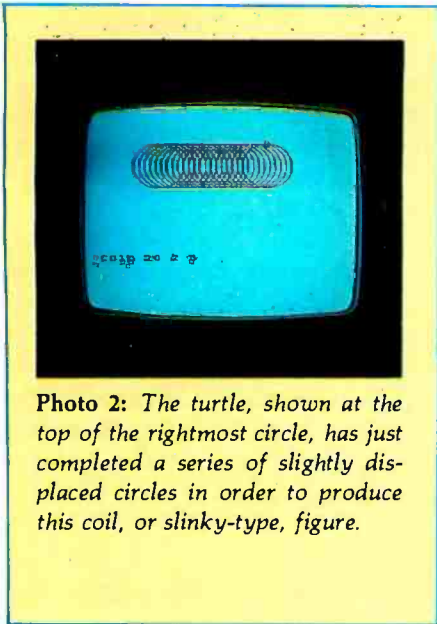


Photo 2: The turtle, shown at the top of the rightmost circle, has just completed a series of slightly displaced circles in order to produce this coil, or slinky-type, figure.

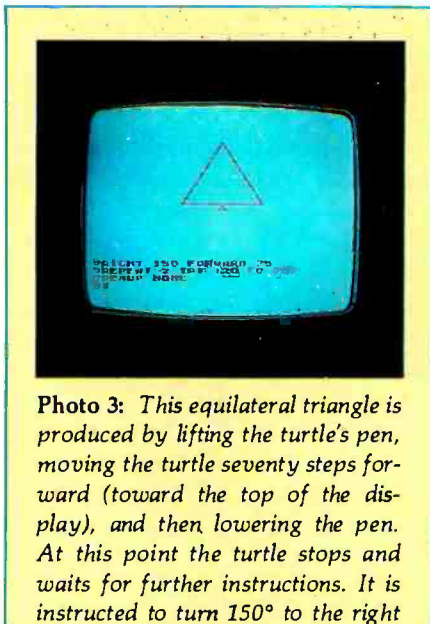


Photo 3: This equilateral triangle is produced by lifting the turtle's pen, moving the turtle seventy steps forward (toward the top of the display), and then lowering the pen. At this point the turtle stops and waits for further instructions. It is instructed to turn 150° to the right and move forward seventy-five steps—this produces the right leg of the triangle. The turtle waits again. It is told to repeat the following sequence twice: turn right 120° and go forward seventy-five steps. This causes the turtle to draw the base and left leg of the triangle. The turtle is then told to raise its pen, return home (to the center of the drawing pad), and put its pen down. Since these instructions are not written in a procedure, it is necessary to reenter the entire sequence each time the triangle is to be reproduced.

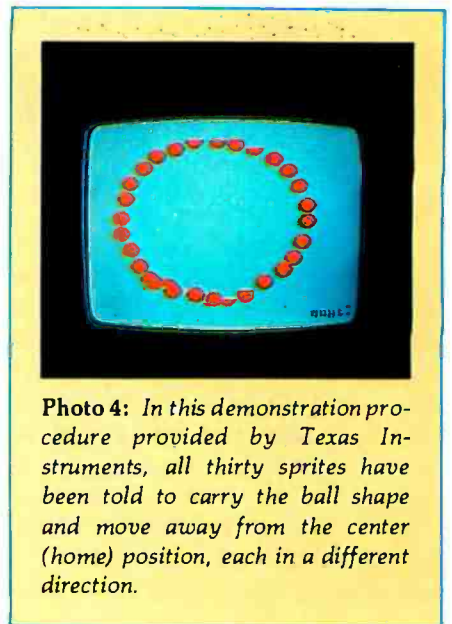


Photo 4: In this demonstration procedure provided by Texas Instruments, all thirty sprites have been told to carry the ball shape and move away from the center (home) position, each in a different direction.

dynamic sprite graphics is unique to TI Logo. As shown in photos 4 and 5a, sprites are TI Logo "beings" (software constructs) that assume various shapes and colors and move in a number of directions at different speeds. (See also listing 1.) Of themselves, sprites possess none of these "physical" characteristics—these must be given to them, once again, by use of simple primitives (see text box on sprite primitives).

Sprites can assume (carry) any one of twenty-eight possible shapes. The first six shapes (turtle, truck, plane, rocket, ball, and box) are predefined in TI Logo (see photo 6). The remaining twenty-two shapes must be user-defined.

A new shape can be created, or an existing one modified (you can change the six predefined shapes), by calling a 16 by 16 square MAKE-SHAPE grid (see photo 5b) and blacking out the desired shape. Each square of the grid represents one pixel (picture element) on the video display. The shape is formed (blacked out) by moving the cursor from square to square within the grid. Once a shape has been defined, any or all of the sprites can carry that shape.

(Displaying sprites seems to be a major capability of Texas Instruments' TMS9918A Video Display Processor. TI has released the TMS9918A, and the unit is beginning to appear in products from indepen-

dent manufacturers. See "Video Display Processor Simulates Three Dimensions," by Karl Gutttag and John Hayn, *Electronics*, November 20, 1980, page 123.)

Characters

TI Logo also allows you to define (or redefine) alphanumeric characters and static designs by using any of the 256 8 by 8 square grids, called *tiles*. Letters, numbers, and other keyboard characters are predefined tiles, but they can be changed. If the predefined keyboard characters are modified (eg: made lowercase), the modified character appears when the appropriate key is typed.

New characters or designs can be defined and placed anywhere on the display screen (see photo 5c). While tiles can be located anywhere on the screen, they cannot move about as

can shapes that are carried by sprites. You can assign colors to tiles and use them in either the turtle or sprite modes to form titles, explanations, or parts of "pictures."

Procedures

Procedures can be considered as either Logo programs or definitions of words that, once defined, can be used like primitives. Procedures are lists of instructions made of primitives and/or the names of previously defined procedures (see photos 7a and 7b, and listings 1, 2, and 3). Resident or defined shapes, colors, and movements can be assigned to sprites in procedures. The turtle can be instructed to draw figures by simply entering the name of a procedure.

It is often easier to define procedures, whether they contain instructions for the turtle, the sprites, or nongraphic operations, rather than enter the individual instructions needed to carry out such tasks. One reason is that several sophisticated programming techniques become quite simple in Logo. It's possible to nest level upon level of procedures by having one procedure call another which, in turn, can call another, and so on. A nested procedure is called by entering its name as an instruction in the procedure being written. *Iteration* is accomplished by merely having the procedure repeat a list of instructions a certain number of times. *Recursion*



Photo 5: The shapes and characters used in the FISHBOWL (photo 5a) were specifically defined (see listing 1 for the procedures). Shapes are defined by blacking out the desired shape on a 16 by 16 square grid (photo 5b). Characters are similarly defined on an 8 by 8 grid (photo 5c).

is a simple matter of using the name of the procedure being defined as an instruction in that procedure—the procedure then calls itself from within itself.

It is also possible to construct a procedure so that it modifies itself. This can be done by having the procedure change the values of local variables and/or by having it define new, or modify already-nested procedures. This type of recursion causes the procedure to produce a different effect at each recursive level—the procedure performs its task, changes itself, performs its modified task, etc. Listing 2 demonstrates how these powerful concepts and techniques become virtual child's play with Logo.

In addition to the ease of writing procedures and all that can be learned in the process, there is another advantage to working with procedures rather than immediate instructions. After entering all of the individual instructions for the turtle or sprites, it would then be necessary to enter the entire sequence each time that activity was to be performed. If the instructions are included in a procedure, it's simply a matter of entering the procedure's name to have the activity performed. In addition, procedures, along with user-defined shapes and characters, can be saved for future recall. In the TI Logo prototype this is done on cassette. In the production

versions it will be possible to do this on disk—a preferable method with regard to both speed and reliability. The production versions of TI Logo have hard-copy capability via a thermal printer. In some settings this can be extremely useful.

The Editor

TI Logo has a full-screen, real-time edit mode that is extremely helpful for writing, modifying, and debugging procedures. While in the edit mode, the cursor can be moved anywhere in the displayed text to

Listing 1: The FISHBOWL procedure turns the video display into a simulated aquarium (see photo 5a) with fish swimming in various directions and bubbles rising to the surface. FISHBOWL first calls TITLE, which places the tiles (see photo 5c) containing the specially designed letters of "Fish Bowl" at the center bottom of the display. The FISHBOWL procedure then tells the background (BG) to set its color (SC) to dark blue (4), and calls the procedures FISHRIGHT, FISHLEFT, BUBBLES, and SHARK. These four procedures assign shapes, colors, and motion to various sprites. For example, FISHLEFT tells three sprites (4, 5, and 6) to carry the shape (7) of a fish swimming to the left (see photo 5b), and sets different colors, headings (SH), and speeds (SS) for each sprite. In BUBBLES, the SETX primitive is used to horizontally fix the two columns of bubbles. The numbers input are the x coordinates of the desired columns.

```
TO FISHBOWL
TITLE
TELL BG SC 4
FISHRIGHT
FISHLEFT
BUBBLES
SHARK
END
```

```
TO TITLE
CS
PUTTILE 12 20 100
PUTTILE 13 20 101
PUTTILE 14 20 102
PUTTILE 15 20 103
PUTTILE 16 20 104
PUTTILE 17 20 105
END
```

```
TO FISHRIGHT
TELL [1 2 3] CARRY 6
TELL 1 SC :RED SH 95 SS 20
TELL 2 SC 8 SH 75 SS 18
```

```
TELL 3 SC :YELLOW SH 105 SS 16
END
```

```
TO FISHLEFT
TELL [4 5 6] CARRY 7
TELL 4 SC :ORANGE SH 273 SS 19
TELL 5 SC :GREEN SH 265 SS 21
TELL 6 SC :LEMON SH 279 SS 17
END
```

```
TO BUBBLES
TELL [7 8 9] CARRY 8
EACH [SC :WHITE SETX -50]
EACH [SH 0 SS 3*YN]
TELL [10 11 12 13] CARRY 8
EACH [SC :WHITE SETX 70]
EACH [SH 0 SS 2*YN]
END
```

```
TO SHARK
TELL 14 CARRY 10
SC :GRAY SH 271 SS 40
END
```

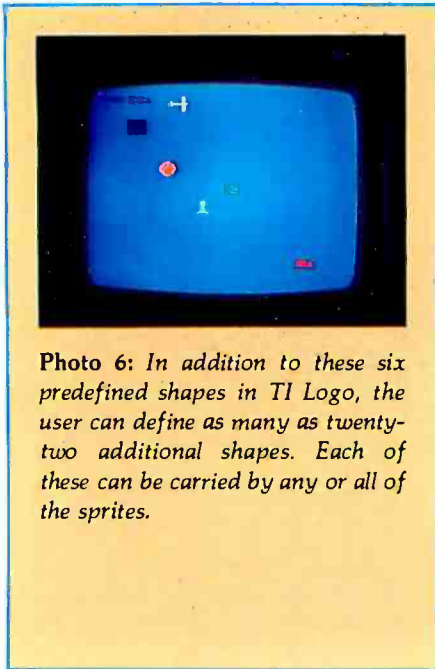


Photo 6: In addition to these six predefined shapes in TI Logo, the user can define as many as twenty-two additional shapes. Each of these can be carried by any or all of the sprites.

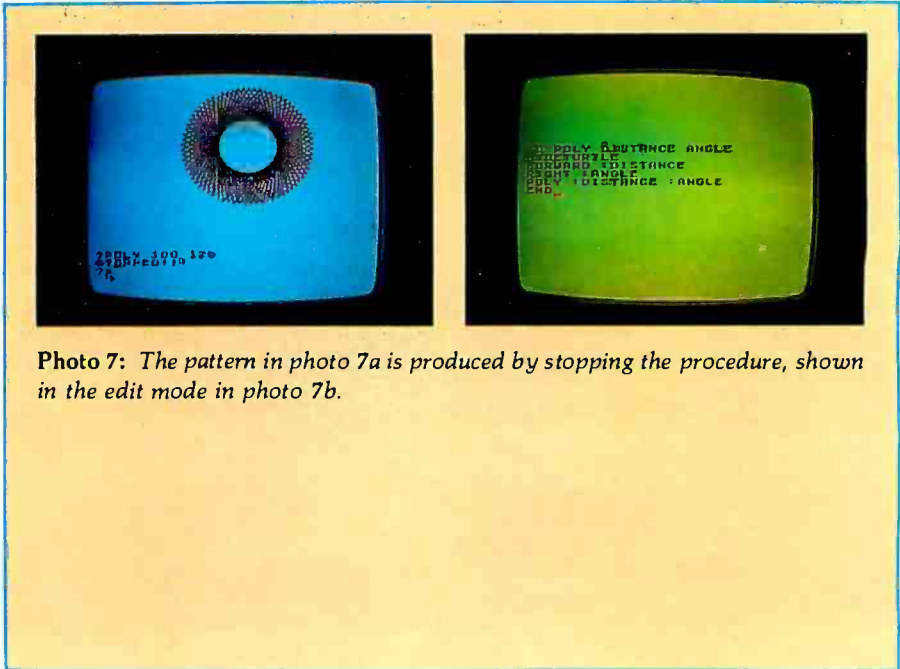


Photo 7: The pattern in photo 7a is produced by stopping the procedure, shown in the edit mode in photo 7b.

Turtle Primitives

The basic turtle primitives are virtually identical in TI and Apple Logo. Differences are noted in parentheses, as are acceptable abbreviations. All primitives can be fully spelled out and most can be entered as two-letter abbreviations.

The turtle mode is entered by the instruction TELL TURTLE (DRAW in Apple Logo). This places the triangular-shaped turtle at the center of the "drawing pad." In TI Logo this position is the origin of a coordinate system whose horizontal (x) axis goes from -128 to 128, whose vertical (y) axis ranges from -96 to 96.

There are four text lines under the pad for entering instructions and receiving messages. The Apple version is almost the same in the split-screen turtle mode (actually the horizontal axis goes from -140 to 138). This is normal turtle mode. Apple Logo, however, also offers a full-screen turtle mode that allows the turtle to draw on the entire pad but eliminates the text lines (see photos 9 and 10a).

Both versions employ the following instructions for moving the turtle:

- | | |
|---|--|
| FORWARD (FD) number }
BACK (BK) number | } { The number represents the number of turtle steps that the turtle is to move. |
| RIGHT (RT) angle }
LEFT (LT) angle | |

It is possible to move the turtle anywhere on the drawing pad and trace virtually any shape with these instructions.

More interesting figures can be obtained by having the turtle draw only part of the time. The following commands, in both versions, control the turtle's pen:

- PENDOWN (PD): Causes the pen to leave a trace of the turtle's path (the pen is down when the turtle mode is entered).
- PENUP (PU): Allows the turtle to move about without leaving a trace.
- PENERASE: Causes the turtle to erase a line it has drawn if the original path is retraced.
- PENREVERSE: Instructs the turtle to draw lines where there are none and erase lines where they are present.

HOME sends the turtle back to the center of the drawing pad. CLEARSCREEN (CS) in TI Logo erases all drawing and text and returns the turtle to the home position. DRAW does almost the same thing in Apple Logo but it does not erase text.

In order to exit the turtle mode, enter the instruction NOTURTLE (NODRAW in Apple Logo). This will return you to the Logo monitor.

change, delete, or insert characters, words, or entire lines. It's also possible to move lines up or down and merge them with other lines.

The editor in the production version of TI Logo is automatically activated for writing procedures. (The prototype does not have this feature.) Several features can be written in the edit mode and all of them entered into memory by exiting the edit mode. One advantage to writing procedures in the edit mode is the ease with which you can change and correct the procedure as it is being written.

You can also use the editor's capabilities as a basic text editor. This is an important feature, since learning to write with a text editor relieves the tedium of making pencil-and-paper corrections and revisions.

Limiting Features

The video hardware of the TI 99/4 does not allow more than four sprites carrying shapes to be displayed on a horizontal row at one time (see photos 8a and 8b). If a fifth sprite is placed on the same row, the first one disappears, and so on. The process is reversible, so as soon as the newcomers move on, the original residents begin to reappear. Once you are aware of this problem, you can work around it.

An annoying occurrence in TI Logo is that the turtle sometimes runs out

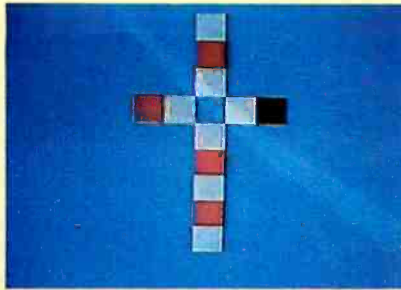
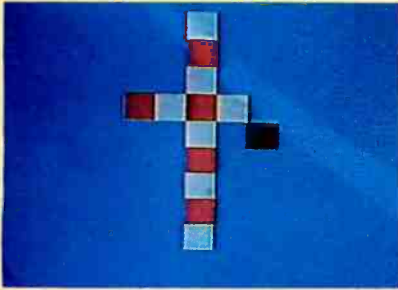


Photo 8: These photos illustrate a slight problem caused by the TI 99/4's video hardware when running Logo. As long as there are no more than four shapes in a horizontal row, there is no difficulty (photo 8a), but as soon as a fifth shape is moved onto a row (the black square in photo 8b), the first shape in that row disappears (the red square that was at the center in photo 8a is gone in photo 8b). The first shape reappears when the fifth shape is moved to another row, so there can never be more than four visible shapes in a row at one time.

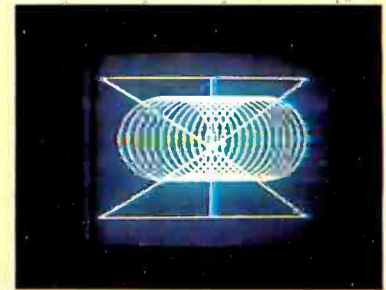


Photo 9: Apple Logo's turtle graphics can produce interesting figures from simple procedures. Straight lines can be drawn by setting the x and y coordinates. The turtle will draw a straight line from its present point to the point you have set. This photo and photo 10a show the full-screen graphics feature of Apple Logo.

of lines. At this point, the turtle stops in its tracks, the procedure halts, and the following message is printed:

NO MORE LINES

Apparently, workspace allocations have to accommodate both sprite and turtle graphics modes. Some tradeoff was necessary, and this message appears to inform you that the workspace (memory) allocated for graphics in the turtle mode has been used up.

Apple Logo

At present, the 5-inch disk version of Logo for the Apple II and Apple II Plus computers is still under development at MIT. (For convenience, we refer to this version as "Apple Logo," as does the Logo Project staff. To our knowledge there is no connection with Apple Computer Inc.) Representatives of MIT and the National Science Foundation, which funded portions of the Logo Project, are involved in discussions concerning distribution rights for Apple Logo. This issue should be resolved soon, and Apple Logo will, it is hoped, be available this summer.

This review is based on a pre-production prototype, and in fact, an updated prototype that will include color is being completed. This feature will allow you to choose the color of

the display background and the lines drawn by the turtle.

Apple Logo has three modes: a nongraphics mode, a graphics (turtle) mode, and an edit mode—but no sprites. However, the Apple version does have much more power in the other modes than TI Logo.

Hardware for Apple Logo

An Apple II or Apple II Plus computer with 48 K bytes of memory,

one disk drive, and an Apple Language Card are all that is needed to run the Apple version of Logo.

Nongraphic Features

Apple Logo can handle *floating-point* as well as integer arithmetic. It also accepts and outputs numbers (when large or small enough), in exponential notation. For example, 2.7E3 can be used in place of $2.7 \times 10^3 = 2700$, and $-4.3N4$ can

Sprite Primitives

Some of the primitives used to instruct the sprites (available only in TI Logo) are as follows:

TELL sprite number(s): Gets the attention of the sprite(s) that you wish to address. You can address one or any combination of sprites from 0 thru 29. To talk to all thirty sprites, the phrase :ALL (read "dots ALL" in Logo jargon) is used in place of a number.

CARRY shape: Tells the sprite(s) which shape to assume. Shapes can be identified either by name or number.

SETCOLOR (SC) color: Identifies, either by name or number, the color of the shape being carried.

SETHEADING (SH) number: Gives the sprite(s) the direction to travel. The number entered corresponds to a compass heading.

SETSPEED (SS) number: Tells the sprite(s) how fast to move.

The displays produced with these five instructions can be amazing, especially when multiple instructions are combined in procedures.

A few other primitives can also be used in interesting ways. HOME causes all active sprites to go to the center of the display screen but, if they have headings and speed, only momentarily. FREEZE stops all active sprites and holds them in place. They will not resume movement until THAW is entered.

Sprites will also respond to the FORWARD (FD), BACK (BK), RIGHT (RT), and LEFT (LT) primitives as used in the turtle mode.

replace $-4.3 \times 10^{-4} = -.00043$.

Apple Logo can also return the sine and cosine of an input in degrees. This means, in effect, that it has full trigonometric capability. The other trigonometric functions can be easily defined in terms of the sine and cosine. Apple Logo can return a random integer in the range of 0 to $n-1$, where n is an integer input by the user. There is, in addition, a randomizing feature to ensure that each sequence of random numbers will be unique.

Apple Logo has features for evaluating logical relationships, assigning values to variables, words to numbers, and working with list structures. The Apple version of Logo also has provisions for going from Logo to the Apple monitor, calling machine-language subroutines, and determining the current amount of free workspace in Logo. (Texas Instruments omitted similar features in order to save memory space.) And it's worth pointing out that the primitives that instruct the turtle are similar in both the Apple and the TI versions of Logo.

Turtle Procedures

The draft of the Apple Logo manual, by MIT Professor Harold Abelson, contains over twenty-five pages of turtle geometry projects of rapidly increasing complexity (see photos 9, 10a, and 10b). This manual also contains some interesting discussions of recursion—in fact, the author suggests a level of recursion that can be used to have the turtle draw a "binary tree" (see listing 3).

The additional mathematical capabilities of Apple Logo, as compared with the TI version, can be used to increase the power of turtle procedures, even though these mathematical features are not graphics features *per se*. That is, the floating-point, trigonometric, and randomizing features can be employed to give straightforward instructions to the turtle that will result in figures otherwise difficult, if not impossible, to produce.

The Editor

The Apple Logo editor functions in



Photo 10: The SPINSLINK figure (photo 10a) is the result of the simple five-line SPINSLINK procedure (shown in the edit mode in photo 10b) that calls the three-line RCIRCLE procedure which, in turn, calls the RCP procedure. Each procedure is nested in the one listed below it. Note the use of floating-point arithmetic in RCP, the use of iteration in RCIRCLE, and the use of recursion in SPINSLINK (it calls itself). (The procedures are taken from the draft of the Apple Logo manual prepared by Harold Abelson.)

essentially the same manner as the production-version TI Logo editor. As soon as you begin to write a procedure, you're automatically in the edit mode. Therefore, all of the editor's features are available whenever procedures are being written. It is also possible, as with TI Logo, to employ these features as a text editor.

There is, however, one confusing sidelight. The command to abort a procedure (rub out what has just been written and exit the edit mode) in Apple Logo is very nearly the same command used in TI Logo to enter the procedure into memory and exit the editor. This could cause considerable confusion if you work with both versions side by side.

An Annoying Feature

If the turtle tries to draw beyond the drawing pad in the turtle mode of Apple Logo, everything stops and you are told that the turtle just went OUT OF BOUNDS. If you are in the process of modifying a procedure to fit onto the pad, this is quite a nuisance. In the TI version, if the turtle leaves his pad he simply wraps around the display, and the procedure continues to execute. This approach seems preferable, because you can visualize the finished product. (In the large-machine versions of Logo you can choose between wrapping and not wrapping—an ideal arrangement.)

Conclusions

Both personal computer versions of Logo are exciting, valuable products. Seymour Papert has said on more than one occasion that Logo provides easy access to very powerful ideas, but the question remained—would this be true of Logo designed for small personal computers? The answer, relative to both versions, is clearly affirmative, whether the user is a young child, a physically handicapped individual, or an adult who discovers computing for the first time.

It's difficult to find anything to criticize in either product. Given their common background of over ten years of development and testing in the Logo Project at MIT, such a situation is not hard to understand. Still, a few items in each version might have been handled differently.

One such example occurs when you attempt to use the Apple and TI Logo nongraphics instructions in the immediate mode. These functions do not simply return a value. For example, in TI Logo:

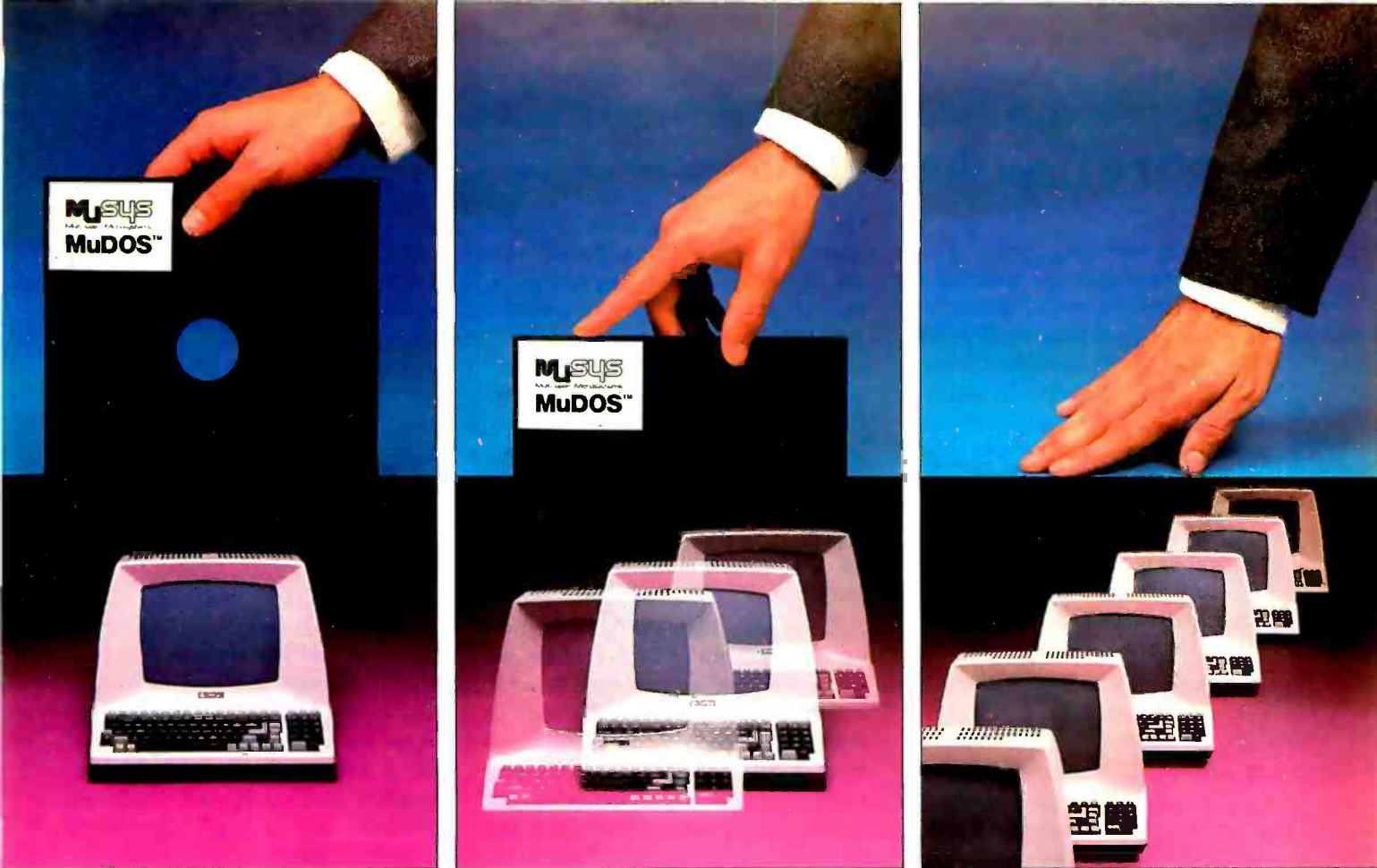
3+4

returns:

TELL ME WHAT TO DO WITH 7

It will not return just the value 7. Similarly, in Apple Logo:

SIN 30



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returns:

```
YOU DON'T SAY WHAT TO DO  
WITH .5
```

The reason for this, apparently, is that these functions are intended for use in instructions in procedures where the value returned will be used for a variable. It would be useful, however, if these functions could be used immediately, and if they returned only the appropriate values: they could then be used more easily for mathematical or logical evaluations, either in planning procedures or for other purposes.

If you type PRINT in front of the statement to be evaluated, only the value is returned. For example:

```
PRINT 3+4
```

will return only the value 7. Still, it would be useful to obtain this kind of return without typing PRINT, especially when you are not "talking" to sprites or the turtle.

Another inconvenience occurs in TI Logo when you have active sprites on the screen and want to go to the turtle mode. There is no easy way to get the active sprites off the video

display. While you can go from the turtle mode to the sprite mode and remove the turtle with everything it has drawn (by entering NOTURTLE), the reverse is not possible. You can leave the sprites there and work with the turtle, but the moving sprites can be distracting. You can also enter the necessary instructions to remove the colors, shapes, speeds, and headings of the sprites, but this can be time consuming. A third alternative is to leave Logo and then restart it. This is often the quickest solution. In any case, it would be helpful to have a single command that would remove all active sprites from the video screen.

There may be features in the production versions of Logo that are not present in the prototypes—in addition to the possibility of color in Apple Logo, there is discussion of including music capability in both personal computer versions of Logo. Texas Instruments has mentioned this possibility, while the Apple Logo documentation already contains some explanation of how to use the music features, even though they are not present in the prototype.

The prototypes of Apple and TI Logo are currently being used in pre-

school through high school classrooms (see *onComputing*, Summer 1981, for details) on a "pilot project" basis, and evidence of its value to students is growing rapidly. This evidence deals not only with amount of material learned, but also with a heightened self-awareness and self-esteem derived from the student controlling a powerful machine and thus his or her own learning. It seems inevitable that Logo will become a forceful learning tool, both in the school and in the home.

Having acquired at least a passing familiarity with these two Logo implementations, I see them as complementary, rather than competitive. Anyone who is seriously interested in education and learning on any level should examine both versions. TI Logo easily attracts user interest (the sprites are a definite attention-getter) and it encourages fundamental exploration of a variety of significant concepts. Apple Logo provides a somewhat deeper exploration of the same concepts. The development of Logo for other popular personal computers such as the Radio Shack TRS-80 and Atari will probably not be far behind. ■

Listing 2: *The COILGROW procedure has CIRCLEMOVE and CIRCLE nested within it. CIRCLE, in turn, is nested in CIRCLEMOVE. Both COILGROW and CIRCLE employ iteration by repeating the instructions in the brackets. COILGROW is a recursive procedure—it calls itself. COILGROW produces a coil consisting of connected circles of increasing diameter. The procedure is run by entering its name and values for the variables NUMBER, DISTANCE, and ANGLE. (The 360/(:ANGLE) in CIRCLE causes an interesting "bending" of the coil, since it returns an integer that may be slightly more or less than the number of iterations required to produce an exact circle. HIDETURTLE, in the CIRCLE procedure, speeds up drawing since the turtle itself need not be redrawn at each "step." SHOWTURTLE causes the turtle to reappear.)*

```
TO COILGROW :NUMBER :DISTANCE :ANGLE  
REPEAT :NUMBER [CIRCLEMOVE :DISTANCE :ANGLE]  
CIRCLE :DISTANCE :ANGLE  
MAKE "ANGLE :ANGLE - 3  
COILGROW :NUMBER :DISTANCE :ANGLE  
END
```

```
TO CIRCLEMOVE :DISTANCE :ANGLE  
CIRCLE :DISTANCE :ANGLE  
FORWARD :DISTANCE  
END
```

```
TO CIRCLE :DISTANCE :ANGLE  
HIDETURTLE  
REPEAT 360/( :ANGLE) [FORWARD :DISTANCE RIGHT :ANGLE]  
SHOWTURTLE  
END
```

For More Information

To add your name to the Apple Logo mailing list, write: Apple Logo, The Logo Project, 545 Technology Square, Cambridge MA 02139. For \$1 they will also send a bibliography of papers produced in conjunction with the project.

For information on TI Logo, write: TI Logo, Texas Instruments Inc, Corporate Engineering Ctr, 12860 Hillcrest Wing E M/S 376, Dallas TX 75230.

Listing 3: *MYSTERY requires that an integer be input for the variable NUMBER. It then prints the integers 1 thru NUMBER in an unexpected order: the STOP in the recursive procedure produces the MYSTERY effect; when the technique is used in a V-drawing procedure, the turtle can draw a "binary tree."*

```
TO MYSTERY :NUMBER  
IF :NUMBER = 0 STOP  
MYSTERY :NUMBER - 1  
PRINT :NUMBER  
END
```

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Recently I was at a local electronics store looking at DVMs (digital voltmeters). I didn't want to buy one, but, like looking at new cars, I wanted to reestablish the cost-effectiveness of what I already owned.

Most of the meters in the showcase were 3½-digit units with five or more ranges and many ancillary functions. The sales pitch for every one sounded alike.

While not trying to be cute, I stopped the clerk in midsentence and asked if he had any DVMs that "talked." He completely ignored the question. I had to interrupt him twice

Steve Ciarcia
POB 582
Glastonbury CT 06033

to get his attention, and even then, he thought I was being difficult.

Eventually, he said that he had no talking DVMs and never expected to see any. Even though I anticipated his answer, I was testing his response to the idea. Considering that we now have talking toys, talking hand-held DVMs shouldn't sound that strange. In fact, such use would be a relatively minor application of synthesized speech. Someday they will be very common.

While I wouldn't consider this salesman a total loss, there are some

people who have to go to Missouri to believe the state exists. I trust, however, that you have an open mind to new technology.

Cost-Effective Speech Synthesis

Advances in the production of high-density LSI (large-scale integrated) circuits and new techniques to synthesize speech have reduced the cost of voice-output systems dramatically. Attaching a speech synthesizer to your computer is now as reasonable financially as adding any other peripheral device.

The cost of a synthesizer is a function of the number of words the synthesizer can speak. Limited-vocabulary synthesizers, such as the TMS0280 unit in the Texas Instruments Speak & Spell toy or any others that have their vocabulary stored totally in ROM (read-only memory), are generally less expensive. Speech interfaces using phoneme synthesis, such as the Votrax SC-01, usually require the help of a computer program running on an external processor to generate extensive voice output. The added complexity makes this type of synthesizer more expensive. Of course, a phoneme synthesizer can have an unlimited vocabulary by using a text-to-speech program running on the external processor.

This article describes the construction of a cost-effective limited-vocabulary voice-synthesis speech-processor board called the Micromouth. It uses the new Digitalker DT1050 integrated circuit set from National Semiconductor, which has a stored vocab-

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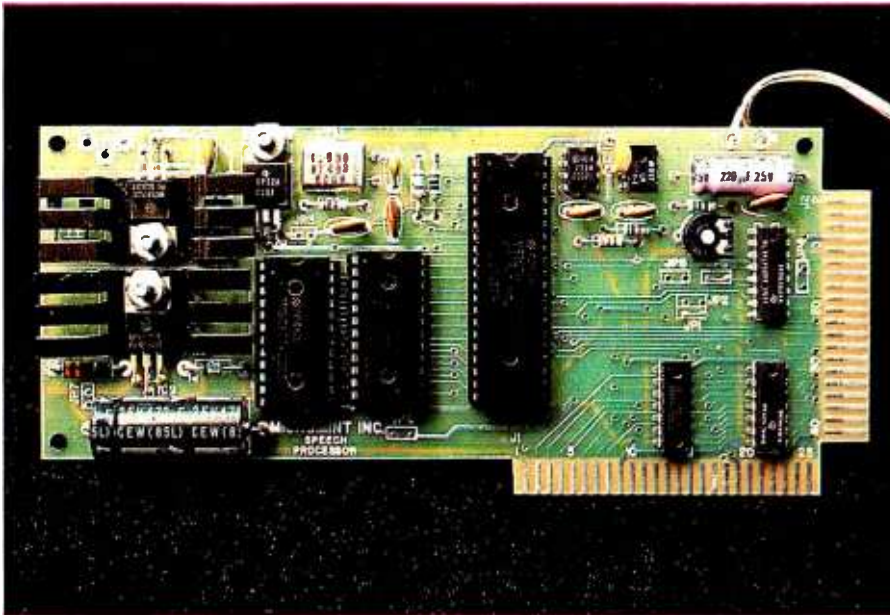


Photo 1: Assembled Micromouth speech-processor board. The 40-pin integrated circuit is the MM54104 speech processor, and the two 24-pin packages are 64 K-bit ROMs, which contain 144 digitized expressions. The 40-pin edge connector on the right is plug-compatible with the Radio Shack TRS-80 Model I, and the 50-pin edge connector on the bottom is plug-compatible with the Apple II. The heat sinks shown in the photo are not generally required but were included on this particular unit for testing.

ulary of 144 expressions. For about \$120, you can build this board and add voice output to monitoring functions, computer games, and calculations. It can say "The time is 6:40 pm" and "Number 4 is set at 6.35 volts"

just as easily as "Control error..." or "Danger...a star is on the left at 8.2 million meters." While a limited-vocabulary synthesizer may never have appealed to you before, I am sure the low price and simple system integra-

tion of this speech interface will spark your interest.

The Micromouth speech-processor board I am presenting is plug-compatible with the Apple II and Radio Shack TRS-80 Model I computers. (It can be used with the TRS-80 Model III with an adapter cable.) It is signal-compatible with other microcomputers, such as the Digital Group product line or the Heath H-8, and can be connected to any computer with an 8-bit parallel I/O (input/output) port, such as a printer port. It requires no external controlling software except a simple BASIC statement to say any expression in its vocabulary. For example, executing OUT 127,120 on the TRS-80 (or POKE -16001,120 on the Apple II) will cause the board to say "Please."

The design and features of the Micromouth speech-processor board are discussed in detail here. But, first, a little background on speech-synthesis techniques, in general, and then details of National Semiconductor's Digitalker system, in particular.

Speech-Synthesis Techniques

Three techniques are presently used to synthesize the human voice: formant synthesis, linear-predictive coding, and waveform digitization. They differ primarily in the number of bits per second of data required to construct a word.

Formant synthesis is essentially a modeling of the natural resonances of the human vocal tract. The bands of resonant frequencies defined are called *formants*. In an electronic synthesizer, these frequencies are generated by excitation sources and are then passed through variable-parameter filters.

One form of the formant technique is called *phoneme synthesis*. In this, the spectral parameters are derived from basic sound units that make up words. A phoneme generator, in turn, reproduces these sounds. In such a circuit, each phoneme has been assigned a code, and the synthesizer module (or chip) utters the corresponding phoneme sound for each code it receives. Creation of continuous speech, therefore, is simply a

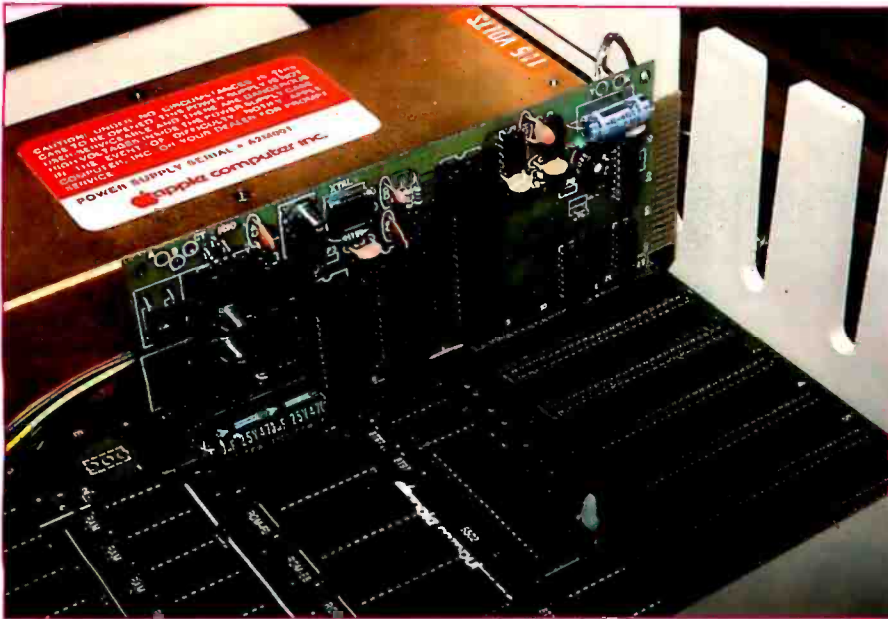


Photo 2: Micromouth speech-processor board shown inserted in peripheral slot 1 of an Apple II computer. Execution of a simple BASIC statement can cause any of the stored vocabulary to be uttered. For example, to make it say "This is Digitalker," a POKE -16001,0 statement would be executed. While the rest of the vocabulary has a male voice, this particular expression has a distinctly female voice.

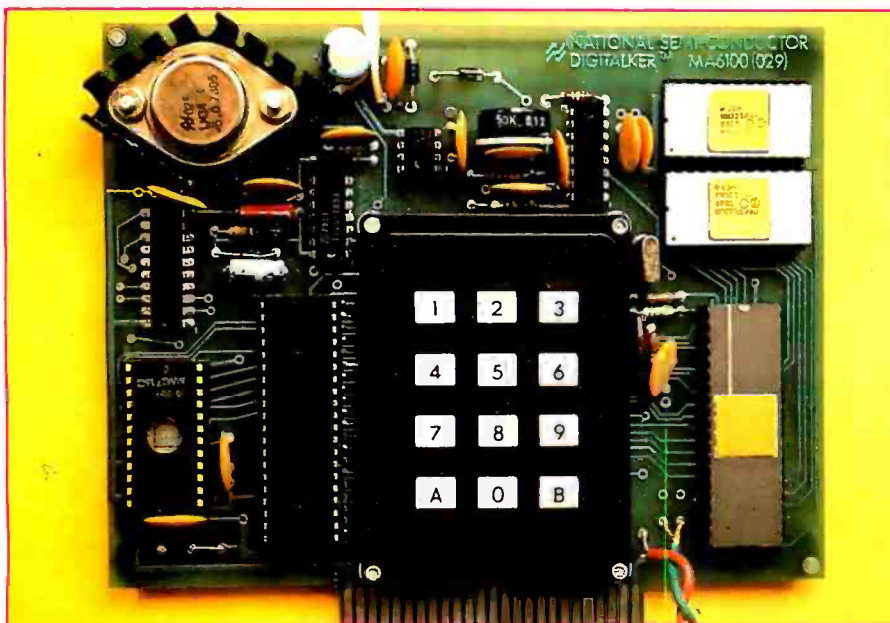


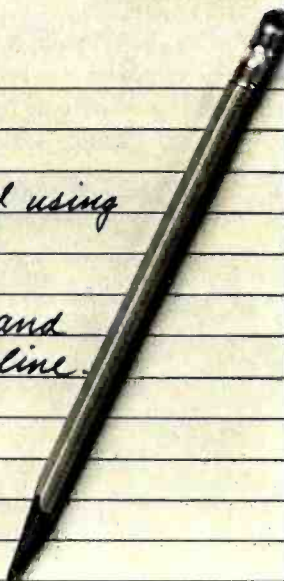
Photo 3: National Semiconductor's DT1000 Speech-Synthesis Evaluation Board. Available from National Semiconductor distributors for \$495, the DT1000 contains a microprocessor equipped with a program that allows a user to hear any single expression or a combination of expressions by entering the appropriate decimal code on the keyboard. While all the I/O lines are available on the Evaluation Board connector and it could be used as a general-purpose speech interface, it is more suitable as a sales tool and demonstration device.

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3:10 P.M. - System Down!

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matter of stringing the phonemes together.

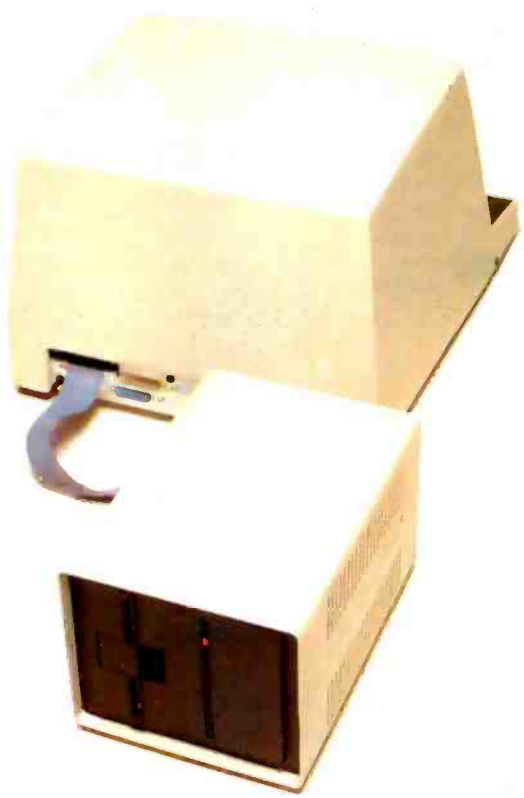
In most cases, the electronic voice generated is quite intelligible, but it may have a mechanical quality about it. Continuous speech using phoneme synthesis can generally be generated with a data rate of less than 400 bps (bits per second). This technique is used by the Votrax Division of Federal Screw Works in the SC-01 Speech Synthesizer Chip and other products.

Linear-predictive coding is similar to formant synthesis. Both techniques are based in the frequency domain and use similar hardware to model

The Digtalker speech processor uses a comprehensive data-compression algorithm.

the vocal tract. Rather than using a simple phoneme code, however, linear-predictive coding stores parameters for filter coefficients, gain, and excitation frequencies. The term "linear-predictive coding" refers to the programmed activities of the multistage lattice filters that produce the desired formants. Adequate-quality speech can generally be achieved with data rates of 1200 to 2400 bps. This synthesis technique is used by Texas Instruments in several products, including the Speak & Spell and the TI 99/4 Text to Speech Translator. It is also used by General Instrument Corporation in its Orator VSM2032 Voice-Synthesis Module.

The third method is *waveform digitization*. This very old technique produces speech by generating a waveform with the time-domain characteristics of voice, in contrast to the previously considered parameter-encoding methods, which represent speech in terms of frequency. The simplest form is uncompressed digital data recording, called PCM, for pulse-code modulation. (In the June 1978 BYTE, my article entitled "Talk to Me: Add a Voice to Your Computer for \$35," page 142, discussed how to build a simple digitized speech interface.)



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In simple PCM recording, the analog speech waveform is sampled at a rate twice that of the frequency of the highest voice component and converted to digital format through an A/D (analog-to-digital) converter. Once stored, the digital signal can be played back through a D/A (digital-to-analog) converter and a low-pass filter. One major advantage of digitally encoded speech is its human-like quality. Since it is in essence a recorded voice, the reproduced speech retains the inflections and ac-

cents of the original voice. Thus, in addition to male and female voices, it is possible to have a speech synthesizer that reproduces regional or foreign accents. The clarity of the reproduction depends on the speech-compression method used.

Unfortunately, one problem in using PCM alone is that it requires very high data rates. Rates above 100 k bps are not unusual with this method. To reduce the data rate, it is necessary to compress the speech data to remove redundant information.

One compression method is called *delta modulation*. As in PCM, the analog speech waveform is sampled, but this time only the *changes* in amplitude (delta values) between samples are stored. Since speech contains many redundant sounds and silences, these changes are much smaller than the absolute amplitude of the waveform, and fewer bits are required to store the smaller values. Delta modulation, therefore, reduces the amount of memory required to store a list of words.

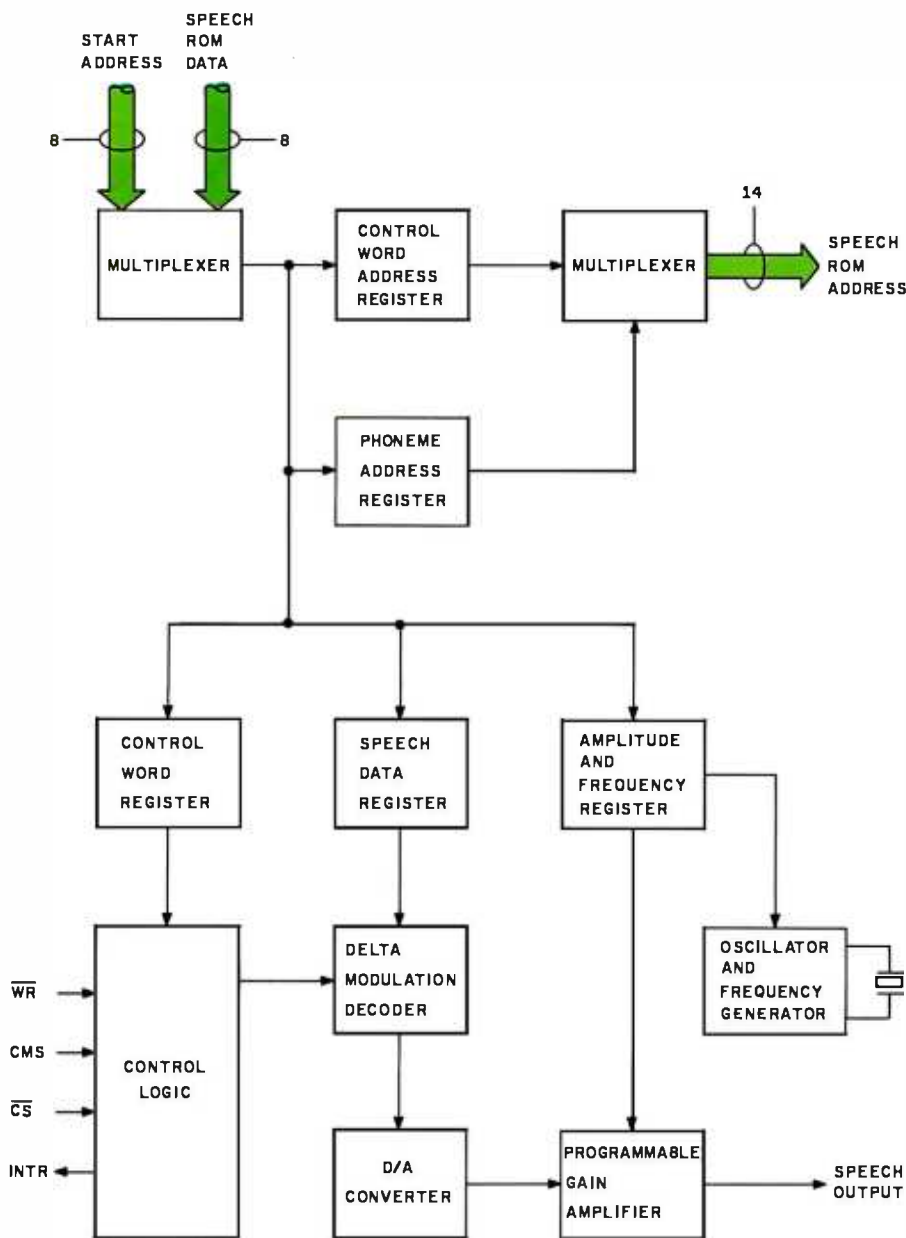


Figure 1a: Block diagram of the National Semiconductor Digitalker MM54104 speech-processor chip. This figure and figure 2 were provided through the courtesy of National Semiconductor Corporation.

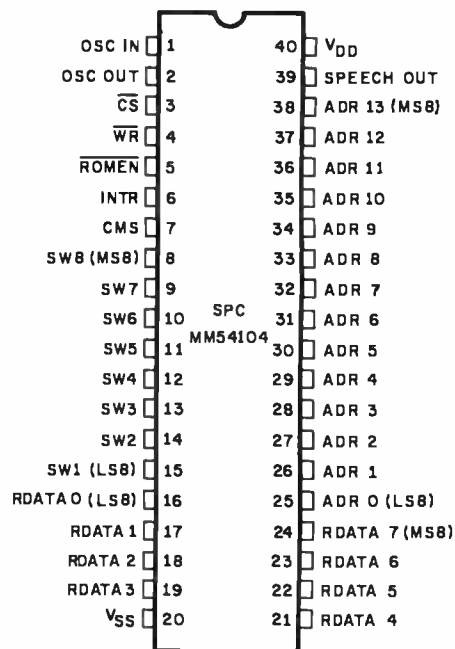
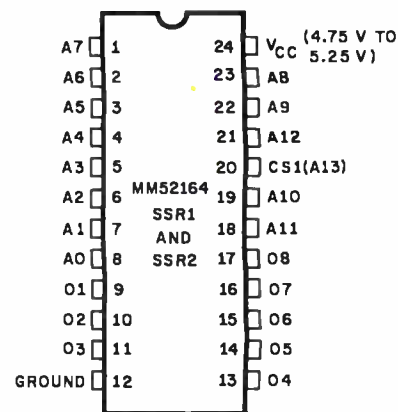


Figure 1b: Pinout specifications of the DT1050 system, which comprises the MM54104 speech-processor chip and the associated MM52164 SSR1 and SSR2 ROMs (read-only memories). The ROMs are designed to be used in sets of two; the chip-select (CS1) signals are set up in complementary fashion.

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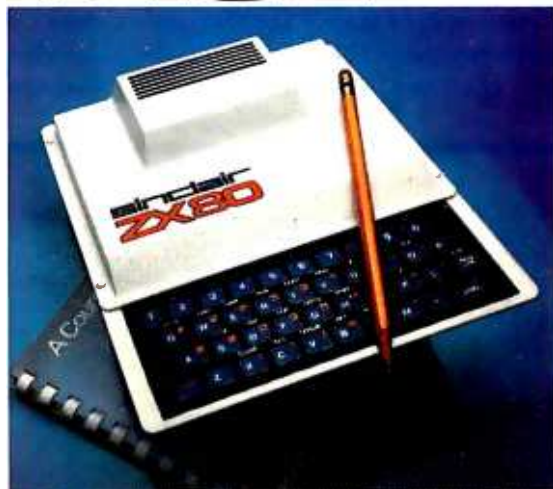
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Ultimately, the total amount of memory required for continuous speech becomes a function of exotic compression algorithms. Data rates as low as 2400 bps have been achieved. The Digitalker speech-synthesis chip set uses data-compressed digitized speech.

Digitalker Components

The Micromouth synthesized-speech-processor board is based upon the National Semiconductor

Digitalker DT1050 speech-synthesizer chip set, which consists of a speech processor (SPC) and two 64 K-bit ROMs (read-only memories).

The speech processor uses PCM encoding with a comprehensive data-compression algorithm developed by Forest Mozer at the University of California, Berkeley. The primary compression method employed is delta modulation. As previously described, this concept recognizes that speech waveforms are generally

smooth and continuous. Rather than storing the absolute amplitude of the voice signal, the differences between successive samples are stored instead. During speech reconstruction, successive amplitudes in the output waveform are obtained by adding these delta values to the previous values, allowing us to avoid using large numbers of bits to store large voltages.

The speech processor also uses phase-angle adjustment and half-

Word	Decimal Address	Binary Address	Word	Decimal Address	Binary Address	Word	Decimal Address	Binary Address
This is Digitalker	000	00000000	P	047	00101111	it	097	01100001
one	001	00000001	Q	048	00110000	kilo	098	01100010
two	002	00000010	R	049	00110001	left	099	01100011
three	003	00000011	S	050	00110010	less	100	01100100
four	004	00000100	T	051	00110011	lesser	101	01100101
five	005	00000101	U	052	00110100	limit	102	01100110
six	006	00000110	V	053	00110101	low	103	01100111
seven	007	00000111	W	054	00110110	lower	104	01101000
eight	008	00001000	X	055	00110111	mark	105	01101001
nine	009	00001001	Y	056	00111000	meter	106	01101010
ten	010	00001010	Z	057	00111001	mile	107	01101011
eleven	011	00001011	again	058	00111010	milli	108	01101100
twelve	012	00001100	ampere	059	00111011	minus	109	01101101
thirteen	013	00001101	and	060	00111100	minute	110	01101110
fourteen	014	00001110	at	061	00111101	near	111	01101111
fifteen	015	00001111	cancel	062	00111110	number	112	01110000
sixteen	016	00010000	case	063	00111111	of	113	01110001
seventeen	017	00010001	cent	064	01000000	off	114	01110010
eighteen	018	00010010	400 Hz tone	065	01000001	on	115	01110011
nineteen	019	00010011	80 Hz tone	066	01000010	out	116	01110100
twenty	020	00010100	20 ms silence	067	01000011	over	117	01110101
thirty	021	00010101	40 ms silence	068	01000100	parenthesis	118	01110110
forty	022	00010110	80 ms silence	069	01000101	percent	119	01110111
fifty	023	00010111	160 ms silence	070	01000110	please	120	01111000
sixty	024	00011000	320 ms silence	071	01000111	plus	121	01111001
seventy	025	00011001	centi	072	01001000	point	122	01111010
eighty	026	00011010	check	073	01001001	pound	123	01111011
ninety	027	00011011	comma	074	01001010	pulses	124	01111100
hundred	028	00011100	control	075	01001011	rate	125	01111101
thousand	029	00011101	danger	076	01001100	re	126	01111110
million	030	00011110	degree	077	01001101	ready	127	01111111
zero	031	00011111	dollar	078	01001110	right	128	10000000
A	032	00100000	down	079	01001111	ss	129	10000001
B	033	00100001	equal	080	01010000	second	130	10000010
C	034	00100010	error	081	01010001	set	131	10000011
D	035	00100011	feet	082	01010010	space	132	10000100
E	036	00100100	flow	083	01010011	speed	133	10000101
F	037	00100101	fuel	084	01010100	star	134	10000110
G	038	00100110	gallon	085	01010101	start	135	10000111
H	039	00100111	go	086	01010110	stop	136	10001000
I	040	00101000	gram	087	01010111	than	137	10001001
J	041	00101001	great	088	01011000	the	138	10001010
K	042	00101010	greater	089	01011001	time	139	10001011
L	043	00101011	have	090	01011010	try	140	10001100
M	044	00101100	high	091	01011011	up	141	10001101
N	045	00101101	higher	092	01011100	volt	142	10001110
O	046	00101110	hour	093	01011101	weight	143	10001111
			in	094	01011110			
			inches	095	01011111			
			is	096	01100000			

Table 1: The 144 spoken expressions in the vocabulary of the standard Digitalker system, with word-access codes in decimal and binary. The "ss" expression is a generalized hissing sound provided to make plurals out of other words in the list. If an address greater than 143 is sent to the speech processor, it "executes data" and nonsense sounds are generated.

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period zeroing compression techniques. Phase-angle adjustment is based on the concept that the intelligibility of speech is not affected by the phase angle of the sine-wave components of the Fourier-transformed waveforms. Therefore, these values can be adjusted to produce a waveform with mirror symmetry; only half the data need be stored.

In half-period zeroing, the low-amplitude portions of a signal are reproduced as silence. For the most part, only the center half of any pitch period needs to be stored since the center half contains most of the energy. The remainder of the wave-

form is relatively insignificant and can be discarded.

The 144-expression Digitalker vocabulary was initially recorded

The Digitalker system introduces low-cost speech output into areas where the expense has not been previously justified.

through a microphone, then differentiated and digitized. A computer program operated on the data to perform

phase-angle adjustment, delta modulation, and half-period zeroing. The redundant pitch periods and phonemes were reduced to individual stored periods and a record of the number of times they are repeated (usually 3 to 8 times). The resulting data containing frequency, amplitude, and control information is stored in the two 64 K-bit speech ROMs.

Figure 1a is a block diagram of the speech-processor chip. Each block of speech data contains a control word specifying the location in ROM of an audible expression, the type of waveform generated, and the number of

Text continued on page 58

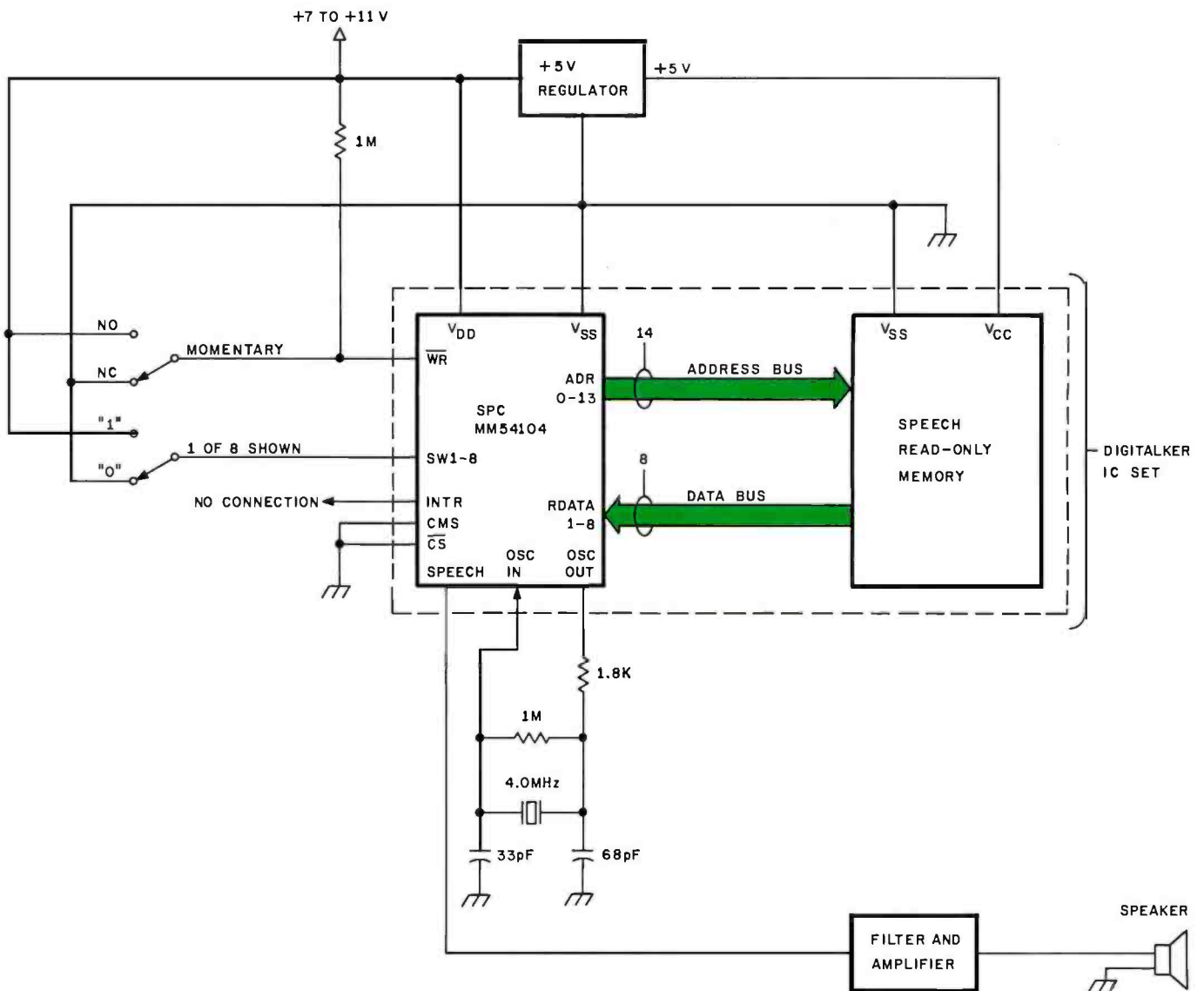
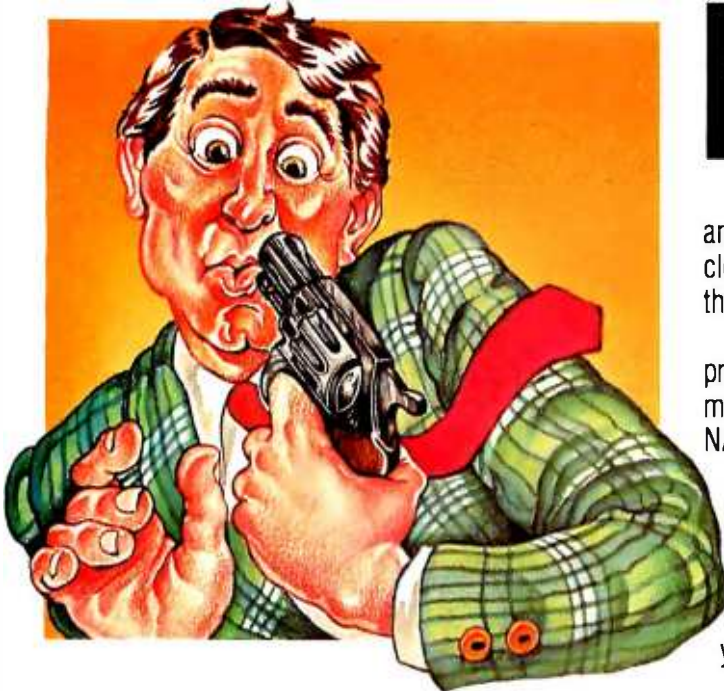


Figure 2: Simplified schematic diagram of a minimum-configuration speech demonstration system, in which mechanical switches are used to set up the desired word. The momentary switch is a single-pole, two-position type. The crystal is a 4.0 MHz Electro Dynamics Corporation HC18 20 pF unit.

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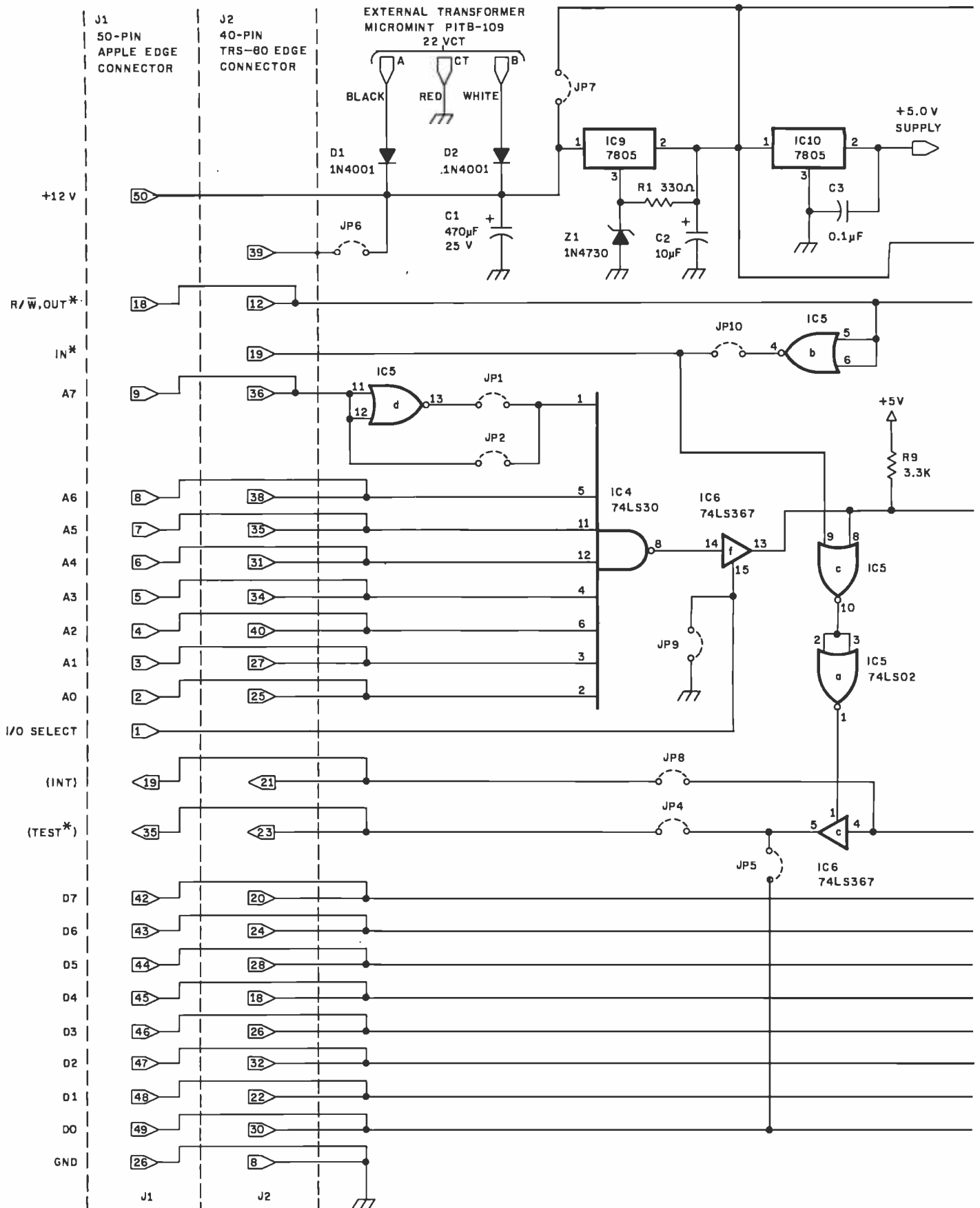
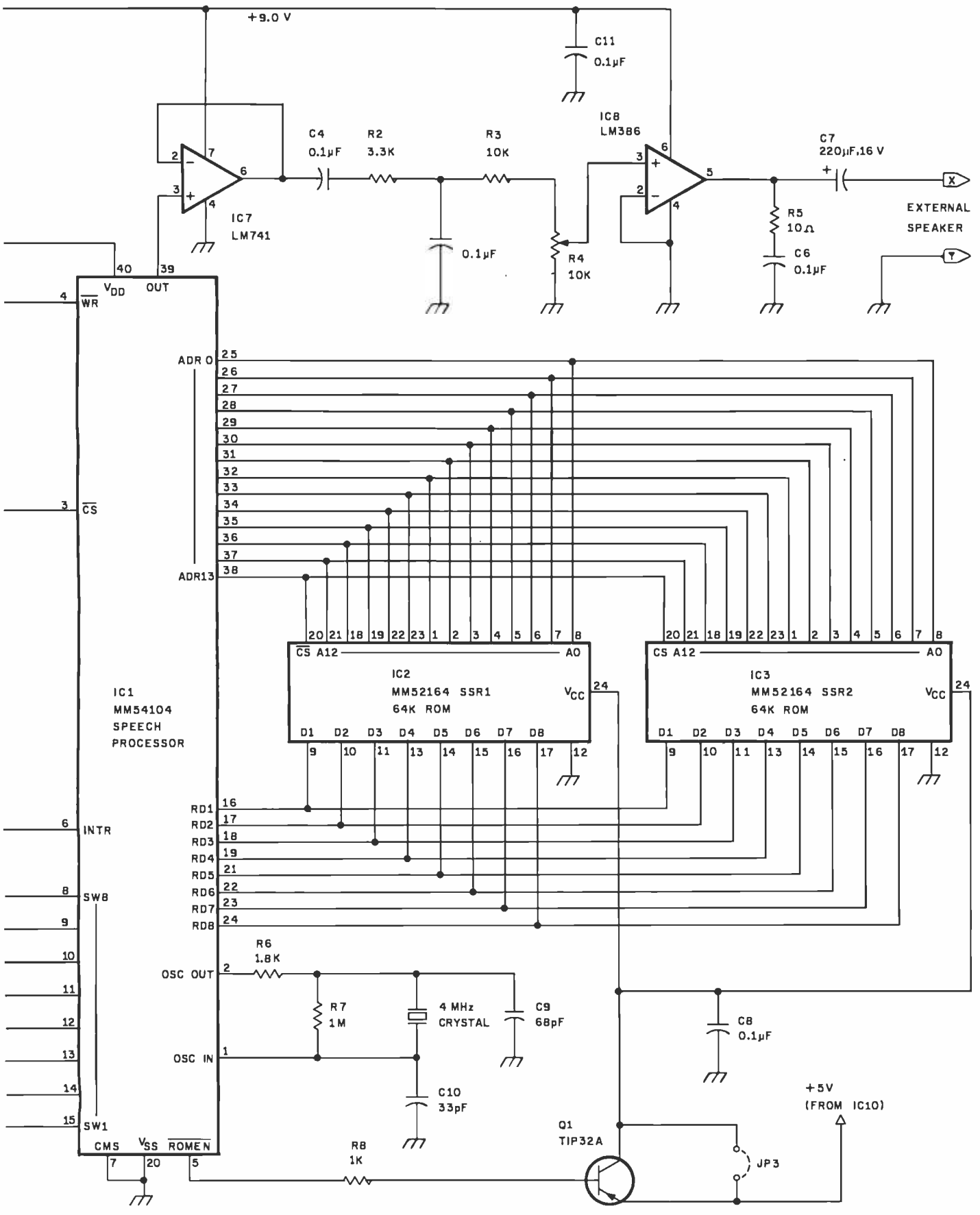


Figure 3: Schematic diagram of the Micromouth speech-processor board. The board is plug-compatible with the Apple II and TRS-80 Model I computers and can be plugged into the TRS-80 Model III with a simple adapter. Several features and options in the circuit are activated by selection of jumper connections; see table 3, on page 58, for a list of jumpers and their purposes. Interface signals are compatible with other microcomputers, including Digital Group, Heath H-8, and S-100-bus systems.



Text continued from page 54:

times it is repeated. Speech data from the ROM is loaded into the speech processor's data register and passed on to the delta-modulator decoder. This produces a 4-bit number that is applied to the D/A converter. Successive and regressive (remember the mirror waveform) digitizations produce a final waveform that is output in real time. Figure 1b shows the pinout specifications of the speech processor and the associated ROMs.

Adding a Digitalker Interface

In general, causing any of the 144

stored expressions to be uttered is done by loading a numeric word code into a register in the speech processor. The code, selected from the list in table 1, is latched when the write-enable and chip-select lines are strobed. The speech processor immediately utters the selected expression.

If the input code is 0, the message "This is Digitalker" is spoken, in about 1.3 seconds. To say a word like "at" takes much less time. If another word-selection address is strobed into the speech processor while it is speaking, it will terminate the current out-

put and begin speaking the newly selected expression. To keep the unit from jamming one word on top of another, a handshaking signal (INTR) goes to a low logic condition when the device is talking.

The simplest Digitalker system can consist of as little as the three speech-system integrated circuits, a 4 MHz oscillator, and an amplifier/filter (as shown in figure 2). Different expressions can be accessed by attaching eight switches to the SW1 thru SW8 input lines and a pushbutton switch to momentarily pulse the write-enable line.

Full use of the Digitalker's capabilities, however, can only be achieved when it is connected to a computer and exercised under program control. Figure 3, on pages 56 and 57, is the schematic diagram of the Micromouth speech-synthesizer interface, which incorporates the Digitalker chips. It is designed to be bus-signal-compatible with a number of computers, and it can be operated through a parallel I/O port. Assembled on the printed-circuit board shown in photo 1, it is plug-compatible with the Apple II and TRS-80 Model I personal computers. The pin numbers listed in the figure for connector J2 correspond to the TRS-80 Model I TRS-BUS edge connector, and pin numbers listed for J1 correspond to the Apple II's I/O card slots. A source for the Micromouth speech-processor assembled unit, blank boards, and components is given in the text box on page 68.

Micromouth Versatility

The Micromouth board is designed to accommodate bidirectional as well as unidirectional data buses. The data-bus lines are normally attached to pins 8 thru 15 of IC1, the speech-processor component. The bus line from the speech processor, INTR, is jumpered (by either jumper connection JP4 or JP5) to meet the requirements of the particular bus being used. For both the TRS-80 and Apple II, which have bidirectional data buses, jumper JP5 is inserted to connect the INTR output to the D0 bus

Text continued on page 62

Peripheral Slot	Address Jumpers			
	JP1		JP2	
	Hexadecimal	Decimal	Hexadecimal	Decimal
1	C17F	- 16001	C1FF	- 15873
2	C27F	- 15745	C2FF	- 15617
3	C37F	- 15489	C3FF	- 15361
4	C47F	- 15233	C4FF	- 15105
5	C57F	- 14977	C5FF	- 14849
6	C67F	- 14721	C6FF	- 14593
7	C77F	- 14465	C7FF	- 14337

Table 2: I/O addresses used by the Apple II in communicating with the Micromouth speech-processor board. These are addresses in the Apple's peripheral-card ROM address space. The driving software can manipulate these registers using memory-reference instructions; in BASIC, PEEK and POKE are used.

Jumper Connection	Purpose
JP1	When connected, sets TRS-80 I/O-port address to decimal 127; mutually exclusive with JP2; see table 2 for Apple II addressing.
JP2	Sets TRS-80 I/O-port address to decimal 255; see table 2 for Apple II addressing.
JP3	To be connected if transistor Q1 is to be omitted and an adequate external power supply is to be used.
JP4	Not for use with either TRS-80 or Apple II computers; provides INTR feedback to computer, gated by the address strobe; see also JP8.
JP5	When connected, enables use of a bidirectional data bus; otherwise a unidirectional bus is assumed.
JP6	Not for use with either TRS-80 or Apple II; when the 40-pin edge connector is used, a +12 V supply may be provided to the board through pin 39.
JP7	May be connected if an external +9 V or +8 V supply is available.
JP8	Not for use with either TRS-80 or Apple II; provides INTR feedback to computer, although not gated as through JP4.
JP9	Must be connected when board is used with a TRS-80; enables I/O commands to be decoded properly.
JP10	Must be connected when board is used with an Apple II; provides proper I/O-command decoding.

Table 3: List of jumper connections in the schematic diagram of figure 3. Various features and options of the Micromouth speech-processor board are activated by connecting different jumpers. Some options are not needed when the board is used with an Apple II or a TRS-80. Experimenters with other computers may use the 40-pin and 50-pin edge connectors in nonstandard ways; therefore some connections have been provided that have no obvious use.

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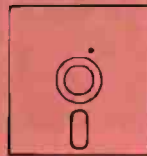
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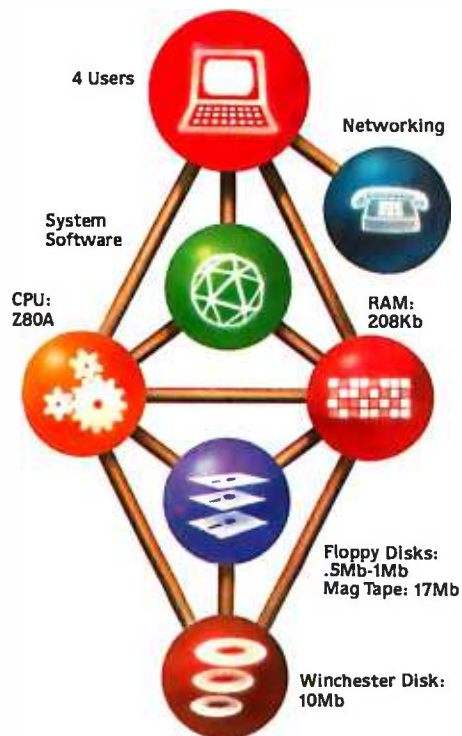
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Text continued from page 58:

line. The controlling computer can read the status of this line with an input instruction; only the least-significant bit will be affected. For a unidirectional data bus, as in a Digital Group computer, JP4 would be inserted and pin 5 of IC6 connected to the least-significant bit of the input bus.

The logic gates of IC4, IC5, and IC6 perform address decoding and chip selection. The I/O-port address of the board is set by inserting jumper JP1 or JP2. With JP1 installed, the address is port hexadecimal 7F (decimal 127). With JP2 installed, it is port hexadecimal FF (decimal 255). On the Apple II, the port address depends upon the slot in which the board is inserted. Table 2 is an address map for the Micromouth speech-processor board installed in an Apple II.

The speech-processor chip requires +7 to +11 V for normal operation, while the ROMs and other integrated circuits require only a +5 V supply. To accommodate the different ranges, I used two separate voltage

regulators. IC9, a 7805 regulator, can safely be fed an input-voltage range of +9 to +24 V. When installed in an Apple II it receives a +12 V supply from the I/O bus. When the board is used with the TRS-80, a separate full-wave power supply using a 22 V center-tapped power transformer supplies approximately +15 V RMS. IC9 and associated components regulate the output to the speech processor to about +9 V. IC10, another 7805, in turn, reduces the +9 V to the +5 V required by the rest of the components.

The typical maximum current requirement of the Micromouth speech-processor circuitry is about 250 mA. Most of this is consumed running the two 64 K-bit ROMs, which are used only a few microseconds at a time. A memory-enable signal, ROMEN, can be used with a transistor (Q1) to gate the power on and off to the ROMs. The average current required ends up being about 80 mA.

The final section for consideration is the filter and amplifier, IC7 and

IC8. As in any digitized analog-signal output, a low-pass filter is required. For low-pitched male voices, the cutoff frequency should be about 100 Hz; for high-pitched female or children's voices it should be 300 Hz. The filter in figure 3 has a cutoff frequency around 150 Hz. That limit wasn't set mathematically; I simply chose a pleasant-sounding range. The frequency response of the output speaker and its enclosure can also affect sound quality. In my opinion, the sound output by this circuit is quite human-like. Any additional filtering usually serves only to eliminate background noise.

Using a Parallel Port

The Micromouth board can also be jumpered so that it can be driven by a parallel I/O port. This is accomplished by inserting jumpers JP8 and JP9. With the input lines to IC5 and IC6 left open, a constant chip-select signal will be generated. The 8-bit parallel output from the computer is attached to pins 8 thru 15 on the speech processor. The same signal that latches the bit values into the output port can be used as the WR strobe on IC1 pin 4. The speech-processor-busy status indication is handled by directly reading the INTR line via an input-port line.

Basic Software Simplicity

The best thing about a fixed vocabulary "canned-speech" synthesizer is the low software overhead. Text-to-speech synthesizers, on the other hand, usually require at least an 8 K-byte driver program, which must be integrated into the existing operating system. With the Micromouth speech-processor board, any or all of the 144 expressions can be spoken using a simple BASIC OUT or POKE statement.

For example, to say "twenty" using the board connected to a TRS-80 system, you would execute an OUT 127,20 statement in BASIC. With the Apple II, the appropriate statement would be POKE -16001,20 if the board were installed in slot 1. As you can see, the control information communicated to the board, a decimal 20,

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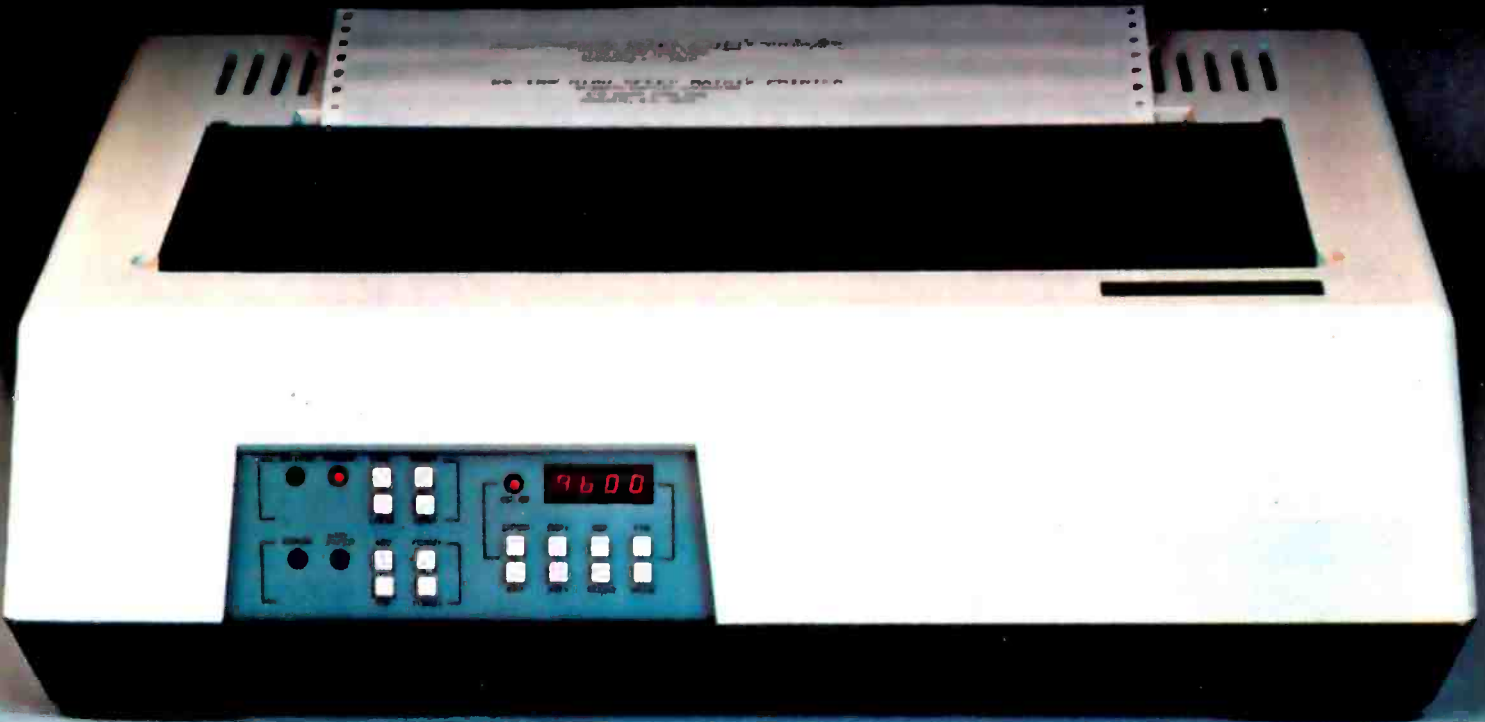
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Listing 1: A BASIC program for the Radio Shack TRS-80 Model I that will cause the Micromouth speech-processor board to say "At the mark the time is 2:45 pm....beep." A program for the Apple II would use the POKE keyword to achieve the same effect as the OUT statement.

```

100 DIM N(15)
110 DATA 61,138,105,71,138,139,
    96,2,4,5,47,44,71,71,65
120 FOR X=1 TO 15 :READ N(X)
    : NEXT X

150 FOR X=1 TO 15 : OUT 127,N(X)
    : GOSUB 1000 : NEXT X
160 GOTO 1999

1000 IF INP(127)=1 THEN
    GOTO 1000 ELSE RETURN
1999 END

```

is the same even though the keywords differ. (Since my program illustrations consistently use OUT statements directed to port 127, I will not bother to restate the conversion in subsequent examples, but you should recognize the direct relationship.)

Listing 2: A BASIC program that will cause the Micromouth speech-processor board to recite multiplication results for any number between 1 and 10.

```

100 PRINT "MULTIPLICATION TABLE EXERCISER"
110 OUT 127,0:REM Say This is Digi-Talker
120 PRINT:PRINT"Which table do you want to review (1 to 10)";
130 INPUT N
140 FOR X=0 TO 10
150 PRINT X;"X";N;"=";X*N:J=X*N
160 IF X=0 THEN OUT 127,31:GOSUB 290:GOTO 180
170 OUT 127,X:GOSUB 290
180 GOSUB 310:OUT 127,N:GOSUB 290
190 OUT 127,80:GOSUB 290:OUT 127,129:GOSUB 290
200 J1=INT(J/10)
210 IF J=100 THEN OUT 127,1:GOSUB 290:OUT 127,28:GOSUB 290:GOTO 260
220 IF J=0 THEN OUT 127,31:GOSUB 290:GOTO 260
230 IF J<20 THEN OUT 127,J:GOSUB 290:GOTO 260
240 OUT 127,18+J1:GOSUB 290
250 IF J-J1*10>0 THEN OUT 127,J-J1*10:GOSUB 290:GOTO 260
260 NEXT X
270 PRINT:GOTO 120
280 REM
290 IF INP(127)=1 THEN 290 ELSE RETURN:REM check end of word
300 REM
310 OUT 127,139:GOSUB 290:OUT 127,129:GOSUB 290:RETURN
320 REM say TIMES

```

READY

Having the board speak in a series of words can be handled in one of two ways. One way is to use timing loops or other program-execution steps to allow enough time for a word to be spoken before loading the speech processor with the next word

code. The preferred method is to check the busy line (INTR) before loading the next word. In this way, speech can sound continuous regardless of the length of each word. The INTR status bit is read as the least-significant bit of port 127 by the function INP(127). In my examples, while the speech processor is talking, the decimal value returned by INP(127) equals 1; while it is not talking, INP(127) equals 0.

Therefore, saying the number twenty-one, which consists of saying "twenty" and "one" successively, goes as follows:

```

100 OUT 127,20 : GOSUB 1000
    : OUT 127,1
110 STOP
1000 IF INP(127)=1 THEN
    GOTO 1000 ELSE RETURN
1999 END

```

A similar program can be used to demonstrate the entire Digtalker vocabulary:

```

100 FOR N=0 TO 143 : OUT
    127,N : GOSUB 1000
    : NEXT N
110 STOP
1000 IF INP(127)=1 THEN
    GOTO 1000 ELSE RETURN
1999 END

```

Longer utterances are typically

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Listing 3: A BASIC program to demonstrate several different ways of using the speech interface.

```

50 DIM M(20),M(60)
55 DATA 71,138,139,96,71,12,69,93,129,71
60 FOR T=1 TO 19: READ M(T):NEXT T
70 DATA 71,76,71,71,75,81,71,71,105,71,7,20,47,44,71,71
75 DATA 83,125,96,1,26,21,6,85,129,32,110,71,71,104,133
80 DATA 2,12,28,049,047,044,60,131,83,125,2,1,26,10,85
85 DATA 129,32,110,71,71,71,71,71
90 FOR T=1 TO 56:READ M(T):NEXT T
100 REM DIGI-TALKER TEST PROGRAM
110 PRINT "DIGI-TALKER TEST PROGRAM"
120 PRINT: PRINT"1. Say entire vocabulary"
130 PRINT"2. Count from 0 to 20"
140 PRINT"3. Tones"
150 PRINT"4. Speech example A"
160 PRINT"5. Speech example B"
165 PRINT"6. Say 'THIS IS DIGI-TALKER'"
170 PRINT:PRINT"Enter choice (1-5) ":INPUT A
180 IF A=1 THEN GOSUB 250
190 IF A=2 THEN GOSUB 300
200 IF A=3 THEN GOSUB 350
210 IF A=4 THEN GOSUB 400
220 IF A=5 THEN GOSUB 450
225 IF A=6 THEN OUT 127,0:GOSUB 1000
230 GOTO 110
250 REM speak entire word list
260 FOR T=0 TO 143:OUT 127,T:GOSUB 1000
270 NEXT T: RETURN
300 REM speak numbers 0-20
310 OUT 127,31: GOSUB 1000
320 FOR T=1 TO 20: OUT 127,T: GOSUB 1000
330 NEXT T: RETURN
350 REM 80 Hz and 400 Hz tone
360 FOR T=0 TO 5:OUT 127,65:GOSUB 1000
370 OUT 127,66:GOSUB 1000:NEXT T
380 RETURN
400 REM Speak time
410 FOR B=0 TO 5:OUT 127,65:GOSUB 1000
415 FOR C=0 TO 2:OUT 127,71:GOSUB 1000:NEXT C
420 NEXT B
425 FOR T=1 TO 18 :OUT 127,M(T):GOSUB 1000:NEXT T
430 FOR T=0 TO 5:OUT 127,65:FOR S=0 TO 100:NEXT S:NEXT T
440 RETURN
450 REM example of use as error detector and verbal annunciator
460 FOR T=1 TO 55: OUT 127,M(T):GOSUB 1000:NEXT T
470 RETURN
1000 IF INP(127)=1 THEN 1000 ELSE RETURN
1010 IF INP(127)=1 THEN 1010 ELSE RETURN

```

READY

handled by storing all the word codes in an array. Such a technique can be used to say, "At the mark the time is 2:45 pm....beep," using the BASIC statements in listing 1.

I have included a few program examples to demonstrate how the speech-processor board can be used. Listing 2 is a simple program for saying multiplication tables. This program asks the operator to choose a multiplication table for a number between 1 and 10. If 8 were chosen, for example, the program would say:

"Zero times eight equals zero."
 "One times eight equals eight."
 "Two times eight equals sixteen."

and so on to:

"Ten times eight equals eighty."

This is just a rudimentary example. The program could be modified easily to posit questions such as "Six times nine equals..." and wait for a typed response. Appropriate answers would be "Error...Please try again," or "Right."

Listing 3, on page 66, is a menu-driven program that further exercises the interface and demonstrates a few more applications. Speech example A says, "beep... beep... beep... beep..." The time is...twelve hours...seventeen minutes...beep." It is very much

Listing 4: The printed output of the program in listing 3. Due to the limitations of magazine printing, we cannot reproduce the audible output produced by the program.

```

run
DIGI-TALKER TEST PROGRAM

1. Say entire vocabulary
2. Count from 0 to 20
3. Tones
4. Speech example A
5. Speech example B
6. Say 'THIS IS DIGI-TALKER'

```

Enter choice (1-5) ?

like the time message heard over shortwave radio station CHU Canada.

Speech example B from listing 3 illustrates how process-control applications might be handled. It says, "Control error...Mark seven twenty pm...Flow rate is thirty gallons a minute...Lower speed to twelve hundred rpm and set flow rate to one hundred gallons a minute."

In Conclusion

Applications that would be enhanced by speech output are limitless. I have demonstrated just a few examples dealing with process control and time.

Many handicapped persons could benefit from speech output. It would be possible, for example, to attach a speech-output device to the user-terminal keyboard of a personal computer. As the keys are pressed, the corresponding letters are spoken aloud. (A simple ROM containing Digitalker equivalents for ASCII [American Standard Code for Information Interchange] characters could be used to interface the speech-processor board.) A similar connection can be made to the printer output (using the INTR-signal handshaking to slow it down) to allow the operator to hear what would otherwise be printed.

I did not attempt to modify any computer games as illustrations. Computer games could easily be made to talk using a few extra BASIC



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layout for all cursor and function keys, screen size, default tab positions, scrolling methods and much more. This setup program requires no programming knowledge or 'patches', but simply prompts you to press a key or enter a parameter.

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statements that are independent of the program flow.

What I'd like to leave you with is an appreciation for the price/performance advantages and ease of use inherent in this speech interface. Soon other Digitalker ROMs will be available, containing specialized vocabularies for medical, aeronautical, or even space-war applications. These other ROMs will be available eventually thru the MicroMint.

[Editor's Note: National Semiconductor Corporation is providing a brief telephone demonstration of the Digitalker speech-synthesis system at (408) 737-3939....RSS]

The invention of Digitalker does not mean the demise of other approaches to computer-generated

speech. Instead, it introduces low-cost speech output into areas that could never have justified the expense previously. Eventually, hand-held talking digital volt-ohmmeters will be mass-produced, and I don't think it will be too far into the future. But that is merely one application. You can expect to see (or rather hear) speech emanating from many commercial products.

Those who work with other speech-synthesis techniques have not been standing still during the development of "canned-speech" chips. Phoneme synthesizers, such as the Votrax SC-01, now accomplish on a single chip what once required a whole circuit board. My investigation of speech synthesis doesn't stop here. In the months ahead I hope to

demonstrate other computer-speech techniques, interfaces, and applications.

Next Month:

Would you think that a computer system capable of running a BASIC interpreter could fit on a 4-inch-square circuit board? Find out how to build one in next month's *Circuit Cellar*. ■

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6. Wiggins, Richard and Larry Brantingham. "Three-Chip System Synthesizes Human Speech," *Electronics*, August 31, 1978, page 109.

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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 that appeared 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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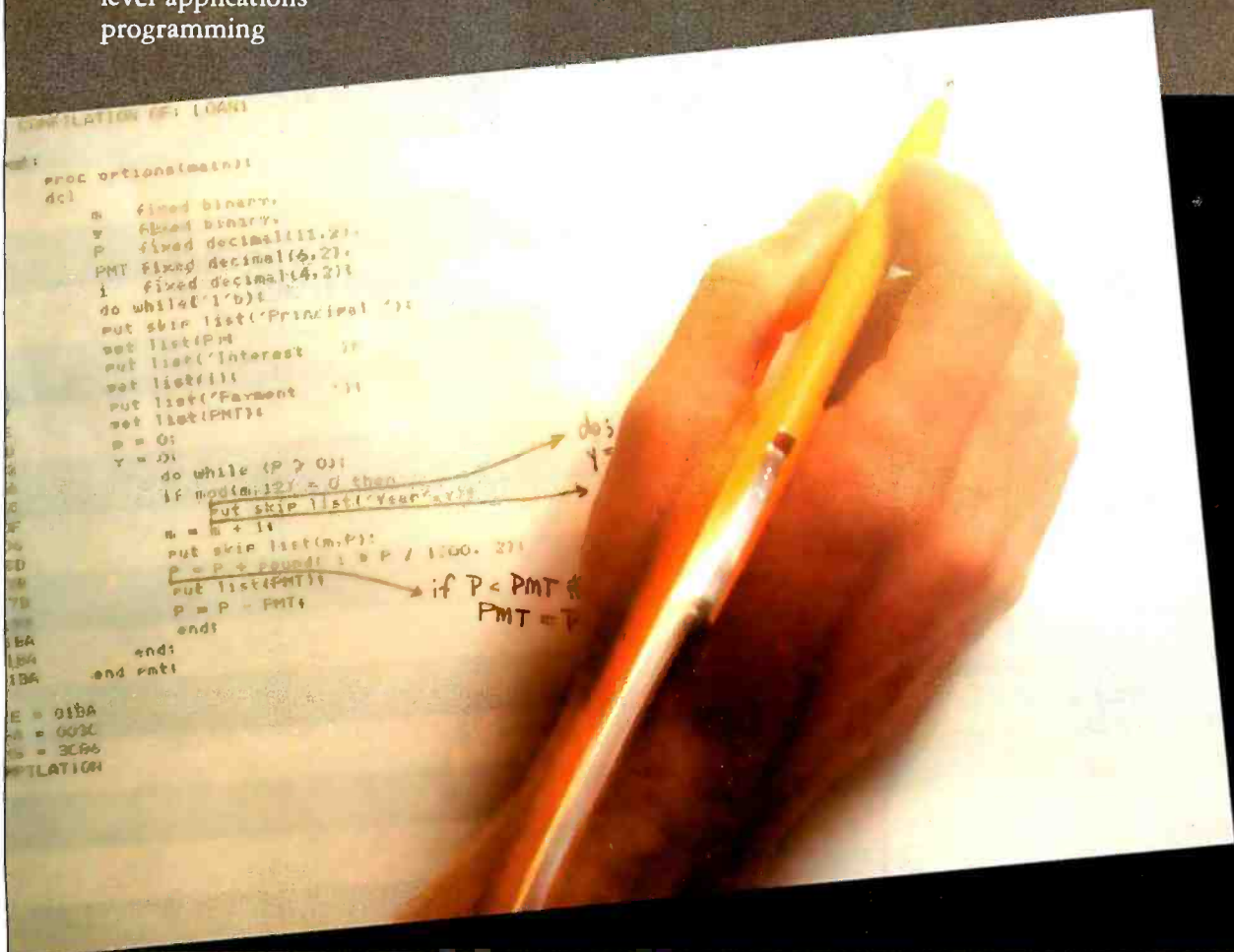
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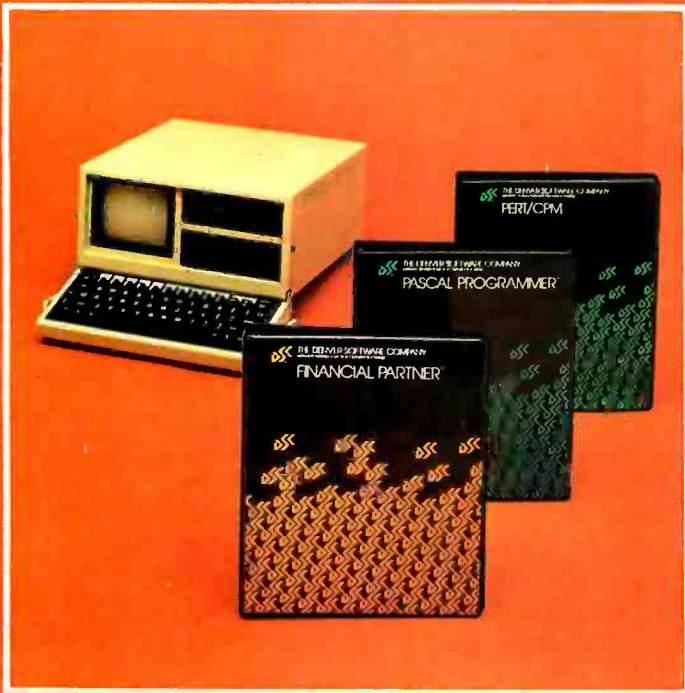


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Mathematical Modeling: A BASIC Program to Simulate Real-World Systems

Randall E Hicks
University of Georgia
Marine Institute
Sapelo Island GA 31327

Editor's Note: The subject of this article, simulating systems by solving a system of differential equations, is difficult, but we feel it is useful to many BYTE readers. In fact, only a rudimentary understanding of the principles involved is needed to use the general-purpose BASIC program of listing 2. The involved mathematics at the end of the article presents the theory on which the program is based. . . . GW

Many academic disciplines have used computers for modeling biological, physical, economic, and social systems. Modeling complicated systems once was time-consuming, expensive, and cumbersome. Yet, as computer-related technology advanced, the magnitude of these problems has dwindled, and the potential for less-expensive modeling and simulation tasks in all disciplines has increased.

My purpose is to demonstrate how useful microcomputers can be in mathematical simulations. I will introduce you to modeling the behavior of a system by describing it mathematically with a system of time-invariant linear differential equations. I will show how to solve systems of differential equations by two separate numerical methods. As a framework for the simulation tasks, I will use a simple model as an example for you to follow: a hydrologic model of the forested uplands surrounding Okefenokee swamp in Georgia. (See reference 3.)

The Conceptual Model

To simulate a system, you must be able to conceptualize it into some logical framework. A flow diagram consisting of compartments and connecting flows satisfies this requirement. (See figure 1.) Each compartment in

About the Author

Randall E Hicks is a graduate student at the University of Georgia working toward his PhD in Ecology at the Institute of Ecology. He is employed by Ecology Simulations Inc, Athens, Georgia, as a marine systems modeling consultant.

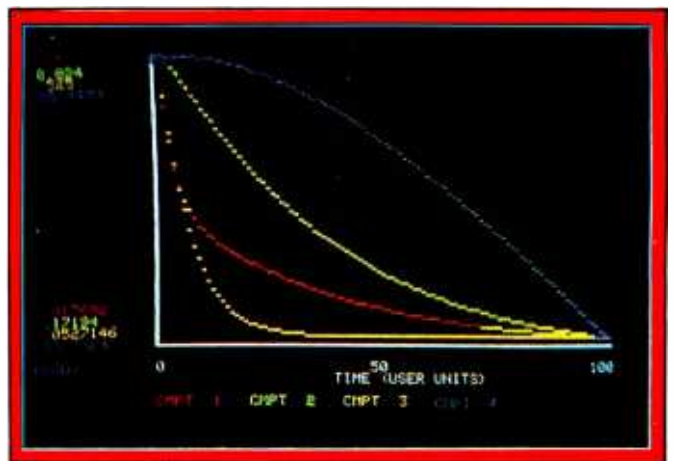


Photo 1: Zero-input response of the Okefenokee swamp hydrologic model simulated with the program in listing 2.

the diagram represents a place for the potential accumulation of energy, matter, or information. A *system* is defined as the collection of compartments that have been outlined and the potential interactions among them. The flows between compartments describe how the system interacts with itself through transfers of the compartmental contents.

The boundaries of the system must also be defined. The *environment* of the system is the area outside the system's periphery. If the system does not interact with its environment, it is called a *closed system*, and the model will not receive inputs from or yield losses to its surroundings. In other words, the system is self-contained. In the Okefenokee swamp uplands hydrologic model, the system is said to be *open* because it interacts with its environment. In the conceptual model (figure 1), this is visualized by an input from the environment to the system and by an output from the system to the environment.

The input to the system (Z) is the sum of the flows to each compartment (f_{i0}) from all environmental inputs. The environment surrounding the system is represented by the numeral 0. In the hydrologic model, there is only

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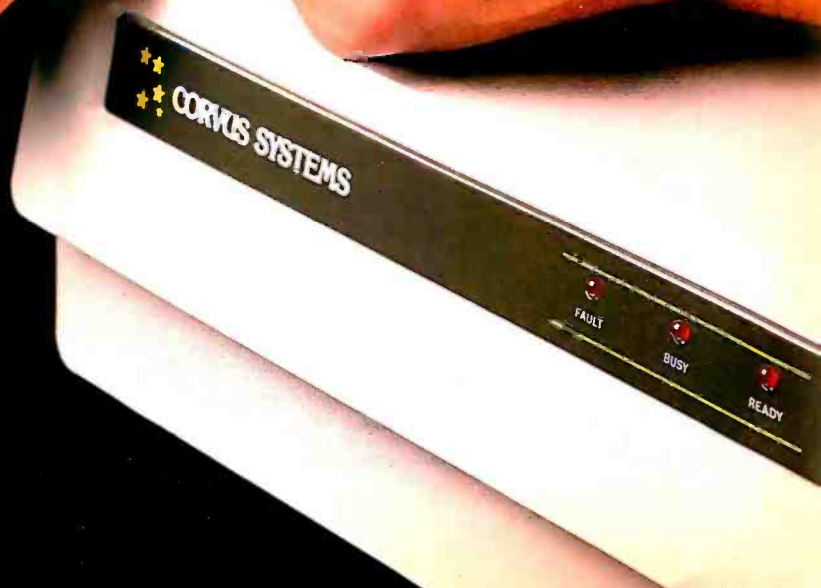
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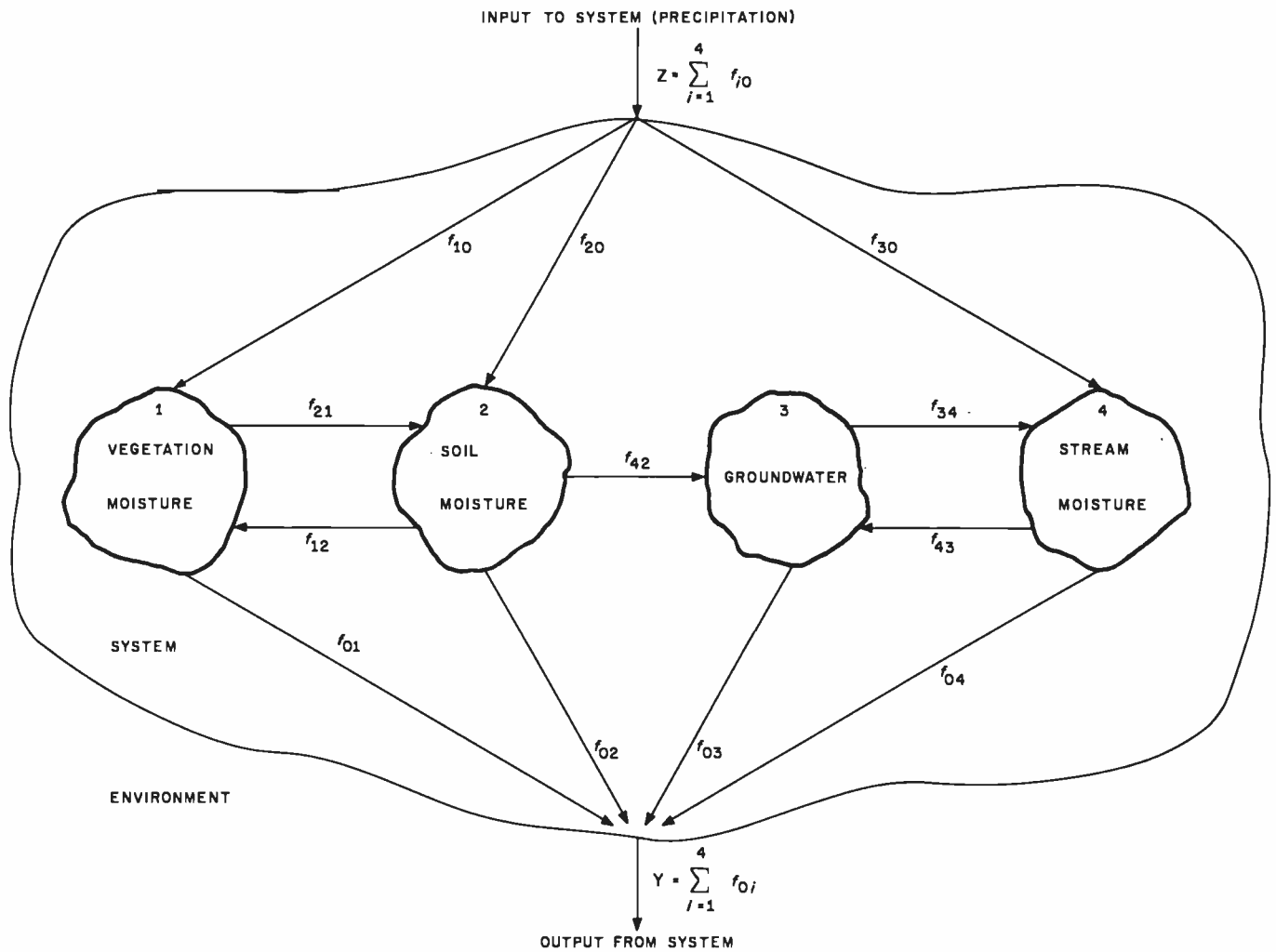


Figure 1: A conceptual model of the hydrology of the forested uplands surrounding Georgia's Okefenokee swamp. The model is subdivided into a system and its environment. The system receives environmental inputs (Z) and yields losses (Y) to the environment. Compartments represent areas of potential water accumulation. Flows and their direction are indicated by connecting arrows. Flows within the system are also given numerical designations. The first number represents the recipient-compartment number and the second represents the donor-compartment number.

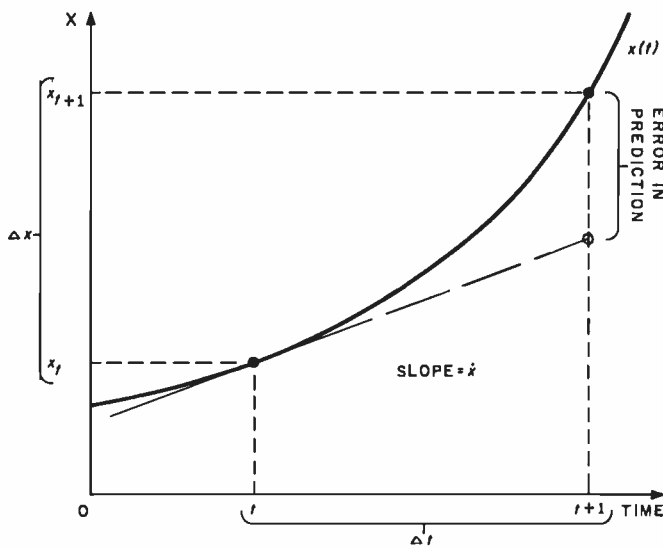
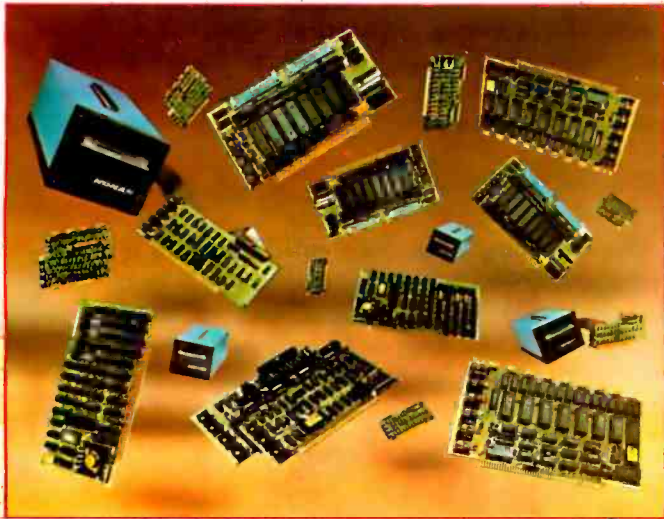


Figure 2: Geometric interpretation of Euler's method for solving differential equations. Compartment size (x) is plotted versus time (t). Actual and predicted compartment sizes are shown.

one environmental input to the system: precipitation. Hence:

$$Z = f_{10} + f_{20} + f_{30} = z_1$$

where the numerical designation of z_k represents an input from environmental input k to the system. Flows within the system are represented by lines connecting compartments; arrows show the direction of flow. These flows are classified by two numbers. The first number indicates the compartment that receives the flow, and the second represents the compartment that yields (i.e. produces) the flow. In figure 1, f_{21} designates an actual flow of moisture from vegetation moisture (compartment 1) to soil moisture (compartment 2). The output from the system (Y) back to the environment is the sum of the losses from each compartment i (f_{0i}). The purpose of the model is to be able to describe the response of each compartment (i.e. how much water is present) at all times in the future.



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The Mathematical Model

The flows into and out of each compartment can be represented by a difference, or a differential, equation. In the model, the flows have been balanced so that no compartment will have a net gain or loss of moisture. The system is said to be at *steady-state*, and the corresponding model will be *static* in nature. The relationships in the flow diagram can be depicted by a system of linear differential equations. In the steady-state example, each differential equation representing a compartment is equal to 0, since inflows and outflows are equal.

For compartment 1 (vegetation moisture), the differential equation would be of the form:

$$\frac{dx_1}{dt} = \dot{x}_1 = f_{10} + f_{12} - f_{21} - f_{01}$$

(Note: In this equation, I have used a dot centered over a variable to simplify notation. Henceforth, this will mean the derivative of a variable with respect to time.)

The actual flows (f_{ij}) can be divided by the steady-state size of the corresponding donor compartment (x_j), or by the environment input (z_k), to give two types of coefficients: intercompartmental rate coefficients and environmental input coefficients:

$$a_{ij} = \frac{f_{ij}}{x_j}$$

and:

$$b_{ik} = \frac{f_{i0}}{z_k}$$

where:

i = the recipient compartment
 j = the donor compartment

and:

k = an environmental input number

Notice that the intercompartmental coefficients a_{ij} (of

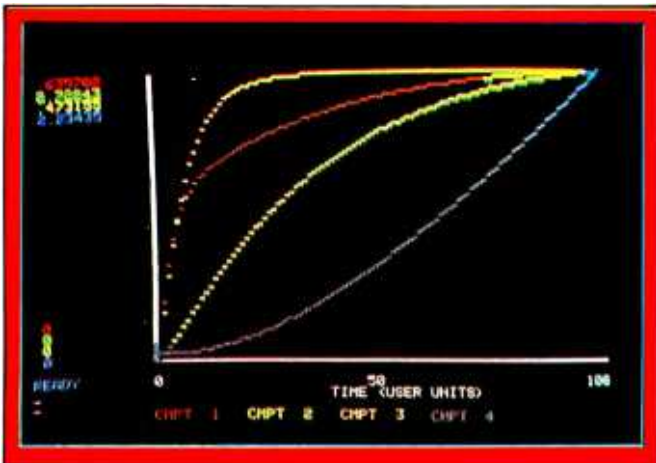


Photo 2: Zero-state response of the Okefenokee swamp hydrologic model simulated with the program in listing 2.

matrix A) have the same numerical designation as their corresponding flows. Also notice that the environment is represented by a 0 in flows. When environmental input coefficients are formed, you subdivide the total environmental input Z into the different types (k) of environmental inputs. These coefficients (b_{ik} of matrix B) are dimensionless and express the percentage of an environmental input (z_k of vector Z) that each compartment receives. These numerical notations define the position of each coefficient in an appropriate coefficient matrix. For compartment 1 (vegetation moisture), the differential equation then becomes:

$$\dot{x}_1 = a_{12}x_2 - a_{11}x_1 + b_{11}z_{11}$$

After redefining all the differential equations into coefficients multiplied by the appropriate donor-compartment size or environmental-input size, you can organize the system of equations into a single matrix equation:

$$\dot{X}_{n1} = A_{nn}X_{n1} + B_{nm}Z_{m1}$$

where:

n = the number of compartments
 m = the number of environmental inputs to the system
 \dot{X}_{n1} = a column vector of differential equations

$$\begin{bmatrix} \dot{x}_1 \\ \vdots \\ \dot{x}_n \end{bmatrix}$$

A_{nn} = an n by n matrix of intercompartmental rate coefficients

$$\begin{bmatrix} a_{11} & \cdot & \cdot & \cdot & a_{1n} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n1} & \cdot & \cdot & \cdot & a_{nn} \end{bmatrix}$$

X_{n1} = a column vector of initial compartment sizes

$$\begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix}$$

B_{nm} = an n by m matrix of input rate coefficients

$$\begin{bmatrix} b_{11} & \cdot & \cdot & \cdot & b_{1m} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ b_{n1} & \cdot & \cdot & \cdot & b_{nm} \end{bmatrix}$$

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and:

Z_{m1} = a column vector of environmental input sizes

$$\begin{bmatrix} z_1 \\ \cdot \\ \cdot \\ \cdot \\ z_m \end{bmatrix}$$

The matrices and vectors for the hydrologic model are:

$$A = \begin{bmatrix} -.369 & .035 & 0.0 & 0.0 \\ .189 & -.0483 & 0.0 & 0.0 \\ 0.0 & 0.0 & -.1632 & .000161 \\ 0.0 & .012 & .000444 & -.000623 \end{bmatrix} \times 1/(10 \text{ years})$$

$$X = \begin{bmatrix} 0.6500 \\ 2.8940 \\ 0.5250 \\ 55.4400 \end{bmatrix} \times 10^8 \text{m}^3 \text{ water} \quad B = \begin{bmatrix} 0.60 \\ 0.07 \\ 0.33 \\ 0.00 \end{bmatrix}$$

and:

$$Z = [.233] \times 10^8 \text{m}^3 \text{ water} / (10 \text{ years})$$

At best, this is a brief treatment of the use of linear differential equations in simulating the behavior of a collection of components. The hydrologic model herein is described by a deterministic general linear model (GLM) of donor-controlled differential equations. This type of model is among the simplest and the most straightforward to use; it has found wide acceptance in many fields. There are many books on general-systems theory and modeling that go into more detail than I can in this article. (For further reading, see references 4 and 5.) Higher-order differential equations can also be used to describe the time-varying changes in flows between compartments in a model. (See reference 2.) A nonlinear model would incorporate higher-order differential equations.

Numerical Solution of Differential Equations

Now that the model has been described with a system of linear differential equations, a method to solve these equations on a computer is needed. Several numerical methods are available for solving differential equations, but I will discuss only two methods and their implementation on microcomputers: the *Euler* and *Runge-Kutta* methods. I will briefly describe each method and list a corresponding algorithm written in BASIC (Disk BASIC 8001, for the CompuColor II microcomputer) for implementation on a microcomputer. For a more detailed description of these and other methods for solving differential equations, consult a book on numerical analysis or modeling. (See references 1 and 5.)

Euler's (Rectangular) Method

Euler's method is a simple but computationally inefficient method for solving finite differential equations. First, let's look at a geometric interpretation of this method. (See figure 2.)

Knowing the present value (state) of a compartment (x_t), you want to be able to predict the next value (x_{t+1}). Your differential equation for the compartment defines the slope of the line at time t . You project this slope to the next point in time ($t+1$), and add the change in x 's value (called Δx) to the value of x at time t (x_t). In many cases (such as in figure 2), the slope of the actual path of the compartment size may not be equal to the predicted value. In these instances, this algorithm has incorporated some error into the predicted value for the compartment size at the new time. In the Euler method, this error is proportional to the time step (Δt). This error can be reduced by decreasing the time step; however, that will increase the algorithm execution time on the computer.

The algorithm for the Euler method is:

1. $\dot{X}_t = f(X_t, Z_t, t)$
2. $X_{t+1} = X_t + \Delta t(\dot{X}_t)$

First, compute the slope of the line at t , which you assume is the same at $t+1$. In the hydrologic model, this is already determined by the time-invariant differential equations for each compartment. Second, you compute the new compartment size (x_{t+1}). Then you return to step 1 and continue the process for as many times as you wish. If you want to reduce the error in the algorithm, you can decrease your time step and perform the algorithm several times. In this way, you increase the number of iterations of the algorithm before you calculate your final value. Listing 1 is a program for the Euler algorithm written in Disk BASIC 8001.

Runge-Kutta Method

Runge-Kutta is a multistep, look-forward method for the numerical solution of differential equations. I will

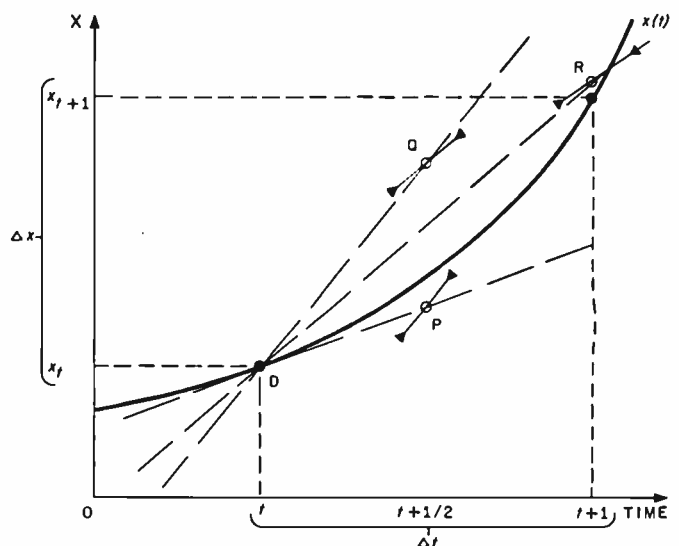


Figure 3: Geometric interpretation of the fourth-order Runge-Kutta method for solving differential equations. Compartment size (x) is plotted versus time (t). Actual and predicted compartment sizes are shown.



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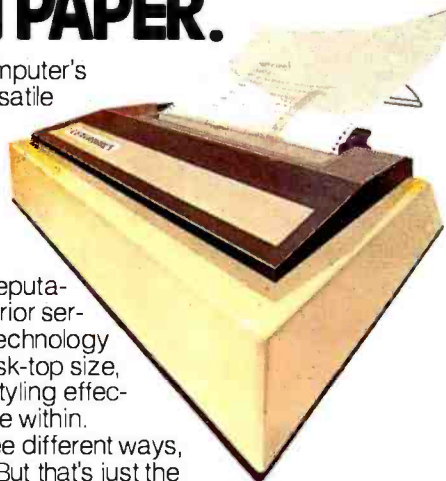
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discuss the fourth-order Runge-Kutta method. It is computationally more involved than Euler's method, but it incorporates less error into the prediction of the next compartment size (x_{t+1}). The geometric interpretation of this method is shown in figure 3.

As with the Euler method, knowing the present compartment value (x_t), you want to predict the next compartment value (x_{t+1}). First, you find the slope (XD) of the line at time t . Then, as in Euler's method, you calculate the compartment size (P), but at time $t + 1/2$. After you calculate the slope (XP) at P , make a second prediction of the compartment size (Q) at time $t + 1/2$. After you calculate the slope (XQ) at Q , make a third prediction of the compartment size (R), but at time $t + 1$. Again, calculate the slope (XR). Next, take a weighted average of all the slopes you calculated and determine your final prediction of the compartment size (x_{t+1}) at time $t + 1$. As with Euler's method, the Runge-Kutta method incorporates some error into your predictions; however, the error is now proportional to the fourth power of the time step (Δt) and is greatly reduced. The error can be reduced further by decreasing the time step.

The algorithm for the fourth-order Runge-Kutta method is:

1. $\dot{X}_t^D = f(X_t, Z_t, t)$
2. $X_{t+1/2}^P = X_t + \Delta t/2(\dot{X}_t^D)$
3. $\dot{X}_{t+1/2}^P = f(X_{t+1/2}^P, Z_{t+1/2}, t + 1/2)$
4. $X_{t+1/2}^Q = X_t + \Delta t/2(\dot{X}_{t+1/2}^P)$
5. $\dot{X}_{t+1/2}^Q = f(X_{t+1/2}^Q, Z_{t+1/2}, t + 1/2)$

Listing 1: *CompuColor II Disk BASIC 8001 program segment of Euler integration algorithm.*

```

190 REM ***** START SIMULATION *****
195 FOR IJ=1 TO 100
200 DT=1/KK
210 REM ***** START EULER INTEGRATION LOOP *****
215 FOR JJ=1 TO KK
220 FOR I=0 TO N
230 AX(I)=0
240 FOR J=0 TO N: AX(I)=AX(I)+A(I,J)*X(J): NEXT J
250 FOR K=0 TO NN: AX(I)=AX(I)+B(I,K)*Z(K): NEXT K
260 NEXT I
270 FOR I=0 TO N: X(I)=X(I)+DT*AX(I): NEXT I
275 NEXT JJ
280 FOR I=0 TO N: XX(IJ,I)+X(I): NEXT I
290 NEXT IJ
300 REM ***** END OF SIMULATION *****

```

6. $X_{t+1}^R = X_t + \Delta t(\dot{X}_{t+1/2}^Q)$
7. $\dot{X}_{t+1}^R = f(X_{t+1}^R, Z_{t+1}, t+1)$
8. $X_{t+1} = X_t + \Delta t(\frac{1}{6}(\dot{X}_t^D) + \frac{1}{3}(\dot{X}_{t+1/2}^P) + \frac{1}{3}(\dot{X}_{t+1/2}^Q) + \frac{1}{6}(\dot{X}_{t+1}^R))$

If you wish to reduce the error in the algorithm, you can decrease the time step (Δt), perform the algorithm several times, and save the last prediction of the compartment size. The Runge-Kutta integration method is incorporated into the GLM program in listing 2.

General Linear Model Program

So far, I have discussed the general linear model form and two different algorithms for the numerical solution of differential equations. I have combined these two topics and written a general-user program for mathematically modeling a system of components described by linear differential equations, solved for 100 time increments with a Runge-Kutta integration algorithm. This program was written in Disk BASIC and is given in listing 2. To use this program, you enter the number of compartments in and environmental inputs to your system, an intercompartmental rate coefficient matrix (**A**), the initial compartment values, an input coefficient matrix (**B**), and the environmental input values. You must also enter the desired number of iterations of the Runge-Kutta algorithm. This value is the reciprocal of the

Text continued on page 86

PLOT 2	Enter graph-plotting mode
PLOT 2, X, Y	Point at X,Y
PLOT 2, 242, X, Y	Vector to X, Y
PLOT 2, 250, X0, Y, XM	Horizontal bar at Y from X0 to XM
PLOT 2, 246, Y0, X, YM	Vertical bar at X from Y0 to YM
PLOT 3, T, L	Cursor to tab T at line L
PLOT 6, C	Defines the color of both the foreground and background
PLOT 8	Cursor to home
PLOT 9	Tab 8 spaces
PLOT 10	Line feed (move cursor down one line)
PLOT 11	Erase line
PLOT 12	Erase page
PLOT 14	Double-height text
PLOT 15	Normal-height text, with blink mode off
PLOT 16 thru PLOT 23	Changes color of foreground or background (whichever is active)
PLOT 27, 4: PRINT	
""[disk commands]":	
PLOT 27, 27	Execute floppy-disk command
PLOT 27, 10	Write text vertically
PLOT 27, 24	Write text horizontally
PLOT 28	Cursor up
PLOT 29	Enable background color
PLOT 31	Blink on
PLOT 255	Cancel graph-plotting mode

Table 1: *The use of the PLOT command in Disk BASIC 8001 (for the CompuColor II). This information will help explain certain parts of listing 2, if you convert that program to another microcomputer.*

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Listing 2: A general-user program written in Disk BASIC 8001 for mathematical modeling with a system of time-invariant linear differential equations. The equations are solved for 100 user time increments with a fourth-order Runge-Kutta integration algorithm. As the program is written, the simulation results are scaled and plotted versus time on a video monitor (Compucolor II microcomputer). This section of the program will have to be modified for other microcomputer systems. See table 1 for further information on the PLOT command.

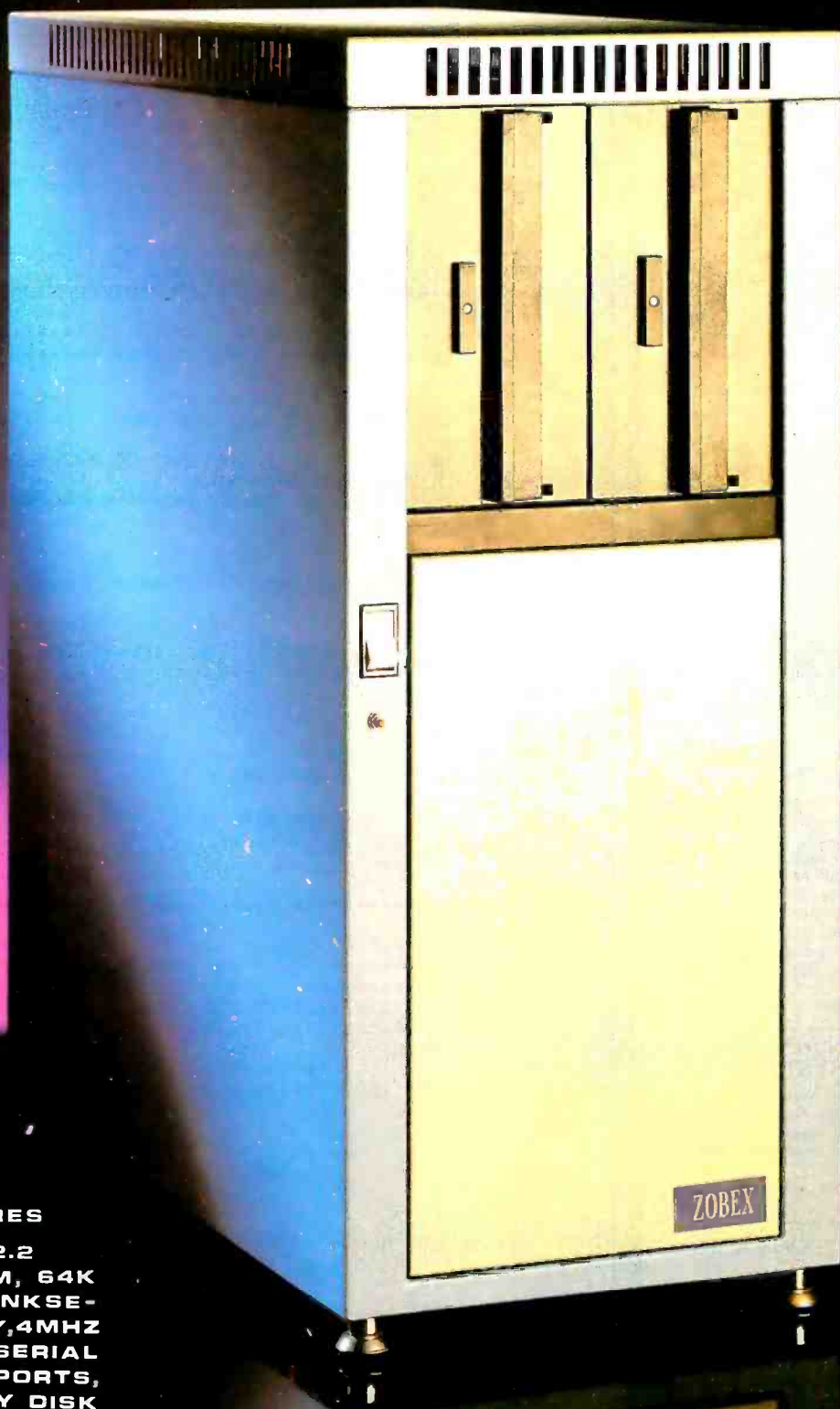
```

10 REM ***** GENERAL LINEAR MODEL SIMULATION PROGRAM *****
11 REM ***** WITH RUNGA-KUTTA INTEGRATION *****
20 REM ***** BY RANDALL E. HICKS *****
21 REM ***** COPYRIGHT 1980 *****
24 PLOT 12
25 PRINT "GIVEN:"
30 PRINT "1) THE NUMBER OF MODEL COMPARTMENTS"
35 PRINT "2) THE NUMBER OF ENVIRONMENTAL INPUTS"
40 PRINT "3) A MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS"
42 PRINT "4) A VECTOR OF INITIAL COMPARTMENT SIZES"
45 PRINT "5) A MATRIX OF ENVIRONMENTAL INPUT COEFFICIENTS"
47 PRINT "6) A VECTOR OF ENVIRONMENTAL INPUT SIZES AND"
50 PRINT "7) THE NUMBER OF ITERATIVE INTEGRATION STEPS --"
51 PRINT
52 PRINT "THIS PROGRAM WILL USE A SYSTEM OF TRANSITION"
53 PRINT "EQUATIONS TO SIMULATE THE BEHAVIOR OF YOUR SYSTEM"
54 PRINT "USING A RUNGE-KUTTA INTEGRATION ALGORITHM WITH THE"
55 PRINT "OUTPUT PLOTTED AS A GRAPH ON THIS TERMINAL!"
74 PRINT
75 INPUT "HOW MANY COMPARTMENTS IN YOUR MODEL (N=1-7)?" :N
80 N= N- 1:PRINT
85 INPUT "HOW MANY INPUT ENVIRONMENTS IN YOUR MODEL (N=1-3)?" :NN
90 NN= NN- 1
95 DIM A(N,N),B(N,NN),XX(100,N),X(N),AX(N),XD(N),XP(N),XQ(N),XR(N),Z(NN)
100 DIM BE(N),S(N),P(N)
110 PRINT "ENTER MATRIX OF INTERCOMPARTMENTAL RATE"
115 PRINT "COEFFICIENTS -- ROW BY ROW, ONE COLUMN AT A TIME."
120 FOR I= 0 TO N
125 FOR J= 0 TO N:INPUT A(I,J):NEXT J
130 NEXT I
135 PRINT "ENTER INITIAL COMPARTMENT VALUES"
140 FOR I= 0 TO N:INPUT XX(0,I):NEXT I
145 PRINT "ENTER YOUR MATRIX OF ENVIRONMENTAL INPUT"
146 PRINT "COEFFICIENTS"
150 FOR I= 0 TO N
155 FOR J= 0 TO NN:INPUT B(I,J):NEXT J
160 NEXT I
165 PRINT "ENTER THE SIZES OF YOUR ENVIRONMENTAL INPUTS"
170 FOR J= 0 TO NN:INPUT Z(J):NEXT J
175 PRINT "ENTER THE NUMBER OF ITERATIONS OF THE ALGORITHM"
176 PRINT "BEFORE INTEGRATION COMPLETION.":INPUT KK
180 REM ***** STORE INITIAL COMPARTMENT VALUES *****
185 FOR J= 0 TO N:X(J)= XX(0,J):NEXT J:PLOT 12
190 REM ***** START SIMULATION *****
195 FOR IJ= 1 TO 100
200 DT= 1/ KK
205 REM ***** START ITERATIVE INTEGRATION LOOP *****
210 FOR JJ= 1 TO KK
215 REM ***** START RUNGA-KUTTA INTEGRATION *****
217 REM ** COMPUTE DX/DT AT TIME J-1 **
220 FOR I= 0 TO N
221 XD(I)= 0
225 FOR J= 0 TO N:XD(I)= XD(I)+ A(I,J)* X(J):NEXT J
230 FOR K= 0 TO NN:XD(I)= XD(I)+ B(I,K)* Z(K):NEXT K
231 NEXT I
240 REM ** COMPUTE FIRST ESTIMATE OF STATE(P) AT TIME IJ-1/2 **
245 FOR I= 0 TO N:AX(I)= X(I)+ (DT/ 2)* XD(I):NEXT I
250 REM ** COMPUTE DX/DT AT P **
255 FOR I= 0 TO N
256 XP(I)= 0
260 FOR J= 0 TO N:XP(I)= XP(I)+ A(I,J)* AX(J):NEXT J
261 FOR K= 0 TO NN:XP(I)= XP(I)+ B(I,K)* Z(K):NEXT K
265 NEXT I
270 REM ** MAKE SECOND ESTIMATE OF STATE(Q) AT TIME IJ-1/2 **
275 FOR I= 0 TO N:AX(I)= X(I)+ (DT/ 2)* XP(I):NEXT I
280 REM ** COMPUTE DX/DT AT Q **

```

Listing 2 continued on page 84

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Listing 2 continued:

```

285 FOR I= 0 TO N
286 XX(I)= 0
290 FOR J= 0 TO N:XX(I)= XX(I)+ A(I,J)+ AX(J):NEXT J
300 FOR K= 0 TO NN:XX(I)= XX(I)+ B(I,K)+ Z(K):NEXT K
310 NEXT I
320 REM ** MAKE ESTIMATE OF STATE(R) AT TIME J **
330 FOR I= 0 TO N:AX(I)= X(I)+ DT+ XX(I):NEXT I
335 REM ** COMPUTE DX/DT AT R **
340 FOR I= 0 TO N
344 XR(I)= 0
345 FOR J= 0 TO N:XR(I)= XR(I)+ A(I,J)+ AX(J):NEXT J
350 FOR K= 0 TO NN:XR(I)= XR(I)+ B(I,K)+ Z(K):NEXT K
355 NEXT I
360 REM ** COMPUTE FINAL VALUES FOR STATE AT TIME J **
364 FOR I= 0 TO N:X(I)= X(I)+ DT+ (X(I)/ 6+ XP(I)/ 3+ XR(I)/ 3+
XR(I)/ 6):NEXT I
370 NEXT J
375 REM ** STORE COMPARTMENT SIZES AT TIME J IN MATRIX **
380 FOR I= 0 TO N:XX(I,J)= X(I):NEXT I
385 REM ***** END OF ITERATIVE INTEGRATION LOOP *****
390 NEXT I,J
395 REM ***** END OF SIMULATION *****
405 REM ***** START OUTPUT *****
409 PLOT 12
410 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+ 1
415 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
"
420 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
421 PRINT "INTEGRATION WAS: ";KK
425 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS
: "
430 PRINT
435 FOR I= 0 TO N
440 FOR J= 0 TO N:PRINT TAB( J+ 10);A(I,J);:NEXT J:PRINT :PRINT
445 NEXT I
450 PRINT :PRINT
455 PRINT "TO SEE A GRAPH OF THE SIMULATION, ENTER CONT AND"
460 PRINT "HIT THE RETURN KEY."
500 END
610 FOR I= 0 TO N:BB(I)= XX(0,I):S(I)= XX(0,I):NEXT I
620 FOR J= 0 TO N
630 FOR I= 1 TO 100
640 IF BB(J)> XX(I,J) THEN 660
650 BB(J)= XX(I,J)
660 IF S(J)< XX(I,J) THEN 680
670 S(J)= XX(I,J)
680 NEXT I
690 NEXT J
830 REM ***** END OF SEARCH *****
860 FOR I= 0 TO N:P(I)= 99.0/ (BB(I)- S(I)):NEXT I
870 REM ***** SCALE VALUES CALCULATED *****
880 PLOT 12,30,16,29,23
890 PLOT 2,26,25,242,127,25,255
900 PLOT 2,26,26,242,26,127,255
910 FOR I= 0 TO N
920 PLOT 15,17+ I,3,(I+ 10+ 13),30
930 PRINT "CMPT";SPC( 1);I+ 1
931 NEXT I
950 PLOT 15,23,3,32,28
960 PRINT "TIME (USER UNITS)";
970 PLOT 3,13,27
980 PRINT "0"
990 PLOT 3,36,27
1000 PRINT "50"
1010 PLOT 3,61,27
1020 PRINT "100"
2000 FOR I= 0 TO N
2010 PLOT 15,17+ I,3,0,I
2020 PRINT BB(I):NEXT I
2030 FOR I= 0 TO N
2040 PLOT 15,17+ I,3,0,I+ 22
2050 PRINT S(I):NEXT I
2060 FOR J= 0 TO N
2070 FOR I= 0 TO 100:XX(I,J)= (XX(I,J)- S(J))+ P(J)+ 1:NEXT I
2080 NEXT J
2105 REM ***** START PLOT OF OUTPUT MATRIX *****
2110 FOR J= 0 TO N
2120 PLOT 17+ J,2,26,XX(0,J)+ 26,255
2130 FOR I= 1 TO 100

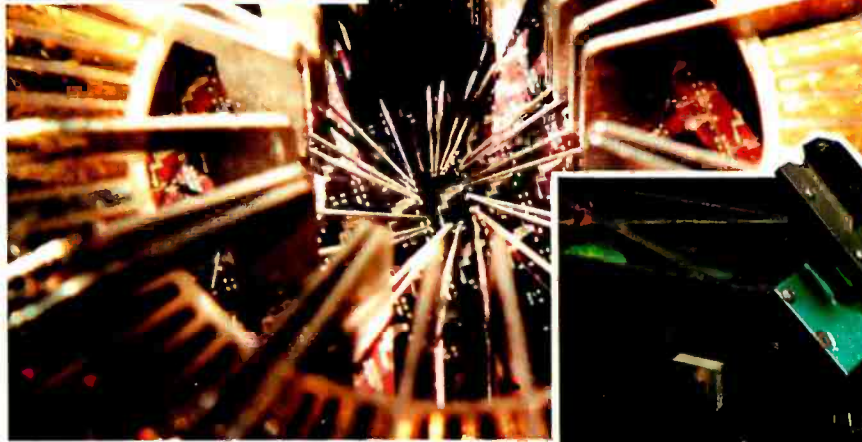
```

Listing 2 continued on page 86

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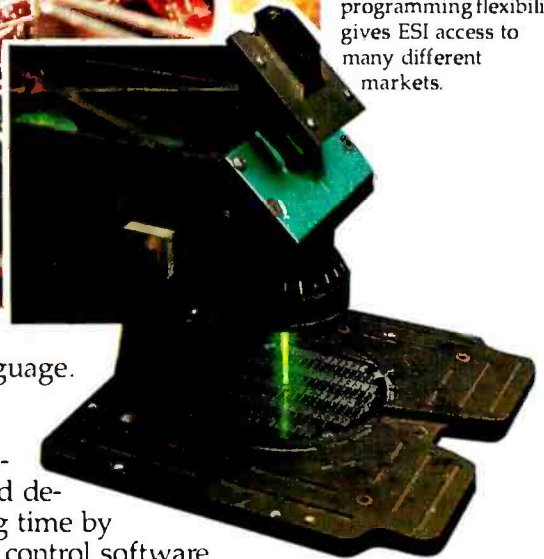
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Left: Pascal-1 controls ESI's laser trimming system. The laser repairs semiconductor memory chips, replacing faulty cells with alternates.

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Listing 2 continued:

```
2140 PLOT Z,(I- 1)+ 27,XX((I- 1),J)+ 27,253,(I- 1)+ 27,XX((I- 1)
,J)+ 27,I+ 27,XX(I,J)+ 27,255:NEXT I
2150 NEXT J
9999 END
READY
```

Text continued from page 80:

desired time step. The program will then simulate the system of compartments for 100 time units and plot a graph of the compartments versus time. To graph the compartment sizes, you must scale the simulation values and plot them on some output device. I have included code for this in listing 2, which will run unmodified on a CompuColor II microcomputer. If you intend to run this program on another computer, check to see if Disk BASIC 8001 coding is compatible with your system. See table 1 for information on the CompuColor PLOT command.

Using the GLM Program

When the Okefenokee swamp uplands hydrologic model is simulated with this program on a microcomputer (on an 8080 microprocessor), the execution time of the Runge-Kutta algorithm is 210 seconds. When Euler's method is used, the execution time is reduced to 51 seconds. This time savings can be beneficial, depending upon the computational accuracy of the microprocessor and systems software. It can be cost-effective to use the Euler algorithm if the computer computational error is larger than the difference in the error between the Euler and Runge-Kutta methods. To give you an idea of the memory requirements necessary for a simulation, the hydrologic model can be simulated with the program in listing 2 if your microcomputer has 8 K bytes of programmable memory.

You can solve the system of linear differential equations for the size of any compartment at any time t . When inputs (Z), rate (a_{ij}) and input (b_{ik}) coefficients are constant, and t is initially equal to 0, the solution is:

$$x_i(t) = e^{\lambda_i t} x_i(0) + \left(\sum_{k=1}^m b_{ik} z_k \right) \int_0^t e^{\lambda_i(t-t')} dt'$$

zero-input response	zero-state response
------------------------	------------------------

where:

- λ_i = eigenvalue of compartment i
- = a_{ii} + behavior caused by intrasystem coupling

This is the general solution of the ordinary differential equations in the linear model. The solution has two distinct parts, which I call the zero-input response and the zero-state response. If you eliminate the zero-state response, then the solution of the equation will give you the values of each compartment when the system does not receive any environmental input (Z). This can be simulated by changing all the input coefficients (b_{ik}) to 0. In the case of the hydrologic model, you would, in effect, be asking, "How is the moisture in each compartment affected if there is no precipitation input?"

You can eliminate the zero-input response from the equation and ask, "How long would it take the system to

come to steady-state conditions if there were no moisture within the system to begin with?" This would be simulated by setting the initial compartment values (x_i) to 0. Photo 1 shows the zero-input response of the hydrologic model simulated with the program in listing 2. Photo 2 shows the zero-state response of the hydrologic model simulated with the same program.

You can start the simulation with different compartment sizes, a different environmental input size, or change the intercompartmental rate or input coefficients, and see how any or all of these changes will affect the outcome. I suggest that you devise a model that can be described with linear differential equations and simulate it at steady-state conditions. A good domestic simulation would be a model of heat losses, subsidies, and circulation within your home. If you have a slant toward business, you can simulate the flow of material or information into, within, and out of a commercial enterprise. As long as all the compartments and flows can be described in the same units, almost any type of measure can be simulated. Once you have completed the steady-state simulation, you can experiment with the GLM program to suit your taste. If you want to make the model more realistic, you can program the inputs to the system as sine waves, square waves, exponential functions, or an impulse function, instead of being constantly added as they are now. You can also test a compartment's sensitivity to a certain parameter by varying that parameter over its range and noting the differences in the compartment.

One warning: you must always be careful to analyze your simulations and decide if they actually mimic the real-world situation *before* you make sweeping generalizations and claims that you can predict how a system will behave under any given set of circumstances. With a little imagination, interesting and sometimes eye-opening results will be seen in mathematical simulations. ■

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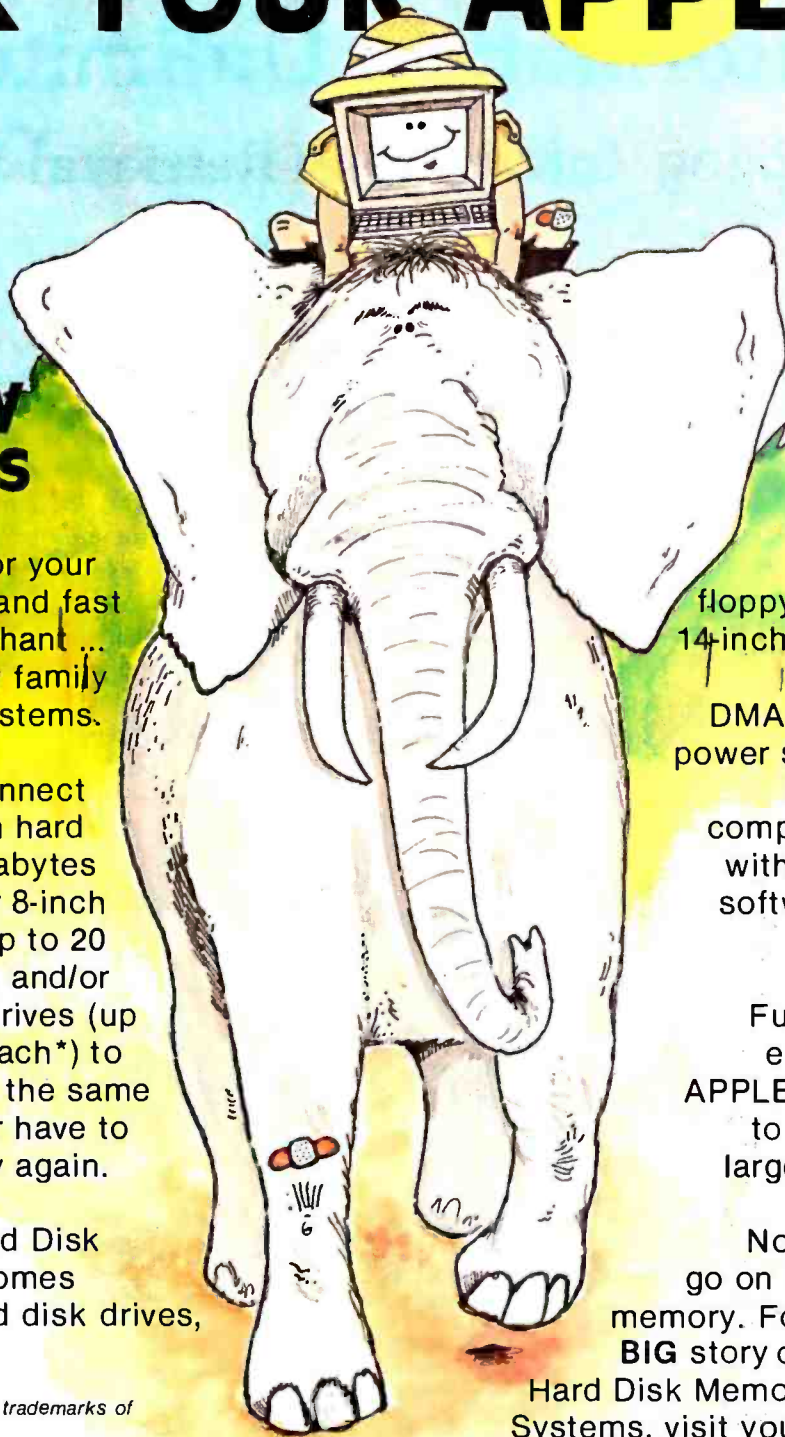
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When speaking of the amount of information available on the Dialog system, the numbers become mind-boggling. Dialog has some 50 billion bytes of information available on-line in some 130 individual data bases. That works out to a rough total of about forty million individual bibliographic abstracts and references (referred to as citations). If all the citations were printed on 8½-by-11-inch paper, the stack would reach higher than the Empire State building.

The newspaper and magazine indexes are among the most popularly oriented data bases—although Dialog also offers a number of specialized data bases for those in education, industry, applied science and technology, and social science and the humanities. Business information and forecasts are also available. Eighteen new data bases were added to the system in 1980, and at least a dozen more will be available by the end of the year. The system is available 110 hours a week in fifty countries, and all data bases are updated regularly. Each day tens of thousands of new citations are added. Also, if you wish to create your own private data bases for use on the system, Dialog provides this service.



Photo 1: The Lockheed Dialog computer room operator station. The system uses two mainframe computers—an IBM 3033 and an AS-9000 (sold in the United States by National Advanced Systems). Each computer contains a complete Dialog operating system; one handles Telenet calls, and the other Tymnet. Direct dial-in calls and leased lines are divided between the computers to even the loads. Because of the large amount of computer power available, the average wait for a response to a query is ten seconds—despite the fact that hundreds of users may be logged in during peak-use periods.

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Type-'N-Talk™ adds a whole new world of speaking roles to your computer. You can program verbal reminders to prompt you through a complex routine and make your computer announce events. In teaching, the computer with Type-'N-Talk™ can actually tell students when they're right or wrong — even praise a correct answer. And of course, Type-'N-Talk™ is great fun for computer games. Your games come to life with spoken threats of danger, reminders, and praise. Now all computers can speak. Make yours one of the first.

Text-to-speech is easy.

English text is automatically translated into electronically synthesized speech with Type-'N-Talk™ ASCII code from your computer's keyboard is fed to Type-'N-Talk™ through an RS 232C interface to generate synthesized speech. Just enter English text and hear the verbal

response (electronic speech) through your audio loud speaker. For example: simply type the ASCII characters representing "h-e-l-l-o" to generate the spoken word "hello."

TYPE-'N-TALK™ has its own memory.

Type-'N-Talk™ has its own built-in microprocessor and a 750 character buffer to hold the words you've typed. Even the smallest computer can execute programs and speak simultaneously. Type-'N-Talk™ doesn't have to use your host computer's memory, or tie it up with time-consuming text translation.

Data switching capability allows for ONLINE usage.

Place Type-'N-Talk™ between a computer or modem and a terminal. Type-'N-Talk™ can speak all data sent to the terminal while online with a computer. Information randomly accessed from a data base can be verbalized. Using the Type-'N-Talk™ data switching capability, the unit can be "de-selected" while data is sent to the terminal and vice-versa — permitting speech and visual data to be independently sent on a single data channel.

Selectable features make interfacing versatile.

Type-'N-Talk™ can be interfaced in several ways using special control characters. Connect it directly to a computer's serial interface. Then a terminal, line printer, or additional Type-'N-Talk™ units can be connected to the first Type-'N-Talk™, eliminating the need for additional RS-232C ports on your computer.

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Type-'N-Talk™ is covered by a limited warranty. Write Votrax for a free copy.

At first glance, Dialog seems expensive. Each data base has an individual charge ranging from \$15 to \$300 per hour of connect time. (It should be stressed that the most-used data bases cost an average of \$50 an hour.) The cost becomes much more reasonable when you realize that an exhaustive search of any subject can be completed in an average of ten minutes. (Simple searches often take only a minute or two.) In addition, Dialog's response time is extremely fast because of the computer power available. Even during peak-use times, there is seldom a wait of more than ten seconds for the system to respond to a query.

It should be stressed that there are dangers inherent in using the Dialog system—especially if you're an "information junkie." It's extremely easy to become so enamored of Dialog's capabilities that you keep on calling up references and lose all track of time. The shock comes at the end of the month, when a very large bill arrives in the mail.

There are two ways to avoid this: the first is to *plan* what you'll be doing when you're logged on the system (explained in more detail below). The second is to keep track of your connect charges. Each time you log off or change data bases, Dialog prints an estimated charge. It's a good idea to keep a pad and a pencil next to your terminal and to keep a running total of charges at the end of every session.

Once you locate what you want, you can have the references and abstracts typed on your printer, although

this can get expensive at the normal speed of 300 bps (bits per second). A better way is to have the citations printed by Dialog's off-line high-speed printer. The cost is minimal (normally \$0.10 to \$0.25 per citation) and they are mailed out the next day. Or, as mentioned above, you can order actual reprints directly from your terminal.

Dialog History

Dialog started modestly as an in-house research and development project at Lockheed in 1963. At that time, an information sciences laboratory was established to deal with what was then recognized as the coming "information explosion." Two years later, what was essentially the first truly interactive information retrieval system was on-line for internal company use.

In 1968, Lockheed won a contract from NASA to design, program, implement, and maintain a computerized index for the half-million documents produced by the American space program. Called RECON (Remote Console Information Retrieval Service), the development process enabled Lockheed to fine-tune the specialized information retrieval command language, which was called Dialog.

After gaining more experience preparing information retrieval systems for the AEC (Atomic Energy Commission), the US Office of Education, and a number of other organizations, Lockheed, in 1972, decided to offer commercial service and officially named the system Dialog.

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Photo 2: Some of the 200 hard-disk drives used by the Dialog system. Most of the CDC (Control Data Corporation) drives hold 637 megabytes of data for a total of more than 50 billion bytes of on-line storage.



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- comprehensive shell command language

UniFLEX, structured for large-scale microprocessor systems, will not run with minimal systems and thus has avoided design compromise. (Off-the-shelf versions and OEM licenses are available.)

The FLEX™ Operating System

FLEX, a powerful, easy-to-use operating system designed for the 6800 and 6809 microprocessors, includes:

- dynamic filespace allocation
- random files
- batch job entry
- automatic space compression
- English error messages
- user environment control
- disk resident commands
- flexible device I/O
- printer spooling

Plus, FLEX can accommodate hard disks as well as floppies. The System is available off-the-shelf for a variety of systems and in a field-adaptable version. (OEM licenses available.)

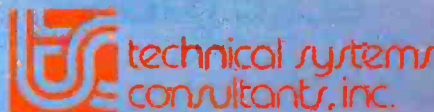
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Sculpture by Joann Chaney

Industrial users continue to be Dialog's largest customers since much of the information in the specialized data bases (such as WORLD ALUMINUM ABSTRACTS or SURFACE COATING ABSTRACTS) is virtually unavailable anywhere else. Government agencies are also heavy users of Dialog's services—followed closely by educational institutions and libraries. Although personal computer users currently make up a very small percent-

age of Dialog customers, Lockheed officials told me they are in the process of adding more general-interest data bases to attract more individuals.

A Visit to Dialog

Dialog's facilities are located in Palo Alto, California. As might be expected, the hardware needed to handle the enormous amount of information contained within the Dialog system has taken over a large portion of its building. For those used to working with a personal computer and a floppy disk or two, a visit to Dialog's computer room is a humbling experience. Two mainframe computers (an IBM 3033 and an AS-9000) are both on-line at all times. When I visited Dialog in January, the AS-9000 had just been put on-line. This so-called "super-mainframe" is sold in the United States by National Advanced Systems. Since its claimed speed far exceeds that of any other mainframe, a Dialog spokesman told me he expects it to greatly increase the system's capacity.

The most interesting part of Dialog's facilities are the hard-disk drives—some 200 of them. Most are CDC (Control Data Corporation) units capable of storing 637 megabytes per drive. Although direct dial-up numbers are available, the majority of Dialog users access the system through Tymnet or Telenet (national data-communication networks that have local telephone numbers in many communities).

Lockheed officials term Dialog a value-added on-line service supplier. All of the approximately 130 data bases are put together by seventy data base producers who have contractual agreements with Dialog. The process of producing and updating each of the data bases is a large one involving literally thousands of people who review publications, journals, and newspapers—many on a daily basis. Many reviewers work at home and transfer their citations to floppy disks, which are sent to the data base producers. The final step is to transfer all the citations to IBM magnetic tape. Between ten and twenty of these tapes, each containing about 20,000 new citations, arrive at Dialog headquarters every day. Before the information is added to the system, every word in all citations is indexed. This is one of the most powerful searching features of the system.

Popular Data Bases

Although many of Dialog's data bases are extremely specialized (such as AQUACULTURE, BHRA FLUID ENGINEERING, or PHARMACEUTICAL NEWS INDEX), a number of the existing data bases are of general interest or of special significance to BYTE readers. Among them are:

- ERIC — One of the first Dialog data bases available, ERIC (Educational Resources Information Center) indexes some 700 publications of interest to every segment of the educational profession. About 3000 citations are added every month.
- COMPENDEX — This data base contains abstracted information from approximately 2000 of the world's



Photo 3: IBM reel-to-reel tape with new and updated data waiting to be placed on the Dialog system. Some twenty tapes arrive at Dialog each day from the outside organizations that prepare the data bases. Each tape contains approximately 20,000 individual references and/or abstracts.

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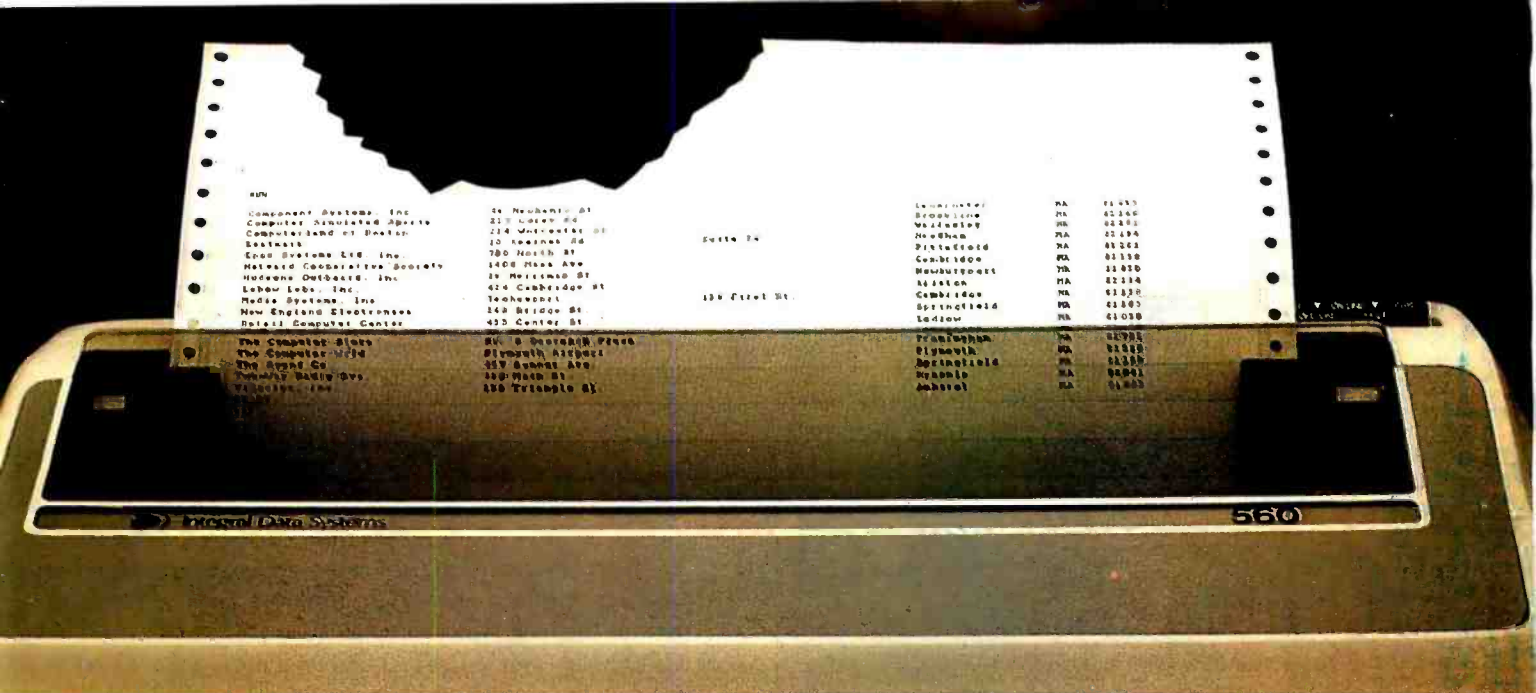
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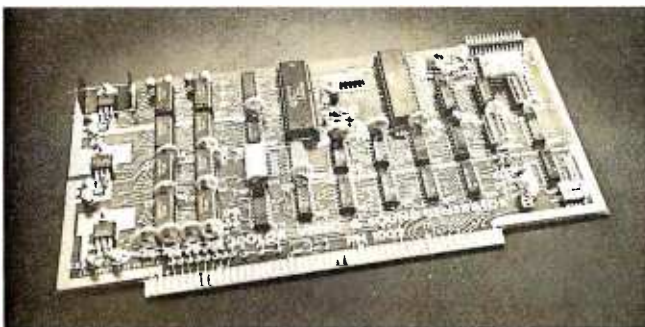
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- **ABI/INFORM** — This data base contains management and administration abstracts from some 400 business-related publications.
- **SCISEARCH** — This is an index to approximately 2600 scientific and technical publications since 1974.



Photo 4: IBM reel-to-reel tape drives used to load new and updated information into the Dialog disk drives.



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- **MAGAZINE INDEX** — Perhaps the most popularly oriented Dialog data base, this is a cover-to-cover index of about 370 popular American magazines since 1976 and contains some 300,000 citations. It's particularly useful for most general-purpose reference questions since it indexes all articles, news reports, editorials, product evaluations, biographical pieces, short stories, poetry, recipes, and reviews. Approximately 5000 citations are added to this data base monthly.
- **SSIE CURRENT RESEARCH** — Compiled by the Smithsonian Science Information Exchange, this data base lists and summarizes most government-funded research projects either in progress or completed within the past two years.
- **GPO MONTHLY CATALOG** — This is the catalog (updated monthly) of US government publications.
- **ENERGYLINE** — This data base contains bibliographical citations as well as abstracts on all aspects of energy.
- **CONFERENCE PAPERS INDEX** — This is an index to meetings and symposia on all scientific and technical fields. Also included are references to conference papers (many of which have never been published). This is a very large data base to which about 10,000 citations are added each year.
- **NATIONAL FOUNDATIONS** — This lists all US private foundations that award grants for charitable purposes.
- **DISCLOSURE** — This data base, updated weekly, provides extracts of reports filed with the SEC (Securities and Exchange Commission) by all publicly owned companies in the United States.
- **NATIONAL NEWSPAPER INDEX** — This data base contains front-to-back indexing of *The New York Times*, *The Wall Street Journal*, and *The Christian Science Monitor* since January 1, 1979. It contains bibliographical references to everything included in the papers, with the exception of advertisements, weather charts, stock market tables, crossword puzzles, and horoscopes. About 15,000 new citations are added monthly.
- **NEWSEARCH** — This is a *daily* update of the **MAGAZINE INDEX**, **MANAGEMENT CONTENT**, the **LEGAL RESOURCE INDEX**, and the **NATIONAL NEWSPAPER INDEX**; it is invaluable for locating references within days of an article's appearance.
- **ENCYCLOPEDIA OF ASSOCIATIONS** — This data base contains detailed information on approximately 15,000 national nonprofit organizations. Included are listings for professional societies, trade associations, labor unions, and cultural and religious organizations.
- **STANDARD AND POOR'S NEWS** — Provides extensive news coverage as well as financial reports on

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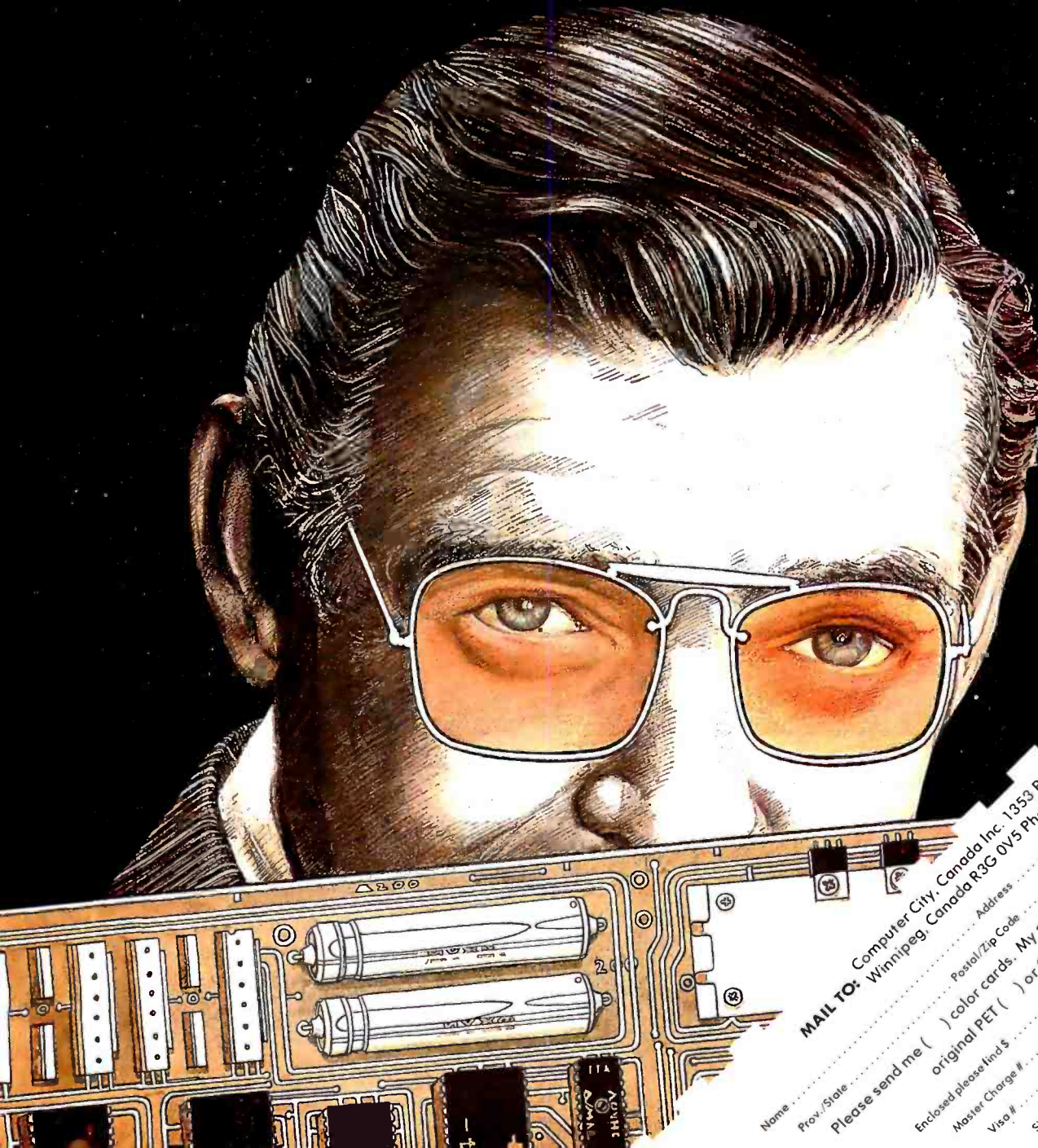
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Photo 5: The Xerox 9700 high-speed printer used by Dialog for off-line printing of references. The printer operates at two pages a second and offers Dialog users a considerable savings over having their references printed out while logged onto the system. The average cost of having references printed off-line and mailed to you is \$0.10 to \$0.25 per citation.



Photo 6: Dialog's customer-service area, where specially trained personnel are available to offer advice. They can be reached by calling a toll-free number.

over 9000 companies. This data base is the equivalent of the Standard and Poor's *Daily News* and *Cumulative News* and often features full-length news stories.

- DIALINDEX — This is perhaps the most useful of the Dialog data bases and contains a collection of the file indexes for *all* data bases. DIALINDEX is a low-cost data base that allows you to ascertain which data bases contain the information you're searching for.
- NTIS — Compiled by the National Technical Information Service of the US Department of Commerce, this data base contains citations to more than 700,000 US reports covering government-sponsored research and development and engineering. Information on almost any subject imaginable is contained within this massive data base.

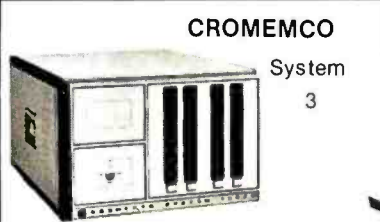
In addition, there are data bases covering psychology, chemistry, agriculture, medicine, biology, physics, and many other fields and disciplines. Dialog provides a free catalog of all the available data bases.

The Dialog staff and data base producers are continually adding new data bases to the system. By the end of this year, plans call for the addition of a biography index with over five million names, a book review index, an index of the Congressional Record, the Federal Index, a grants index, data from the Bureau of Labor Statistics, and Medline (a medical information data base designed for both physicians and consumers).

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PTS FEDERAL INDEX	SCIENCE	SURFACE COATINGS ABSTRACTS
	AQUACULTURE	TRIS (Transportation)
	AQUALINE	WELDSEARCH
	AQUATIC SCIENCES & FISHERIES ABSTRACTS	WORLD ALUMINUM ABSTRACTS
	BIOSIS PREVIEWS (Life Sciences)	WORLD TEXTILE ABSTRACTS
	CHEMICAL ABSTRACTS GROUP	
	CA SEARCH	

Figure 1: Available Dialog data bases as of February 1981. Eighteen new data bases were added to the system in 1980; about a dozen more are planned to be operational by the end of 1981.

have been provided with a password, the easiest means of accessing the system is through either the Tymnet or Telenet networks. Currently, Tymnet charges \$8 per hour and Telenet charges \$5 per hour. The network connect charges are added to your Dialog monthly statement. (At the present time, Dialog bills monthly, but it is studying the possibility of billing through charge cards.) Dialog provides a list of telephone numbers and passwords/access numbers for both networks. If you have to make a toll call to access the networks, that's an addi-

tional charge. This expense is minimized, of course, for subscribers in Dialog's local area or those who have access to WATS (wide-area telephone service) lines. There are also direct-access lines to Dialog and incoming WATS lines are available at \$15 per month.

Using Dialog

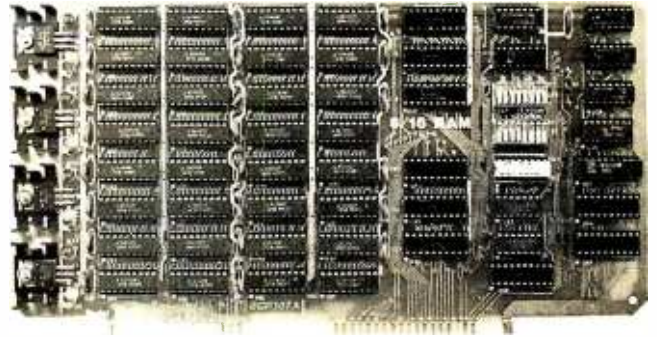
There are a number of levels at which the Dialog system can be used. Most of the time, you'll find a simple search with a couple of terms the easiest way to go. A

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16K BYTE 8/16 RAM

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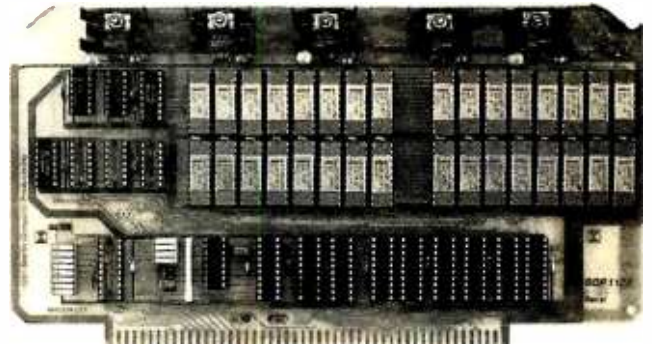
OTHER RAM SAVINGS

16K PLUS RAM—this fully static RAM has become the standard of the industry. It features 200 nsec. chips and Cromemco style bank select using port 40H. Addressable to any continuous 16K on 4K boundaries. Any 4K block may be disabled. High reliability, low noise design. Prices: 1-9, \$280; 10-19, \$260.

16K STANDARD RAM—this fully static RAM is frequently used by OEMs in systems which do not require bank select. High reliability, low noise circuits. Uses 200 nsec. chips. Addressable to any continuous 16K on 4K boundaries. Any 4K block may be disabled. Prices: 1-9, \$265; 10-19, \$245.

64K STATIC 8/16 RAM

AVAILABLE JULY 6—This state-of-the art board uses 2167 16K static 70/100 nsec. chips in a "power down" mode. This means you can expect the first 64K in a system to use 1.6 amps with subsequent boards using about .8 amps each. Built for the same high reliability you have come to expect from using our other boards. Has 24-bit extended addressing which can be disabled. Initial quantities will be limited—reserve yours now to ensure early delivery. Prices: 1-9, \$1295; 10-19, \$1195.



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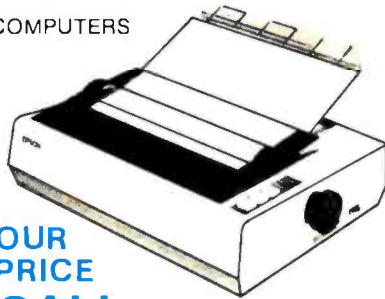
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Super Breakout	30
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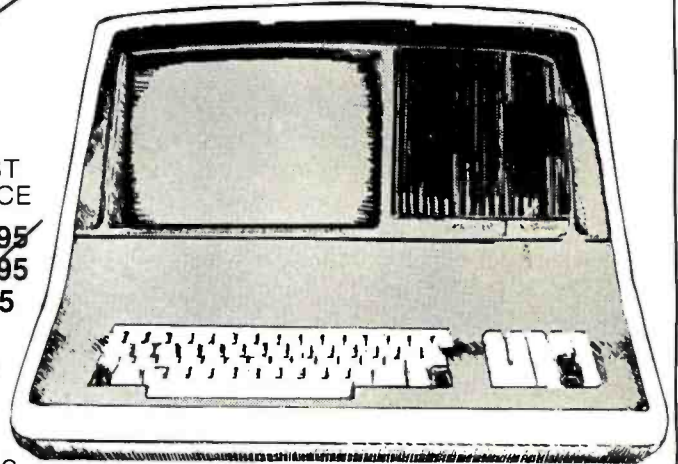
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PRICE

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Integer Basic Firmware Cd.	149
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CCS Parallel Print Cd. 7720A	155
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Assembled & Tested	189
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Apple Stellar Invaders	19	Forth II by Softape	45
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Applebug Debugger	29	Head-on	25
AppleGraph & Plot Sys.	59	Integer Basic Cassette Demos	29
Applepost Mailing List Sys.	44	Lazer Systems Lower Case + Plus ...	59
Applesoft Cassette Demos	29	Microsoft 16K Ramcard	179
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CCA Data Mgmt. Sftwe.	84	Package for Apple	
3-D Animation Pack	55		
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DOS Tool Kit	65		

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number of advanced searching functions are available; however, they probably won't be needed until you have quite a bit of experience on the system. Dialog's searching commands are simple, straightforward, and easy to learn. Dialog representatives do offer formal training classes on a regularly scheduled basis at locations

throughout the country. However, they're mainly designed for those with no computer experience and those who will be using Dialog as a regular part of their job (such as librarians). New users are given some free time on the system in order to have an opportunity to get a feel for how Dialog works.

Text continued on page 106

Listing 1: A typical search on the Dialog Information Retrieval Service—using the MAGAZINE INDEX data base. For the most efficient use of the system, as well as lower cost to the user, the search strategy (steps) should be planned on paper before logging in. See the text box of Basic Dialog Commands for a summary of the Dialog language. A SELECT statement can be up to 240 characters (when Boolean operators are used). Each search can create up to 98 sets, and there is a limit of one million citations per search.

```

Dialog system prompt
? SELECT COMPUTER?
  1  4251  COMPUTER?
Number of citations
Set number

? SELECT MICROCOMPUTER?
  2  308 MICROCOMPUTER?
Indicates the two terms must be adjacent to one another in the index

? SELECT STEPS PERSONAL(W)COMPUTER? OR MHOME(W)COMPUTER?
  3  122 PERSONAL(W)COMPUTER?
  4   85 HOME(W)COMPUTER?
  5  185 3 OR 4
Previously selected set number

? SELECT S5 AND JN =BYTE
      824 JN=BYTE
      6  20  S5 AND JN=BYTE
Journal name (special index field)
Set number
Format number

? TYPE 6/ 1/ 1
6/1/1
1536795
Set Item number
Dialog reference number

? TYPE 6/2/1
6/2/1
1536795
FCC regulation of personal- and home-computing devices. (Federal
Communications Commission)
Mahn, Terry G.
Byte v5 p180(7) Sept 1980 CODEN: BYTEDJ
DESCRIPTORS: United States. Federal Communications Commission-rules and
regulations; computers-rules and regulations
IDENTIFIERS: personal computers-rules and regulations

? TYPE 6/3/1
6/3/1
1536795
FCC regulation of personal- and home-computing devices. (Federal
Communications Commission)
Mahn, Terry G.
Byte v5 p180(7) Sept 1980 CODEN: BYTEDJ

? TYPE 6/4/1
6/4/1
1536795

```

Listing 1 continued on page 104

You'll be a little richer after building one of these.

H-19 Professional Video Terminal



H-8 Personal Computer with Dual Floppy Disk Storage



H-11A 16-Bit Computer with Dual Floppy Disk Storage



H-89 All-In-One Computer with Floppy Disk Storage



H-14 Serial Printer



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(In Canada write Heath Company, 1480 Dundas St. E., Mississauga, Ont. L4X 2R7)

Listing 1 continued:

FCC regulation of personal- and home-computing devices. (Federal Communications Commission)

? TYPE 6/3/1-20

6/3/1

1536795

FCC regulation of personal- and home-computing devices. (Federal Communications Commission)

Mahn, Terry G.

Byte v5 p180(7) Sept 1980 CODEN: BYTEDJ

6/3/2

1522838

The Heath H-89 computer. (evaluation)

Dahmke, Mark

Byte v5 p46(6) Aug 1980 CODEN: BYTEDJ

illustration

6/3/3

1508584

Bills introduced in Congress. (dealing with personal computers)

6)

Byte v5 p186(6) June 1980 CODEN: BYTEDJ

6/3/4

1508580

A personal computer on a student's budget.

Johnston, J.C.

Byte v5 p138(6) July 1980 CODEN: BYTEDJ

illustration

.....

.....

6/3/17

1017592

User's report: the PET 2001. (evaluation)

Fylstra, Dan

Byte v3 p114(9) March 1978

6/3/18

1017578

Personal computers in a distributed communications network.

Steinwedel, Jeff; S

Byte v3 p80(8) Feb 1978

6/3/19

1017469

Speech recognition for a personal computer system.

Boddie, James R.

Byte v2 p64(7) July 1977

6/3/20

1017464

Personal computer network.

Byte v2 p59(2) Sept 1977

? END/SAVE

Serial# 4QDI

Serial number of search strategy (steps used)

Listing 1 continued on page 106

POWER-ONE D.C. POWER SUPPLIES

Our customers select their favorite models




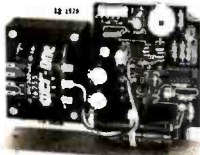
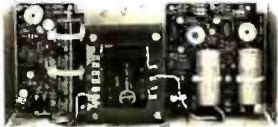



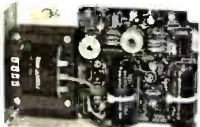
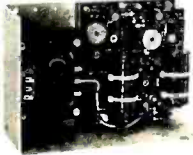
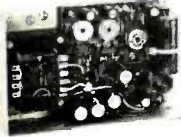


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<p>Disk-Drive</p> <ul style="list-style-type: none"> • Powers Most Popular Drives • 7 "Off the Shelf" Models • Powers Drives & Controller • UL & CSA Recognized • 115/230 VAC Input 	<p>5 1/4" FLOPPY SUPPLIES</p>  <p>CP340, 1 Drive : \$44.95 CP323, Up to 4 Drives : \$74.95</p>	<p>8.0" FLOPPY SUPPLIES</p>  <p>CP205, 1 Drive : \$69.95 CP206, 2 Drives : \$91.95 CP162, Up to 4 Drives : \$120.00</p>	<p>WINCHESTER SUPPLIES 2 Models to Power any Manufacturer's Drive</p>  <p>CP379, CP384 : \$120.00</p>
<p>Open-Frame Linear</p> <ul style="list-style-type: none"> • Industry Standard Packages • 115/230 VAC Input • ±.05% Regulation • Two Year Warrantee • UL & CSA Recognized • Industry's Best Power/Cost Ratio 	<p>SINGLE OUTPUT</p>  <p>5V @ 3A 24V @ 1.2A 12V @ 1.7A 28V @ 1.0A 15V @ 1.5A 250V @ 0.1A</p> <p>HB Series : \$24.95</p>	<p>SINGLE OUTPUT</p>  <p>5V @ 6A 24V @ 2.4A 12V @ 3.4A 28V @ 2.0A 15V @ 3.0A 48V @ 1.0A</p> <p>HC Series : \$44.95 to \$49.95</p>	<p>DUAL OUTPUT</p>  <p>± 12V @ 1.0A or ± 15V @ 0.8A</p> <p>HAA15-0.8 : \$39.95</p>
<p>DUAL OUTPUT</p>  <p>± 12V @ 1.7A or ± 15V @ 1.5A</p> <p>HBB15-1.5 : \$49.95</p>	<p>TRIPLE OUTPUT</p>  <p>5V @ 2A ± 9V to ± 15V @ 0.4A</p> <p>HTAA-16W : \$49.95</p>	<p>TRIPLE OUTPUT</p>  <p>5V @ 3A ± 12V @ 1A or ± 15V @ 0.8A</p> <p>HBAA-40W : \$69.95</p>	<p>POWER FAIL MONITORS</p>  <ul style="list-style-type: none"> • Indicates pending system power loss. • Monitors AC line and DC outputs. • Allows for orderly data-save procedures <p>PFM-1 : \$24.95 PFM-2 : \$39.95</p>



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POWER-ONE
D.C. POWER SUPPLIES



Listing 1 continued:

```
? BEGIN 111 _____ Dialog file number
File111:National Newspaper Index
(Copr. IAC)
Set Items Description (+=OR;*=AND;-=NOT)
-----
```

```
? .EXECUTE 4QDI _____ Execute previous search strategy
1588 COMPUTER?
7 MICROCOMPUTER?
23 PERSONAL(W)COMPUTER?
19 HOME(W)COMPUTER?
35 3 OR 4
0 JN=BYTE
```

```
? BEGIN 47
File47*:Magazine Index -
(Copr. IAC)
Set Items Description (+=OR;*=AND;-=NOT)
-----
```

```
? EXPAND COMPUTER _____ Find all index terms alphabetically close to specified term
```

Ref	Index-term	Type	Items	RT
E1	COMPUTATIONAL COMPLEXITY		1	
E2	COMPUTATIONS-----		1	
E3	COMPUTE-----		4	
E4	COMPUTED-----		3	
E5	COMPUTEK-----		2	
E6	--COMPUTER-----		3228	
E7	COMPUTER AIDED DESIGN----		24	
E8	COMPUTER AND BUSINESS EQUIPMENT MANUFACTUR--		2	
E9	COMPUTER AND COMMUNICATI ONS ASSOCIATION-----		1	
E10	COMPUTER AND COMMUNICATI ONS INDUSTRIES ASS----		1	
E11	COMPUTER AND SYSTEMS ENGINEERING LTD.-----		1	
E12	COMPUTER ANIMATION-----		5	
E13	COMPUTER APPLICATIONS CORP.-----		2	
E14	COMPUTER ARCHITECTURE----		2	

Text continued from page 102:

Searching

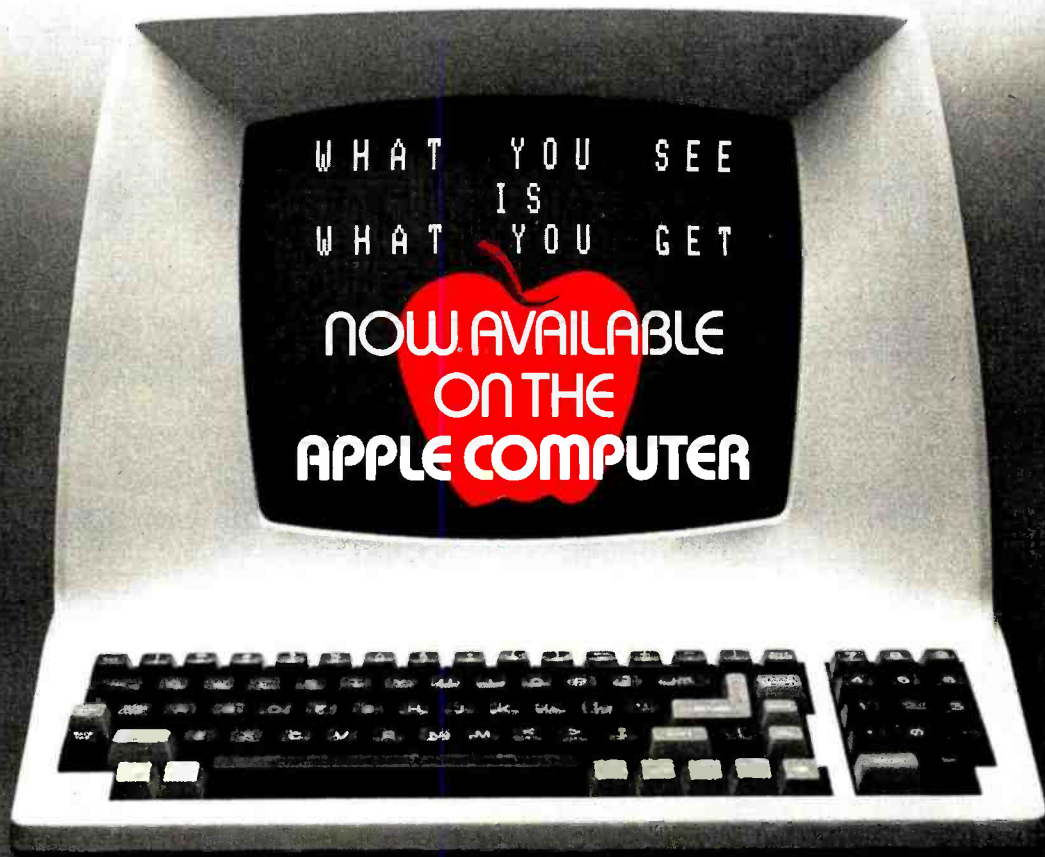
A Dialog spokesman stressed to me the importance of developing a general search *strategy*. This means sitting down with paper and pencil *before* logging on to the system, organizing questions or topics into logical groups, and then combining the groups through the use of logical (Boolean) relationships. This is an important point since wasting time with an inefficient searching strategy can become very expensive.

Since every word in every citation is indexed, the key to efficient searching is being as specific as possible. For example, the MAGAZINE INDEX contains 1.3 million individual citations; searching for all references to COMPUTER? (the ? is a "wildcard" character that matches any letters at the end of the word) yielded 4251 citations (see

listing 1). Obviously, steps must be taken to pare down the number of citations by being much more specific. Searching for MICROCOMPUTER? yielded 308 citations, still a healthy number. HOME(W)COMPUTER? OR PERSONAL(W)COMPUTER? yields 185 citations. (The (W) indicates the two words must be adjacent to one another.)

Besides the every-word indexing, all Dialog data bases contain special indexes that vary from file to file. If I wish to search for all home and personal computer articles in BYTE, I can AND my set of 185 citations with JN=BYTE—giving me a total of twenty citations. There are also special indexes which allow you to specify publication year, author name, article type (such as product review), or a number of other special features. Obviously, sitting down beforehand and planning your search

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Basic Dialog Commands

Although there are many commands available in the Dialog searching language, a small number are the only ones used for the majority of searches. They include:

- **EXPLAIN** — an on-line help file that provides a detailed description of any specified command. The file also contains a list and description of all available data bases and system news.
- **SELECT** — sets aside index terms or groups of terms you specify into numbered sets (up to 98). More than one term can be combined into a single **SELECT** statement by inserting Boolean operators between terms. For example:

```
SELECT PETROLEUM AND PRICES AND OPEC AND PY=1979
```

A command line can contain up to 240 characters.
- **SELECT STEPS** — similar to **SELECT**, except that each individual item in a single command statement is assigned its own set number.
- **EXPAND** — used to display a listing of index terms that are alphabetically close to the term entered. Each term is given a reference number that can be **SELECT**ed, and the number of individual entries for each term is listed.
- **TYPE** — displays records on-line from the sets you've previously retrieved. A number of different formats and ranges can be entered. For example, the Dialog reference number, the title only, or the full record can be displayed.
- **PRINT** — orders the specified search results to be printed off-line using Dialog's high-speed printer. The printouts are normally received in three to four days. If you've retrieved a large number of references and/or abstracts, having them printed

off-line is considerably less expensive than using connect time to dump them to your own printer.

- **END/SAVETMP** — ends a search session and saves the search strategy (individual **steps**) you've used in an individual data base. The strategy is saved until the end of the calendar day and in that period can be used in other data bases by using the **EXECUTE** command.
- **EXECUTE** — searches a data base using the search strategy saved by the **END/SAVETMP** command. This eliminates the time and expense of having to enter individual steps every time a different data base is entered.
- **END/SDI** — ends a search session and instructs the Dialog system to run the same search strategy in the specified file each time the file is updated. If new information is found, it is printed off-line and mailed to you. (This service is not available on all Dialog files.)
- **KEEP** — saves the references and/or abstracts you specify in a special set from which documents may be ordered using **DialOrder**.
- **ORDER** — automatically orders reprints specified by the **KEEP** command. The document supplier can be specified from a list supplied by Dialog.

For more information on Dialog and an application for service, contact:

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Department 52-89/BT
3460 Hillview Ave
Palo Alto CA 94304
(800) 227-1617, ext 518
California (800) 772-3545, ext 518

makes the process proceed much more quickly, smoothly—and inexpensively.

If you have problems finding the correct search strategy, there is a toll-free hotline number to Dialog's Customer Service Department, which is open twelve hours a day. Besides helping beginning searchers, there is a specialist on each data base available who can help with a particularly complicated search.

Other Features

Dialog allows you to reconnect to the system within ten minutes of a disconnect (such as being dropped by one of the networks). Up until this time limit, all the set you've created will still be in the user area. Unfortunately, if the disconnect lasts longer, you'll have to start again from the beginning.

Users who wish to keep their own private data bases on the Dialog system can do so through the Private File Service. The cost for storage of data is \$12 per million characters per month. Currently, in order to take advantage of the Private File Service, users must supply Dialog with

IBM reel-to-reel tapes. However, Dialog's staff is in the process of developing a method that will enable users to build up their personal data bases from their own terminal.

Summary

Dialog is an invaluable service for anyone who needs to locate information on any imaginable subject from aardvarks to zymology. (Remember, the system is *not* designed to be everything to all people. Unlike the Source or Micronet, you can't play games or get the latest news from one of the wire services; not only are those services unavailable, but the cost of just "browsing" adds up very quickly.) Although the cost of the service seems expensive, the system's speed, efficiency, and interactive nature make it a net time and money saver when it's used for its intended purpose—finding references to information.

A Dialog staffer put it this way: "On the system, searching is an adventure." I can add that this adventure is *much* less frustrating than the computer game of the same name. ■

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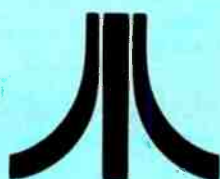
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A Computer-Based Laboratory Timer

John Gibson
Physics Department
Alma College
Alma MI 48801

Accurate time measurement is a fundamental requirement of every elementary physics laboratory. Thanks to modern electronics, most laboratories now use digital timing devices that are activated by photocells or microswitches. This is a great improvement over the hand-operated mechanical stop-clocks that were prevalent only a few years ago, but most electronic timers are still unsatisfactory in one important respect: only the most sophisticated (and expensive) are able to rapidly make and record a succession of elapsed-time measurements.

Data acquisition and logging are natural provinces of the microcomputer. Since small microcomputers and microcomputer trainers are now so widely available, it is only natural to try to adapt them for use in a variety of laboratory measurements. This article will show how a very modest microcomputer can be wired and programmed for use as a sophisticated laboratory timer.

First we will examine the system-

independent design considerations for a microcomputer-based, two-channel, data-logging, millisecond timer. Then we will build this design on a Heath ET-3400 microprocessor trainer used with the ETA-3400 expansion accessory.

The Programmable Timer

The heart of this design is a microcomputer peripheral device called a *programmable timer*. This device connects directly to the microcomputer bus and may be configured (by software) to perform the timing measurements required. When the programmable timer and microcomputer are connected for use as a laboratory timer, there is a clear division of labor: the programmable timer performs the time measurements, and the microcomputer records the results.

Figure 1 is a programming model of a common programmable timer. In addition to its connections to the microcomputer bus, the timer also has a gate input \overline{G} , an external clock

input \overline{C} , and an output O . Inside the timer are three addressable registers:

- An 8-bit, write-only *control register* that is used to establish the timer's operating mode, in much the same way as a control register configures the operation of a common PIA (peripheral interface adapter);

- A 16-bit write-only *latch*. Its contents are divided into two 8-bit bytes, called M , for the more-significant (or high-order) byte, and L , for the less-significant (or low-order) byte. The latch's contents are preset to hexadecimal FFFF on system power-up or RESET, and they may be changed at any time by the program running in the microcomputer;

- A 16-bit write-only *counting register*. A momentary logic-0 level at the timer's gate input causes this register to be loaded with bytes M and L from the latch. The counting register then decrements on each cycle of a specified timing signal. Further operating details are dictated by the timer's operating mode.

Text continued on page 114

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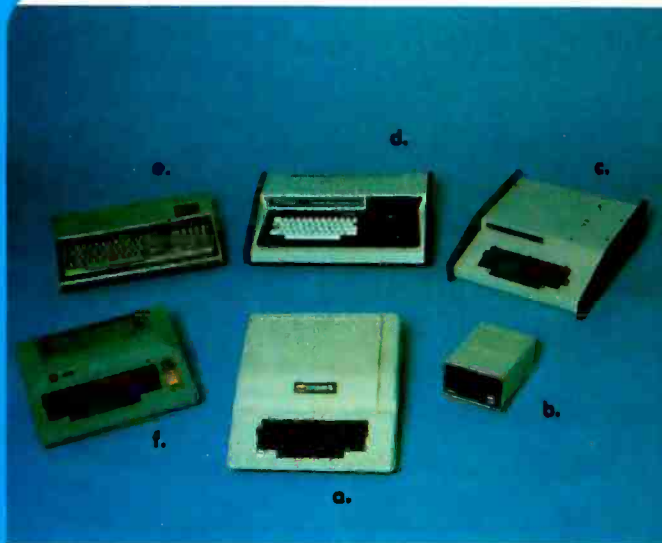
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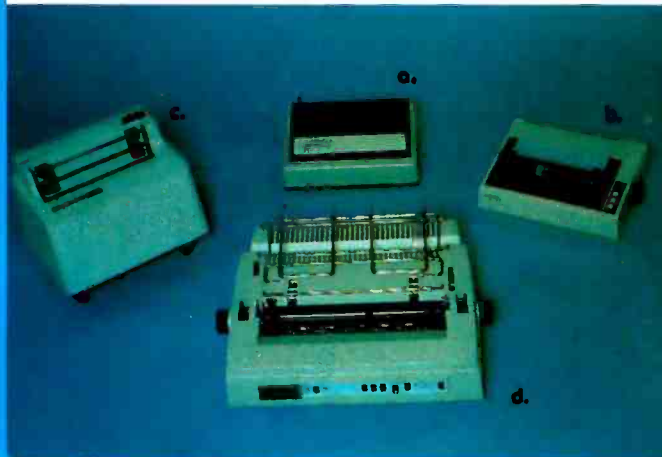
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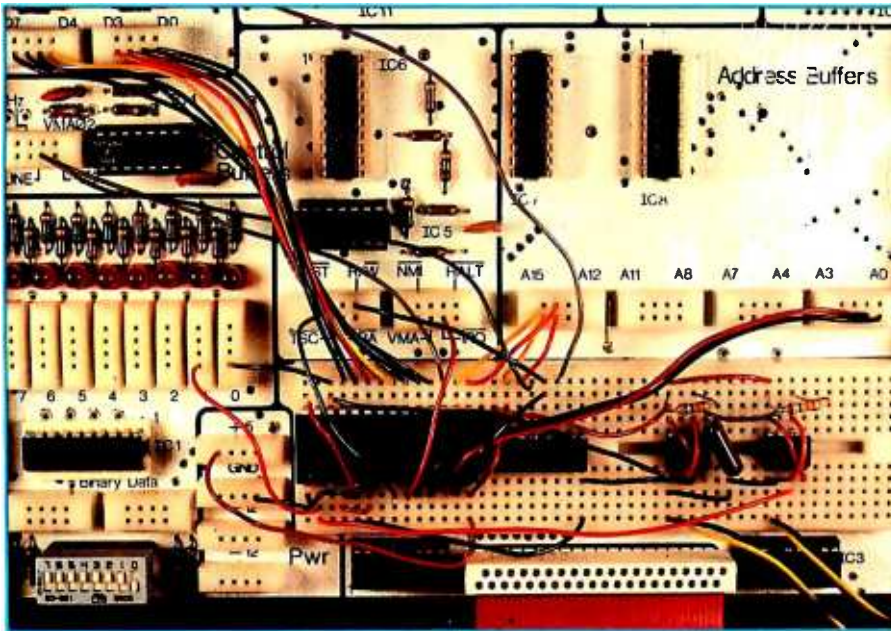


Photo 1: Heath ET-3400 microcomputer trainer wired for use as a two-channel, data-logging, millisecond timer. The picture shows all circuit components except the phototransistors, which are connected to the type-555 integrated circuits (used as input comparators) via the two yellow-black twisted pairs of wires at the lower right.



Photo 2: Lamp and phototransistor attached to one end of the air track. For best timing resolution, the lamp is mounted so that its filament is vertical.

Text continued from page 110:

The programmable timer is a versatile device with several operating modes, two of which are useful for elapsed-time measurements:

- *Pulse-width-comparison mode*, in which the timer measures the length of time its gate input is held at logic 0;
- *Frequency-comparison mode*, in which the timer measures the time between two successive logic 0s at its gate input.

These two types of time measurement are illustrated in figure 2.

Time-Interval Measurement

Each elapsed-time measurement

consists of six steps. The first three steps are performed by the programmable timer, and the last three are performed by the microcomputer.

The following three measurements are those performed in sequence by a timer programmed for operation in the *pulse-width-comparison mode* (by storing hexadecimal 58 in its control register):

1. The timer's gate input, normally at logic 1, is pulled to logic 0 at the beginning of the timed event. This loads the timer's counting register with bytes M and L from the latch.
2. The counting register then decrements on each cycle of a timing

signal applied to the timer's external-clock input and continues to do so while the gate input is held at logic 0. 3. The gate input is driven back to logic 1 at the end of the timed event. If this occurs before the counting register reaches zero, the count stops, and the timer generates a program interrupt by pulling the microcomputer's active-low \overline{IRQ} (interrupt-request) line to logic 0.

The three measurement steps performed by a timer programmed for operation in the *frequency-comparison mode* (by storing hexadecimal 48 in its control register) are as follows:

1. The timer's gate input, normally at

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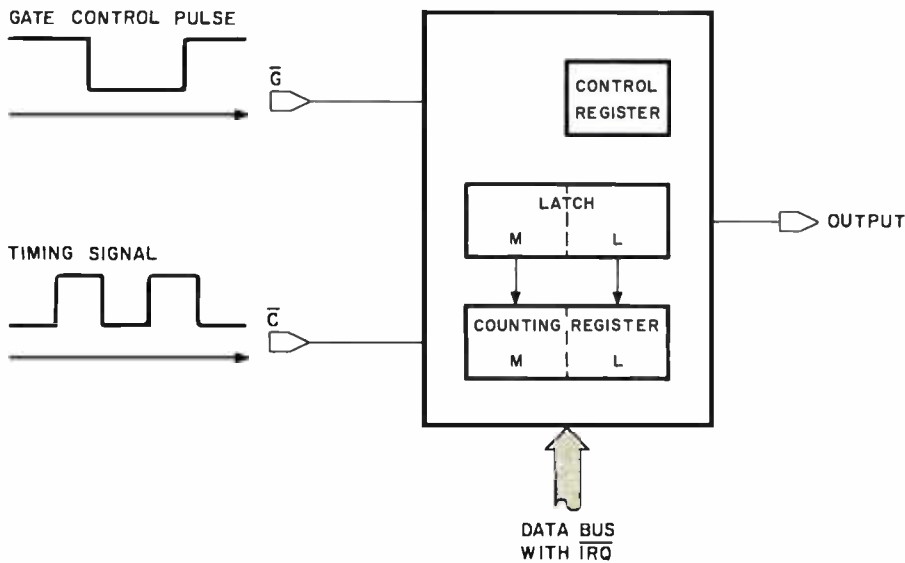


Figure 1: Model of the programmable timer, showing gate input \bar{G} , external-clock input \bar{C} , output O , the connection to the microcomputer bus, and the addressable registers. The arrows pointing from the latch to the counting register indicate the data transfer that takes place at the beginning of each count. Output O is not used in either the pulse-width-comparison or frequency-comparison modes of operation.

logic 1, is momentarily pulled to logic 0 at the beginning of the timed event. This loads the timer's counting register with bytes M and L from the

latch.
2. The counting register then decrements on each cycle of a timing signal applied to the timer's external-

clock input and continues to do so, even though the gate input returns to logic 1.

3. The gate input is again momentarily pulled to logic 0 at the end of the timed event. If this occurs before the counting register reaches zero, the count stops, and the timer generates a program interrupt by pulling the microcomputer's \overline{IRQ} line to logic 0.

For either operating mode, the timer ends its three-step sequence by signaling the microcomputer over its \overline{IRQ} line. The microcomputer's task begins when it receives the interrupt signal indicating that the timer has finished a count. The microcomputer then takes over the last three steps and:

4. Reads the timer's counting register.
5. Transforms the count into a useful measurement of elapsed time.
6. Saves the result.

We will now examine all of these

Text continued on page 118

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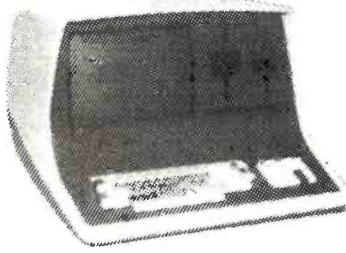
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Text continued from page 115:

measurement steps in detail.

Step 1 is initiated by the gating device (eg: a photocell) that is connected to the programmable timer's gate input. Figure 3 shows two circuits for coupling phototransistors to the timer.

In figure 3a, the phototransistor is illuminated normally, and the programmable timer's gate input is held at logic 1. An object passing in front of the phototransistor will cause the programmable timer's gate input to be pulled to logic 0 and held there for as long as the light is blocked. If the timer is operating in the pulse-width-comparison mode, it will measure the length of time the light is blocked. If it is operating in the frequency-comparison mode, the timer will measure the elapsed time from the first extinction of the light to the second.

In figure 3b, both phototransistors are normally illuminated, and the timer's gate input is held at logic 1. An object passing in front of either phototransistor produces a momentary logic 0 at the programmable timer's gate input. A second momentary logic 0 occurs as the object passes in front of the second phototransistor. If operated in the frequency-comparison mode, the timer will measure the time from the first extinction of the light (at one phototransistor) to the second (at the other phototransistor).

Text continued on page 122

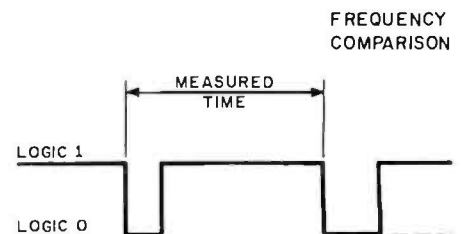
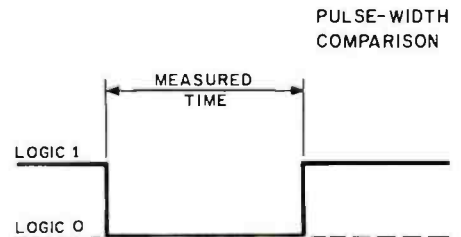
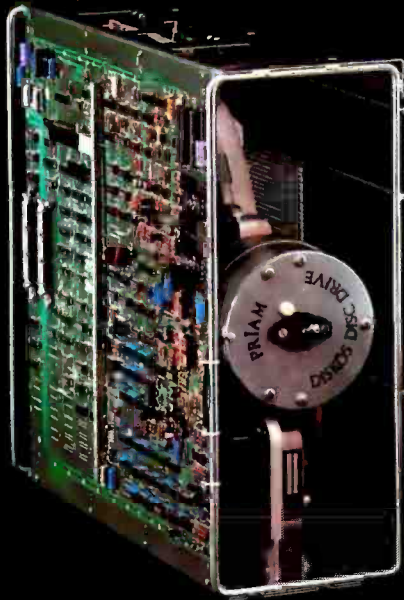


Figure 2: The time intervals measured by the programmable timer for the pulse-width and frequency-comparison modes.

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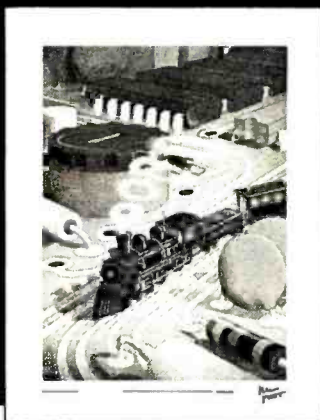
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COLLECTOR EDITION BYTE COVERS

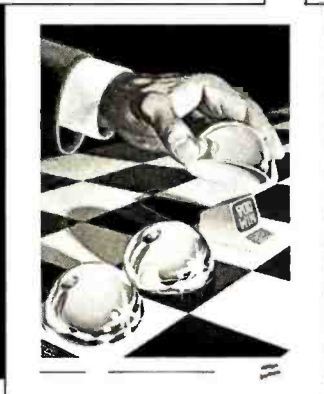
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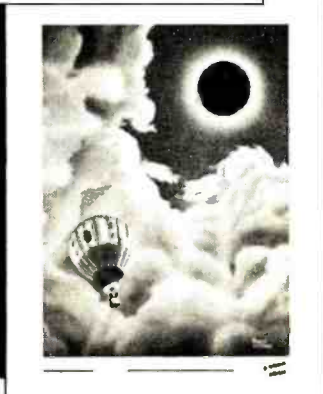
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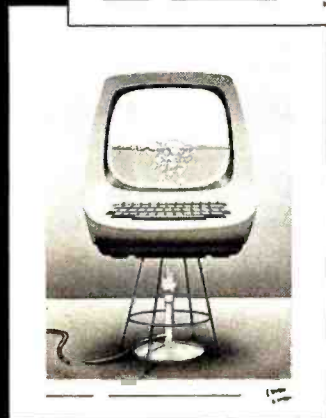
#2



#6



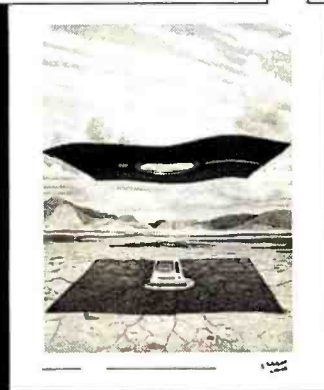
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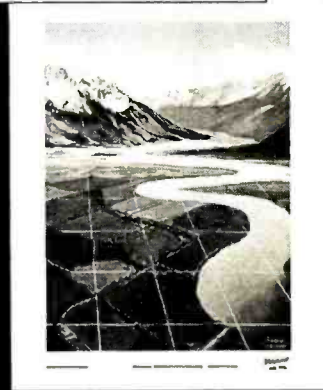
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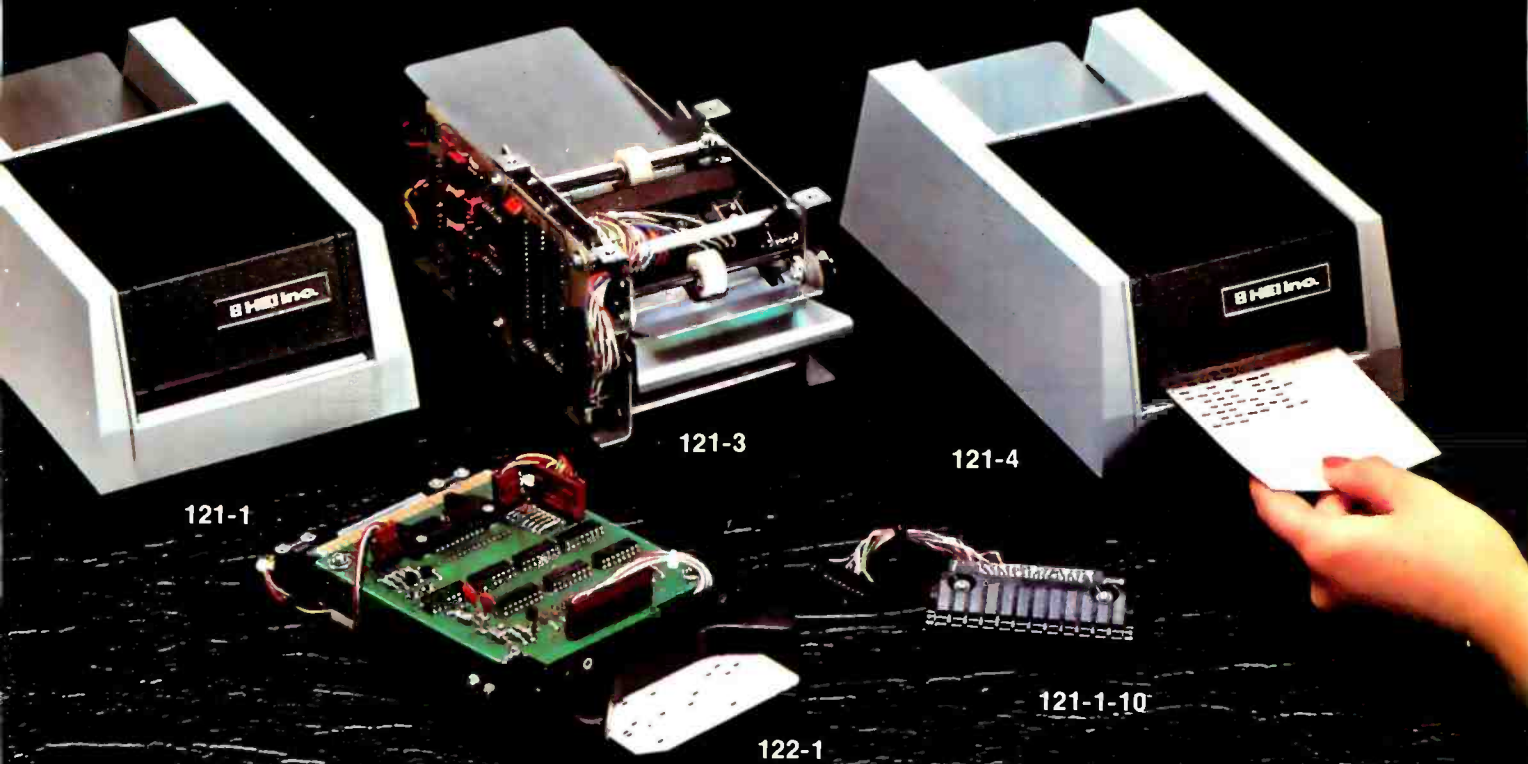
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Text continued from page 118:

Step 2 states that the counter decrements on each cycle of an external timing signal. The period of this timing signal therefore becomes the *limit of resolution* of any time measurement. My applications required elapsed-time measurements that were accurate to the nearest ms (millisecond). This resolution was achieved by applying a 1 kHz timing signal to the timer's external-clock in-

put. (Later I will describe how this timing signal is produced by using another programmable timer to scale the microprocessor's clock frequency.)

Step 3 says that the count stops, and the microcomputer is signaled, if the timed event ends before the counting register decrements to zero. Recall that the timer's latch is preset to unsigned 65,535 (hexadecimal

Text continued on page 126

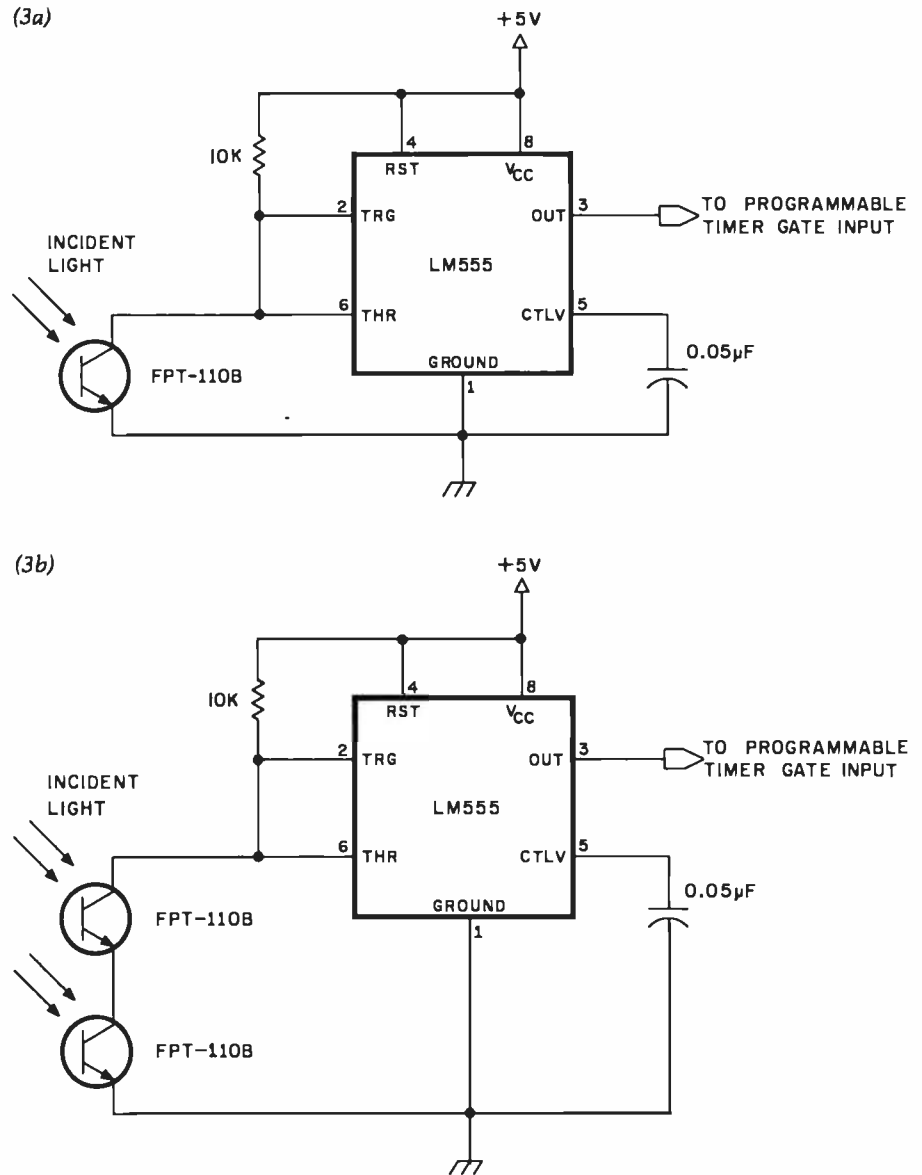


Figure 3: Two circuits for connecting phototransistors to programmable-timer gate inputs. Figure 3a shows control of the timer gate by a single phototransistor; figure 3b shows control by two phototransistors.

These type-555 integrated circuits are not used as timers; instead, they serve as inverting comparators. A 555 component connected in this manner has an input hysteresis in excess of 1.6 V, twice that of a type-7413 Schmitt trigger.

The 10 k-ohm resistor is chosen to saturate the phototransistor when illuminated, and hold it near its cutoff point when the light is blocked. The 10 k-ohm resistance is optimal for a 1 W incandescent bulb located 5 cm (approximately 2 inches) in front of the phototransistor. Other setups may require a different resistor.

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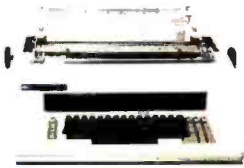
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Listing 1: Interrupt-service routine for reading a programmable timer's counting register, converting the number to a decimal elapsed time and saving the result.

Line	Label	Op Code	Comments
1		LDA A M	Read the timer's counting register and clear the timer's
2		LDA B L	interrupt request.
3		LDX POINT	Fetch the pointer.
4		CPX #LAST +3	Are all memory locations loaded?
5		BEQ DONE	Branch if all are loaded.
6		COM A	Complement the count to get the hexadecimal elapsed
7		COM B	time.
8		STA A 1,X	Save the hexadecimal elapsed time in this memory loca-
9		STA B 2,X	tion.
10		LDA A #\$80	Set bit 7 to show that this memory location has been
11		STA A 0,X	loaded.
12		BSR BD	Perform a subroutine that converts the 2-byte hexa-
			decimal number in 1,X and 2,X to a 2½-byte BCD
			number in 0,X, 1,X and 2,X.
13		INX	
14		INX	Advance the pointer to the next 3-byte memory loca-
15		INX	tion.
16		STX POINT	Save the new pointer value.
17	DONE	RTI	

FFFF) on system power-up or RESET. Unless changed by the program, this value is automatically loaded into the counting register at the beginning of each timed event. The counting register cannot decrement more than this number of counts. A 1 kHz timing signal will therefore permit a maximum time measurement of 65,535 ms, or 65.535 seconds.

Step 4 begins the program's interrupt-service routine by reading the timer's counting register. Aside from fetching the counting register's contents, this step has another purpose: the read operation causes the programmable timer to release the microcomputer's IRQ line. This is important, because it is the *only* way the timer's interrupt request can be cleared.

Step 5 indicates a need for transforming the count. The quantity read from the timer's counting register (for a 1 kHz timing signal) is the *hexadecimal* number of milliseconds *remaining* until the counter decrements to zero. To be useful, this number should be transformed into the *decimal* number of milliseconds *elapsed* during the timed event. This transformation is a two-step process:

5a. Convert the hexadecimal milliseconds remaining to hexadecimal milliseconds elapsed during the timed event.

5b. Convert the hexadecimal milliseconds to decimal milliseconds.

Step 5a is easily performed. If the timer's counting register is set to hexadecimal FFFF at the beginning of the count, the hexadecimal number of elapsed milliseconds is equal to FFFF- n_i , where n_i is the remainder read from the counting register at the end of the timed event. But, since FFFF- n_i is just the one's complement of n_i , step 5a simply requires taking the one's complement of the number read from the counting register.

Step 5b is a hexadecimal-to-decimal conversion routine. Any appropriate routine may be used here. Listing 2 contains a fully documented demonstration program that includes a suitable hexadecimal-to-decimal conversion routine.

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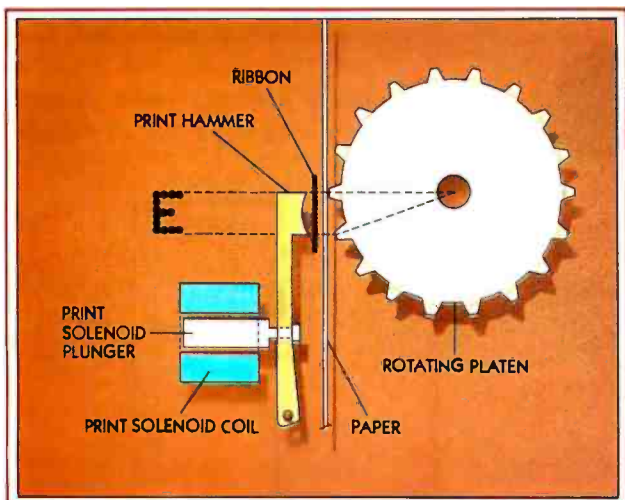
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Step 6 states that the microcomputer must save the result (ie: save the transformed time measurement). If several time measurements are made in rapid succession, the computer must log these results in a manner that permits easy access.

Successive time measurements are saved in successive 3-byte memory locations in a reserved memory block. Why 3 bytes? Although the binary number read from the timer's counting register is contained in only 2 bytes, that number converted to decimal form may require five BCD (binary-coded decimal) digits (for a maximum elapsed time of 65,535 ms). Stored in "packed" BCD form, such a number occupies 2½ bytes of memory. I allow 3 bytes, because I use bit 7 of the most-significant byte as a flag that is set when the memory location has been loaded with a measured time.

Listing 1 is a set of MC6800 instructions for accomplishing steps 4, 5, and 6 of the measurement sequence. This interrupt-service routine reads

the timer's counting register, transforms the count into a decimal-radix elapsed time, and saves the result.

Lines 3, 4, and 5 of the listing merit further explanation. POINT always contains the address of the next memory location in which a time measurement will be stored. Line 3 loads the index register with this pointer. Line 4 examines the pointer to see if the allocated memory space has been exceeded. If it has, line 5 causes a skip of the remaining steps.

Notice that the testing of the pointer does not occur until *after* the timer's counting register has been read (lines 1 and 2). The counting register must *always* be read, whether or not the results are to be saved. Otherwise the timer's interrupt request will not be cleared.

A Programmable-Timer Module

Thus far, I have described how a single programmable timer may be used with a microcomputer to measure and log elapsed times of suc-

cessive events. I now wish to show how a particular commercial device, the Motorola MC6840 programmable-timer module, may be used in the design of a two-channel event timer.

Figure 4 is a pin-assignment diagram for the MC6840. This integrated circuit contains three independent programmable timers, each with gate input, external-clock input, and output. There are ten addressable registers. Nine of these are the control registers, latches, and counting registers for the three timers; the tenth is a status register containing interrupt flags. (Details of register selection for the MC6840 were described in my earlier article, "A Computer-Controlled Light Dimmer," January 1980 BYTE, page 56.)

A two-channel event timer requires the use of one programmable timer for each channel. If timer 1 is assigned to channel 1 and timer 2 is assigned to channel 2, then timer 3 may be used to scale the microprocessor clock frequency to provide the timing signal required by timers 1 and 2.

To operate as a frequency scaler, timer 3 must be configured for use in the *continuous operating mode*. This is achieved by grounding the timer's gate and loading hexadecimal 82 into its control register. The timer then produces a square wave whose frequency is equal to that of the micro-

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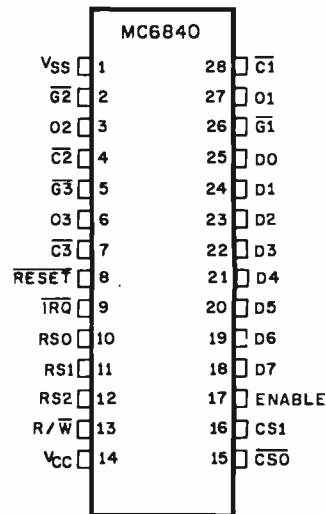


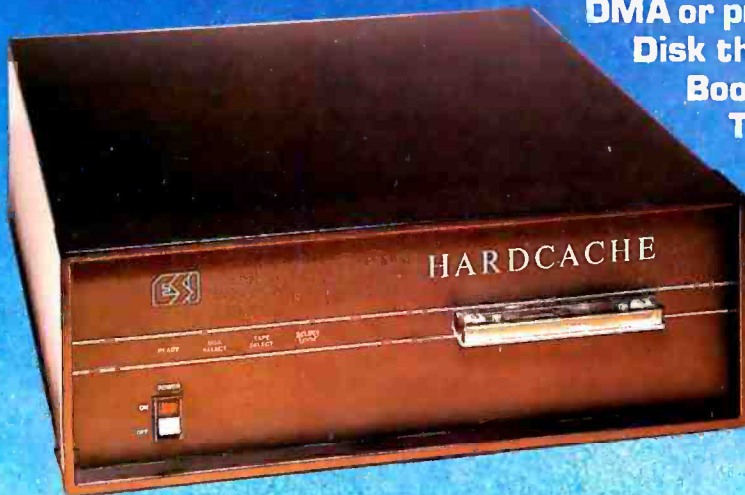
Figure 4: Pin-assignment diagram for the Motorola MC6840 programmable-timer module.

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Photo 3: The trainer's six-character LED display is used to indicate which memory locations have been loaded with elapsed-time measurements. This is how the display appears after time measurements have been logged in memory locations A and B (for phototransistor 1) and location D (for phototransistor 2).

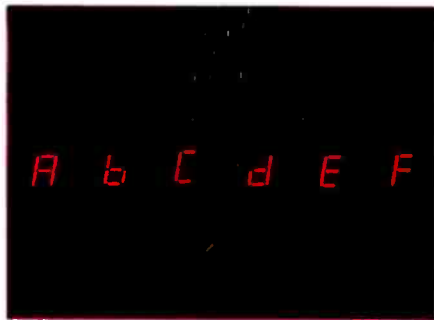


Photo 4: The trainer's six-character LED display after elapsed-time measurements have been logged in all six memory locations, A thru F.



Photo 5: A measured time is read by pressing a letter key on the trainer's hexadecimal keyboard. This is the display's appearance when the A key is pressed to read out the elapsed-time measurement (here 1.581 seconds) stored at memory location A.

processor clock divided by $2(n+1)$, where n is the 16-bit number stored in the timer's latch. (For example, given a microprocessor clock frequency of 1 MHz, storing decimal 499 [hexadecimal 01F3] in the timer's latch will cause the timer to generate a 1 kHz square wave.) Figure 5 shows the appropriate input and output connections for timer 3.

Polling the Timers

When timers 1 and 2 are operated in either the pulse-width-comparison mode or the frequency-comparison mode, either timer may signal the completion of a count by pulling the microcomputer's \overline{IRQ} line low. The microcomputer, with the aid of the MC6840's status register, then polls the timers to find which produced the interrupt.

The status register is an 8-bit, read-only register containing interrupt flags. It shares an address with control register 2 (CR2). The R/\overline{W} line selects whether CR2 is written or the status register is read. Individual bits of the status register are assigned as shown in table 1.

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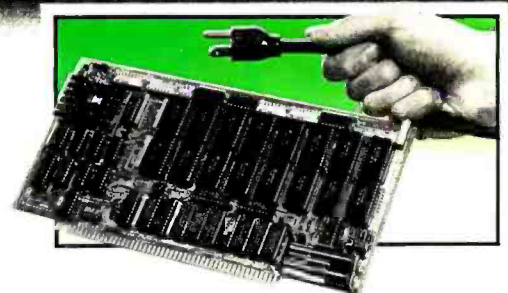
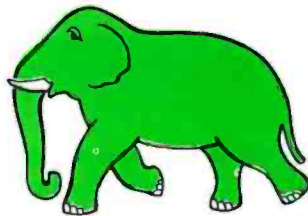
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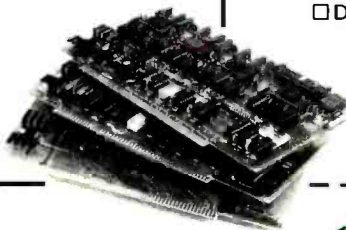
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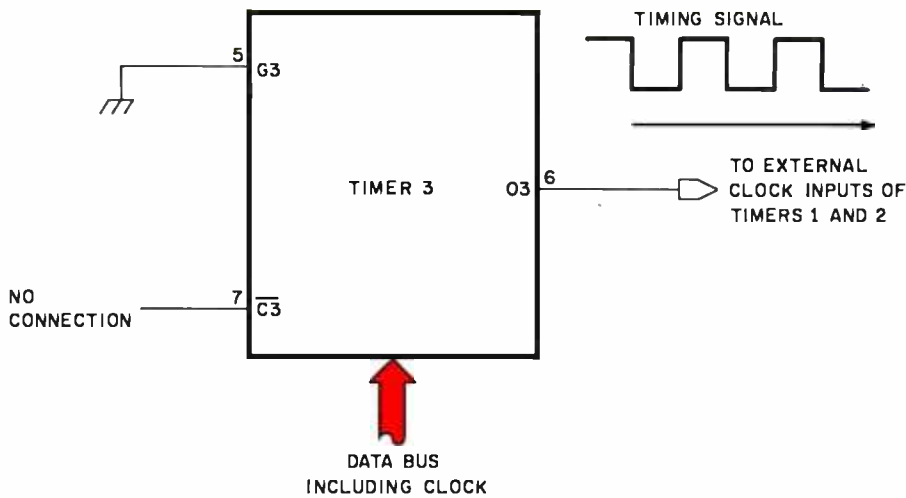


Figure 5: Connection of the MC6840's timer-section 3 for use as a frequency scaler. The microprocessor's clock frequency is divided by $2(n+1)$ to provide a timing signal to timers 1 and 2.

comparison mode or the frequency-comparison mode, then its individual interrupt flag is set whenever the timer completes a time measurement before its counting register decrements to zero. The flag is automatically cleared when the status register and the timer's counting register are read (in that order).

The composite interrupt flag is the logical OR of the individual interrupt flags. For the operating modes that I have selected for the three timers, the composite interrupt flag will be clear only if both the timer 1 and timer 2 flags are clear. (Timer 3's configuration as a scaler prevents it from affecting the composite interrupt flag.)

Bit 0:	Timer 1 individual interrupt flag.
Bit 1:	Timer 2 individual interrupt flag.
Bit 2:	Timer 3 individual interrupt flag.
Bit 3:	Composite interrupt flag.
Bits 4 thru 7:	All read as zero.

Table 1: Assignment of bits in the status register of the Motorola MC6840 programmable-timer module.

The MC6840 pulls the microcomputer's \overline{IRQ} line low when the composite interrupt flag is set, which, for these operating modes, is whenever the timer 1 or timer 2 individual interrupt flags are set. The \overline{IRQ} line is released only when both timer 1 and timer 2 individual interrupt flags are cleared.

Upon receipt of the interrupt request (\overline{IRQ} line pulled low), the microcomputer performs an interrupt-service routine that examines the status register to find which timer's interrupt flag is set. With that deter-

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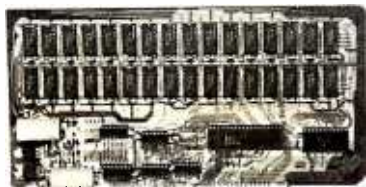
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mined, it then performs the remaining steps (4, 5, and 6) of the program's data-acquisition routine.

Building the Timing System

I have just described the system-independent design details of a two-channel, data-logging, millisecond timer using a Motorola MC6840 programmable-timer module; I will now show you how to implement this design on a Heathkit ET-3400 microprocessor trainer.

We have seen that a millisecond-resolution timer requires a 1 kHz external timing signal, and we have seen how this external timing signal can be scaled from a 1 MHz microprocessor clock. The implementation assumes the use of an ET-3400 trainer with a 1 MHz crystal-controlled clock. This 1 MHz clock is a feature of all trainers modified for use with the Heathkit ETA-3400 expansion accessory.

The demonstration program (see listing 2) assumes the availability of

340 bytes of memory for program storage. This exceeds memory available in the trainer alone, unless some page-zero memory is used for this purpose. Addition of the ETA-3400 expansion accessory easily provides the additional program-storage space required.

Figure 6 is a complete circuit diagram for the two-channel, millisecond timer. The entire circuit (except for the phototransistors) may be wired on the trainer's built-in breadboard socket (see photo 1).

Figure 6 contains one system-dependent feature that requires explanation. The ET-3400 trainer uses a bidirectional buffer to couple its data bus to outside devices. Normally set in the write (output) state, this buffer is placed in the read (input) state by pulling the trainer's RE (read enable) line low. The 7445 binary-to-decimal decoder in figure 6 provides the address decoding needed to do this each time the trainer reads the MC6840 registers. *Text continued on page 144*

Listing 2: Complete timer-demonstration program for using the Motorola MC6840 with Heath's ET-3400 microcomputer trainer. The program (written in 6800 assembly language) assumes the availability of 340 bytes of memory for program storage, so an ETA-3400 memory-expansion module must be installed.

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MOTOROLA M6800 CROSS ASSEMBLER, RELEASE 1.2

```

00001          NAM      TIMLOG  BY J. H. GIBSON, ALMA COLLEGE

00003 0000          ORG      0

00005 0000 0003    T11     RMB    3      / ELAPSED TIME A
00006 0003 0003    T12     RMB    3      / ELAPSED TIME B
00007 0006 0003    T13     RMB    3      / ELAPSED TIME C

00009 0009 0003    T21     RMB    3      / ELAPSED TIME D
00010 000C 0003    T22     RMB    3      / ELAPSED TIME E
00011 000F 0003    T23     RMB    3      / ELAPSED TIME F

00013 0012 0001    TEMP1   RMB    1
00014 0013 0001    TEMP2   RMB    1

00016 0014 0002    POINT1  RMB    2      / POINTER FOR TIMER #1
00017 0016 0002    POINT2  RMB    2      / POINTER FOR TIMER #2

00019          00F7      UIRQ   EQU    $00F7 / MONITOR VECTORS HERE ON IRQ

00021          * ADDRESSES IN PROGRAMMABLE TIMING MODULE

00023          8000      CR1    EQU    $8000
00024          8001      CR2    EQU    CR1+1
00025          8000      CR3    EQU    CR1

00027          8001      STATUS EQU    CR2      / CONTAINS INTERRUPT FLAGS

00029          8002      M1     EQU    CR1+2
    
```

Listing 2 continued on page 136

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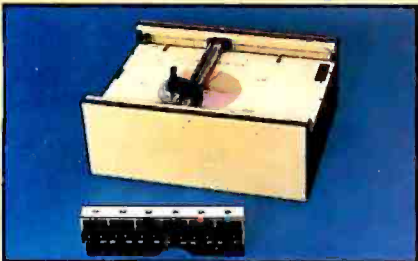
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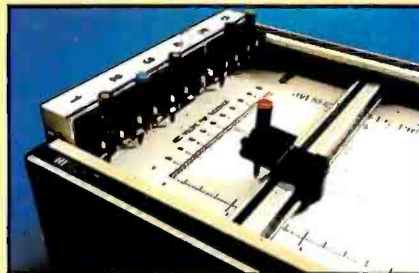
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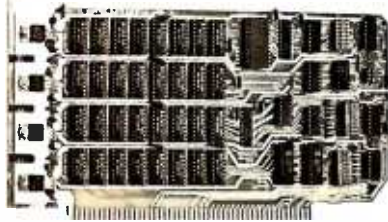
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Listing 2 continued:

```

00030      8003      L1      EQU      CR1+3
00032      8004      M2      EQU      CR1+4
00033      8005      L2      EQU      CR1+5
00035      8006      M3      EQU      CR1+6
00036      8007      L3      EQU      CR1+7

00038
* THESE ET-3400 MONITOR SUBROUTINES ARE USED.

00040      FC8C      REDIS  EQU      $FC8C      / RESETS DISPLAY TO 1ST LED
00041      FE28      OUTHEX EQU      $FE28      / DISPLAYS HEX DIGIT FROM 'A'
00042      FE3A      OUTCH  EQU      $FE3A      / DISPLAYS CODED CHARACTER
00043      FD8F      ENCODE EQU      $FD8F      / RETURNS KEY'S HEX VALUE
00044      FD7B      DISPLAY EQU      $FD7B      / DISPLAYS HEX DIGIT STRING
00046
* THESE STEPS INITIALIZE TIMERS 1 AND 2 FOR USE IN
* THE PULSE WIDTH COMPARISON MODE IN WHICH AN IRQ
00048 * INTERRUPT IS GENERATED AT THE END OF EACH TIMED
00049 * INTERVAL. TIMER 3 IS USED TO SCALE THE 1MHZ
00050 * MICROPROCESSOR CLOCK TO PROVIDE A 1KHZ EXTERNAL
00051 * CLOCK FREQUENCY TO TIMERS 1 AND 2.

00053 0100
                                ORG      $100      / START FROM THIS ADDRESS.

00055 0100 0F      START  SEI
                                / MASK IRQ INTERRUPT

00057 0101 CE 01F3  LDX      $499      / SCALING FACTOR = 2(499+1)
00058 0104 FF 8006  STX      M3
                                / INITIALIZE TIMER #3

00060 0107 86 82      LDA  A  $82      / CONFIGURE TIMER #3 FOR USE
00061 0109 E7 8100    STA  A  CR3
                                / AS A SCALAR

00063 010C 86 59      LDA  A  $59      / CONFIGURE TIMERS #1 AND #2
00064 010E E7 8001    STA  A  CR2
                                / FOR PULSE WIDTH COMP MODE;
00065 0111 E7 8100    STA  A  CR1
                                / INTERNALLY RESET ALL TIMERS

00067 0114 4A
00068 0115 E7 8000    STA  A  CR1
                                / CLEAR INTERNAL RESET BIT
                                / TO ENABLE ALL TIMERS

00070
* ON IRQ, THE ET-3400 VECTORS TO LOCATION
00071 * $UIRQ, WHERE IT MUST FIND A JUMP INSTRUCTION
00072 * AND A VECTOR TO TRANSFER TO THE PROGRAM'S
00073 * IRQ SERVICE ROUTINE AT LOCATION $POLL.

00075 0118 86 7E      LDA  A  $7E      / LDA A WITH JUMP COMMAND
00076 011A 77 F7      STA  A  UIRQ
                                / STORE JUMP COMMAND AT UIRQ

00078 011C CE 018E    LDX      $POLL      / JUMP TO THIS LOCATION
00079 011F DF FB      STX      UIRQ+1
                                / STORE $POLL AT UIRQ VECTOR

00081 0121 0E      CLI
                                / CLEAR IRQ INTERRUPT MASK

00083
* INITIALIZE THE MEMORY LOCATION POINTERS

00085 0122 CE 0009    LDX      $T21
00086 0125 DF 16      STX      POINT2

00088 0127 CE 0000    LDX      $T11
00089 012A DF 14      STX      POINT1
00091
* CLEAR ALL MEMORY LOCATIONS

00093 012C 6F 00      CLEAR  CLR      0,X      / CLEAR THIS BYTE
00094 012E 08          INX
                                / POINT TO THE NEXT BYTE
00095 012F 8C 0012    CPX      $T23+3
                                / DONE YET?
00096 0132 26 FB      BNE      CLEAR
                                / GO CLEAR THE NEXT BYTE

00098
* MAIN PROGRAM LOOP

0100 0134 8D 11      RUN     BSR      SHOW
                                /SHOW LETTERS OF LOGGED TIMES
0101 0136 8D 30      BSR     KEY
                                /RETURNS DEBOUNCED KEY IN 'A'
0102 0138 24 FA      BCC    RUN
                                / GO BACK IF NO KEY PRESSED

0104 013A 4D          TST  A
0105 013B 27 C3      BEQ    START
                                / GO TO START ON '0' KEY

0107 013D 8D 35      BSR     SETX
                                / POINT TO KEYED LOCATION
0108 013F 24 F3      BCC    RUN
                                / BRANCH IF KEYS 1-9 PRESSED

0110 0141 8D 44      BSR     READOU
                                / SHOW KEYED ELAPSED TIME
0111 0143 8D 6E      BSR     RELEAS
                                / WAIT FOR KEY RELEASE
0112 0145 20 ED      RUN     RELEAS
                                / RETURN TO SHOW LETTERS

```

Listing 2 continued on page 138



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one	eighteen
two	nineteen
three	cancel
four	case
five	cent
six	40hzerts tone
seven	50hzerts tone
eight	20ms silence
nine	40ms silence
ten	80ms silence
eleven	120ms silence
twelve	200ms silence
thirteen	300ms silence
fourteen	400ms silence
fifteen	500ms silence
sixteen	600ms silence
seventeen	700ms silence
and	800ms silence
at	900ms silence
down	1000ms silence
equal	1100ms silence
error	1200ms silence
feel	1300ms silence
flow	1400ms silence
fuel	1500ms silence
lessor	1600ms silence
limit	1700ms silence
low	1800ms silence
lower	1900ms silence
mark	2000ms silence
meter	2100ms silence
mile	2200ms silence
mile	2300ms silence
high	2400ms silence
higher	2500ms silence
hour	2600ms silence
in	2700ms silence
near	2800ms silence
right	2900ms silence
second	3000ms silence
set	3100ms silence
space	3200ms silence
speed	3300ms silence
ster	3400ms silence
start	3500ms silence
stop	3600ms silence
than	3700ms silence
the	3800ms silence
time	3900ms silence
try	4000ms silence
up	4100ms silence
volt	4200ms silence
weight	4300ms silence
ready	4400ms silence
ready	4500ms silence
right	4600ms silence

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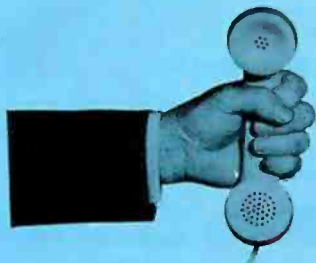
Listing 2 continued:

00114							* THIS ROUTINE DISPLAYS LETTERS FOR MEMORY
00115							* LOCATIONS IN WHICH ELAPSED TIMES ARE LOGGED.
00117	0147	CE	0000	SHOW	LDX	#T11	/ POINT TO THE FIRST LOCATION
00118	014A	B6	0A		LDA	#\$0A	/ INITIALIZE DISPLAY LETTER
00119	014C	BD	FCBC		JSR	REDIS	/ INITIALIZE DISPLAY POINTER
00121	014F	E6	00	SHOW1	LDA	B 0,X	/ TEST BIT7 FOR TIME LOGGED
00122	0151	2A	05		BFL	SHOW2	/ BRANCH IF NO TIME LOGGED
00124	0153	BD	FE2B		JSR	OUTHEX	/ SHOW THE LETTER FROM 'A'
00125	0156	20	06		BRA	SHOW3	
00127	0158	36		SHOW2	FSH	A	/ SAVE THE LETTER FROM 'A'
00128	0159	4F			CLR	A	/ PREPARE TO SHOW A BLANK
00129	015A	BD	FE3A		JSR	OUTCH	/ SHOW A BLANK HERE
00130	015D	32			FUL	A	/ RESTORE KEYED LETTER TO 'A'
00132	015E	4C		SHOW3	INC	A	/ INC 'A' TO THE NEXT LETTER
00133	015F	08			INX		
00134	0160	08			INX		/ ADVANCE THE POINTER TO THE
00135	0161	08			INX		/ NEXT 3-BYTE MEMORY LOCATION
00136	0162	8C	0012		CFX	#T23+3	/ DONE YET?
00137	0165	26	E8		BNE	SHOW1	/ EXAMINE THE NEXT LOCATION
00139	0167	39				RTS	
00141							* THIS ROUTINE DEBOUNCES A PRESSED KEY AND RETURNS
00142							* ITS HEX VALUE IN ACC A. THE ROUTINE ALSO
00143							* RETURNS CARRY SET FOR KEY PRESSED, CARRY
00144							* CLEAR FOR NO KEY PRESSED.
00146	0168	C6	14	KEY	LDA	B #20	/ INITIALIZE DELAY COUNTER
00148	016A	BD	FDBB	KEY1	JSR	ENCODE	/ RETURNS KEY VALUE IN 'A'
00149	016D	24	04		BCC	KEY2	/ BRANCH IF NO KEY DOWN
00151	016F	5A			DEC	B	/ DECREMENT THE DELAY TIME
00152	0170	26	F8		BNE	KEY1	/ GO BACK, IF DELAY NOT DONE
00154	0172	0D			SEC		/ SET CARRY IF KEY DOWN
00156	0173	39		KEY2	RTS		
00158							* THIS ROUTINE USES THE HEX VALUE (IN ACC A)
00159							* OF THE KEY PRESSED TO POINT X TO THE PROPER
00160							* MEMORY LOCATION. THE ROUTINE RETURNS CARRY
00161							* SET IF KEYS A-F PRESSED, CARRY CLEAR
00162							* IF KEYS 1-9 ARE PRESSED.
00164	0174	CE	0000	SETX	LDX	#T11	/ POINT X TO FIRST LOCATION
00165	0177	C6	0A		LDA	B #\$0A	/ INITIATE 'B'
00167	0179	11		SETX1	CBA		/ DOES 'B' EQUAL KEY VALUE?
00168	017A	27	09		BEQ	SETX2	/ BRANCH IF EQUAL
00170	017C	0C			CLC		/ CLEAR THE A-F KEY FLAG
00171	017D	2B	07		BMI	SETX3	/ RTS IF 'B' > KEY VALUE
00173	017F	08			INX		
00174	0180	08			INX		/ ADVANCE THE POINTER TO THE
00175	0181	08			INX		/ NEXT 3-BYTE MEMORY LOCATION
00176	0182	5C			INC	B	/ INCREMENT 'B' AND
00177	0183	20	F4		BRA	SETX1	/ GO COMPARE AGAIN
00179	0185	0D		SETX2	SEC		/ SET THE A-F KEY FLAG
00181	0186	39		SETX3	RTS		
00183							* READOUT ROUTINE; DISPLAYS KEYED LETTER AND
00184							* ELAPSED TIME STORED IN THIS LOCATION. THE
00185							* DISPLAY IS IN SECONDS WITH RESOLUTION TO
00186							* 1 MILLISECOND, LEADING ZEROS TO THE LEFT
00187							* OF THE DECIMAL POINT ARE SUPPRESSED.
00189	0187	E6	00	READOU	LDA	B 0,X	/ FETCH BIT 7
00190	0189	2A	27		BFL	READ2	/ BRANCH IF NO TIME LOGGED
00192	018B	36			FSH	A	/ SAVE KEY VALUE (FROM 'A')
00193	018C	BD	FCBC		JSR	REDIS	/ INITIALIZE DISPLAY POINTER
00194	018F	C6	03		LDA	B #03	/ TO DISPLAY 3 BYTES
00195	0191	BD	FD7B		JSR	ISPLAY	/ DISPLAY THIS ELAPSED TIME
00197	0194	BD	FCBC		JSR	REDIS	/ RESET THE DISPLAY POINTER
00198	0197	32			FUL	A	/ RESTORE KEY VALUE TO 'A'

Listing 2 continued on page 140

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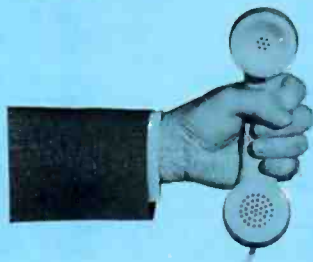
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Listing 2 continued:

```

00199 019B 8D FE2B      JSR   OUTHEX / SHOW KEY PUSHED (FROM 'A')

00201 019B A6 00      LDA A 0,X   / GET 1ST DIGIT (AND BIT 7)
00202 019D B4 0F      AND A #$0F / MASK TO FIRST DIGIT
00203 019F 26 0C      BNE  READ1  / BRANCH IF NOT LEADING ZERO

00205 01A1 8D FE3A      JSR   OUTCH  / BLANK 2ND 7-SEGMENT LED

00207 01A4 A6 01      LDA A 1,X   / GET 2ND (AND 3RD) DIGIT
00208 01A6 B4 F0      AND A #$F0 / MASK TO 2ND DIGIT
00209 01AB 26 03      BNE  READ1  / BRANCH IF NOT ALSO ZERO

00211 01AA 8D FE3A      JSR   OUTCH  / BLANK 3RD 7-SEGMENT LED

00213 01AD 86 01      READ1: LDA A #$01
00214 01AF B7 C147      STA A $C147 / LIGHT 3RD DECIMAL POINT

00216 01B2 39          READ2: RTS

00218                  * THIS ROUTINE WAITS FOR A KEY RELEASE

00220 01B3 C6 14      RELEAS LDA B #20 / INITIALIZE DELAY COUNTER

00222 01B5 8D F0B8    REL1: JSR   ENCODE / GET KEY RELEASE CONDITION
00223 01B8 25 F9      BCS   RELEAS / KEEP TRYING UNTIL RELEASE

00225 01BA 5A          DEC B / DECREMENT THE DELAY TIME
00226 01BB 26 F8      BNE  REL1   / GO BACK IF DELAY NOT DONE

00228 01BD 39          RTS
00230                  * THIS BEGINS THE IRQ SERVICE ROUTINE THAT
00231                  * READS AND LOGS THE MEASURED TIMES.

00233 01BE B6 8001    POLL  LDA A STATUS / GET THE INTERRUPT FLAGS

00235 01C1 44          POLL1: LSR A / SHIFT TIMER1 FLAG INTO 'C'
00236 01C2 36          PSH A / SAVE THE TIMER2 FLAG
00237 01C3 24 11      BCC  POLL2  / BRANCH IF NO TIMER1 FLAG

00239 01C5 B6 8002    LDA A M1 / READ THE TIMER1 COUNT AND
00240 01CB F6 8003    LDA B L1 / CLEAR THE TIMER1 FLAG

00242 01CD DE 14      LDX  POINT1 / POINT TO THE T1X LOCATION
00243 01CD 8C 0009    CFX  #T13+3 / TIMER1 MEMORY BLOCK FULL?
00244 01D0 27 04      BEQ  POLL2  / BRANCH IF FULL

00246 01D2 8D 18      BSR  LOG   / LOG COUNT, ADV POINTER
00247 01D4 DF 14      STX  POINT1 / SAVE THE NEW POINTER

00249 01D6 32          POLL2: PUL A / RESTORE THE TIMER2 FLAG
00250 01D7 44          LSR A / SHIFT TIMER2 FLAG INTO 'C'
00251 01D8 24 11      BCC  DONE  / BRANCH IF NO TIMER2 FLAG

00253 01DA B6 8004    LDA A M2 / READ THE TIMER2 COUNT AND
00254 01DD F6 8005    LDA B L2 / CLEAR THE TIMER2 FLAG

00256 01E0 DE 16      LDX  POINT2 / POINT TO THE T2X LOCATION
00257 01E2 8C 0012    CFX  #T23+3 / TIMER2 MEMORY BLOCK FULL?
00258 01E5 27 04      BEQ  DONE  / BRANCH IF FULL

00260 01E7 8D 03      BSR  LOG   / LOG COUNT, ADV POINTER
00261 01E9 DF 16      STX  POINT2 / SAVE THE NEW POINTER

00263 01EB 3E          DONE: RTI

00265                  * THIS SUBROUTINE TRANSFORMS AND LOGS THE
00266                  * MEASURED TIMES AND ADVANCES THE POINTER.

00268 01EC 43          LOG   COM A / COMPLEMENT THE COUNT TO GET
00269 01ED 53          COM B / HEXADECIMAL ELAPSED TIME
00270 01EE 8D 5F      BSR  SAVE  / SAVE THE HEX ELAPSED TIME

00272 01F0 86 80      LDA A #$80 / SET BIT 7 TO SHOW THAT THIS
00273 01F2 A7 00      STA A 0,X / MEMORY LOCATION IS FILLED
00274 01F4 8D 04      BSR  RD    / CONVERT HEX TIME TO DECIMAL

00276 01F6 08          INX / ADVANCE THE POINTER TO THE
00277 01F7 08          INX / NEXT 3-BYTE MEMORY LOCATION
00278 01F8 08          INX

00280 01F9 39          RTS
00282                  * THIS ROUTINE CONVERTS THE 2-BYTE HEX NUMBER IN
00283                  * 1,X AND 2,X TO A 3-BYTE DECIMAL NUMBER IN

```

Listing 2 continued on page 142

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VAX-11 Unix/V32 VMS	C: \$1130 Pascal: \$1380	*	C: \$630 Pascal: \$880	C: \$1130 Pascal: \$1380
M68000 VERSA dos	*	*	*	C: \$630 Pascal: \$880

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Listing 2 continued:

00284					* 0,X, 1,X AND 2,X.				
00286	01FA	7F	0012	BD	CLR	TEMP1	/TO	HOLD	1000'S & 100'S COUNT
00287	01FD	7F	0013		CLR	TEMP2	/TO	HOLD	10'S COUNT
00289	0200	8D	48	BD4	BSR	FETCH	/	FETCH	REMAINDER
00290	0202	C0	10		SUB B	##10			
00291	0204	B2	27		SRC A	##27	/	SUBTRACT	10,000
00292	0206	25	06		BOS	BD3	/	BRANCH	IF REMAINDER NEGATIV
00294	0208	8D	45		BSR	SAVE	/	SAVE	REMAINDER
00295	020A	6C	00		INC	0,X	/	INCREMENT	10,000'S COUNT
00296	020C	20	F2		BRA	BD4	/	GO	SUBTRACT ANOTHER 10,000
00298	020E	8D	3A	BD3	BSR	FETCH	/	FETCH	REMAINDER
00299	0210	C0	E8		SUB B	##E8			
00300	0212	B2	03		SRC A	##03	/	SUBTRACT	1000
00301	0214	25	0A		BOS	BD2	/	BRANCH	IF REMAINDER NEGATIV
00303	0216	8D	37		BSR	SAVE	/	SAVE	REMAINDER
00304	0218	76	12		LDA A	TEMP1	/	GET	1000'S COUNT
00305	021A	B8	10		ADD A	##10	/	INCREMENT	1000'S COUNT
00306	021C	97	12		STA A	TEMP1	/	SAVE	1000'S COUNT
00307	021E	20	EE		BRA	BD3	/	GO	SUBTRACT ANOTHER 1000
00309	0220	8D	28	BD2	BSR	FETCH	/	FETCH	REMAINDER
00310	0222	C0	64		SUB B	##64			
00311	0224	B2	00		SRC A	##00	/	SUBTRACT	100
00312	0226	25	07		BOS	BD1	/	BRANCH	IF REMAINDER NEGATIV
00314	0228	8D	25		BSR	SAVE	/	SAVE	REMAINDER
00315	022A	7C	0012		INC	TEMP1	/	INCREMENT	100'S COUNT
00316	022D	20	F1		BRA	BD2	/	GO	SUBTRACT ANOTHER 100
00318	022F	8D	19	BD1	BSR	FETCH	/	FETCH	REMAINDER
00319	0231	C0	0A		SUB B	##0A			
00320	0233	B2	00		SRC A	##00	/	SUBTRACT	10
00321	0235	25	0A		BOS	BD0	/	BRANCH	IF REMAINDER NEGATIV
00323	0237	8D	16		BSR	SAVE	/	SAVE	REMAINDER
00324	0239	D6	13		LDA B	TEMP2	/	GET	10'S COUNT
00325	023B	CB	10		ADD B	##10	/	INCREMENT	10'S COUNT
00326	023D	D7	13		STA B	TEMP2	/	SAVE	10'S COUNT
00327	023F	20	EE		BRA	BD1	/	GO	SUBTRACT ANOTHER 10
00329	0241	76	12	BD0	LDA A	TEMP1	/	GET	1000'S & 100'S COUNT
00330	0243	D6	13		LDA B	TEMP2	/	GET	10'S COUNT
00331	0245	EB	02		ADD B	2,X	/	ADD	REMAINDER TO 10'S COUNT
00332	0247	8D	06		BSR	SAVE	/	SAVE	DECIMAL COUNTS
00333	0249	39			RTS				
00335									
00336									
00338	024A	A6	01		FETCH	LDA A	1,X		
00339	024C	E6	02			LDA B	2,X	/	FETCH THESE VALUES
00341	024E	39			RTS				
00343									
00344									
00346	024F	A7	01		SAVE	STA A	1,X		
00347	0251	E7	02			STA B	2,X	/	SAVE THESE VALUES
00349	0253	39			RTS				
00351					END				

SYMBOL TABLE

T11	0000	T12	0003	T13	0006	T21	0009	T22	000C
T23	000F	TEMP1	0012	TEMP2	0013	POINT1	0014	POINT2	0016
UIR()	00F7	CR1	B000	CR2	B001	CR3	B000	STATUS	B001
M1	B002	L1	B003	M2	B004	L2	B005	M3	B006
L3	B007	REDIS	FCBC	OUTHEX	FE28	OUTCH	FE3A	ENCODE	FB88
DISPLAY	FD7B	START	0100	CLEAR	012C	RUN	0134	SHOW	0147
SHOW1	014F	SHOW2	0158	SHOW3	015E	KEY	0168	KEY1	016A
KEY2	0173	SETX	0174	SETX1	0179	SETX2	0185	SETX3	0186
READO	0187	READ1	01AD	READ2	01B2	RELEASE	01B3	REL1	01B5
POLL	01BE	POLL1	01C1	POLL2	01D6	DONE	01EB	LOG	01EC
BD	01FA	BD4	0200	BD3	020E	BD2	0220	BD1	022F
BD0	0241	FETCH	024A	SAVE	024F				



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Text continued from page 134:

The demonstration program was used to time the motion of two colliding air cars on a linear air track. [This apparatus is a cousin to an air-hockey table....RSS] Each timer was

controlled by one phototransistor illuminated by a 1 W incandescent bulb, and each air car carried an opaque vane 10 cm long (see photo 2). The vane blocked the light as the car passed in front of the phototran-

sistor. With timers 1 and 2 operating in the pulse-width-comparison mode, the microcomputer measured how long each phototransistor was blocked as the cars approached and then recoiled from the collision. These measured times, the known lengths of the opaque vanes, and the cars' masses were then used to calculate momenta before and after the collision.

I required that each timer be able to record three elapsed times. Each timer therefore has three memory locations reserved for saving its measurements. Labeled T11 thru T23 in the demonstration program, these memory locations are accessed during readout as times A, B, and C for timer 1 and times D, E, and F for timer 2.

The trainer's six 7-segment LEDs (light-emitting diodes) are used for data display. Each experimental trial begins with the LEDs dark. The 7-segment LEDs then light individually to show letter labels of the elapsed times as they are measured (see photos 3 and 4). When the experimental trial ends, each of the keys A thru F, when pushed, will produce a display of the corresponding elapsed time (see photo 5). Pushing the zero key clears all six memory locations to prepare for another trial.

Although the demonstration program specifies operation of timers 1 and 2 in the pulse-width-comparison mode, it will just as easily support their operation in the frequency-comparison mode. To make the conversion, simply change the number stored at hexadecimal location 010D from hexadecimal 59 (for pulse-width-comparison mode) to hexadecimal 49 (for frequency-comparison mode).

Conclusion

This computer-based timer has been a stable and dependable measurement tool in my introductory physics laboratory. The students enjoy using it and appreciate the repeatability of results attained with it. I hope that you too will find it useful, and I would be interested to hear from readers who develop their own applications. ■

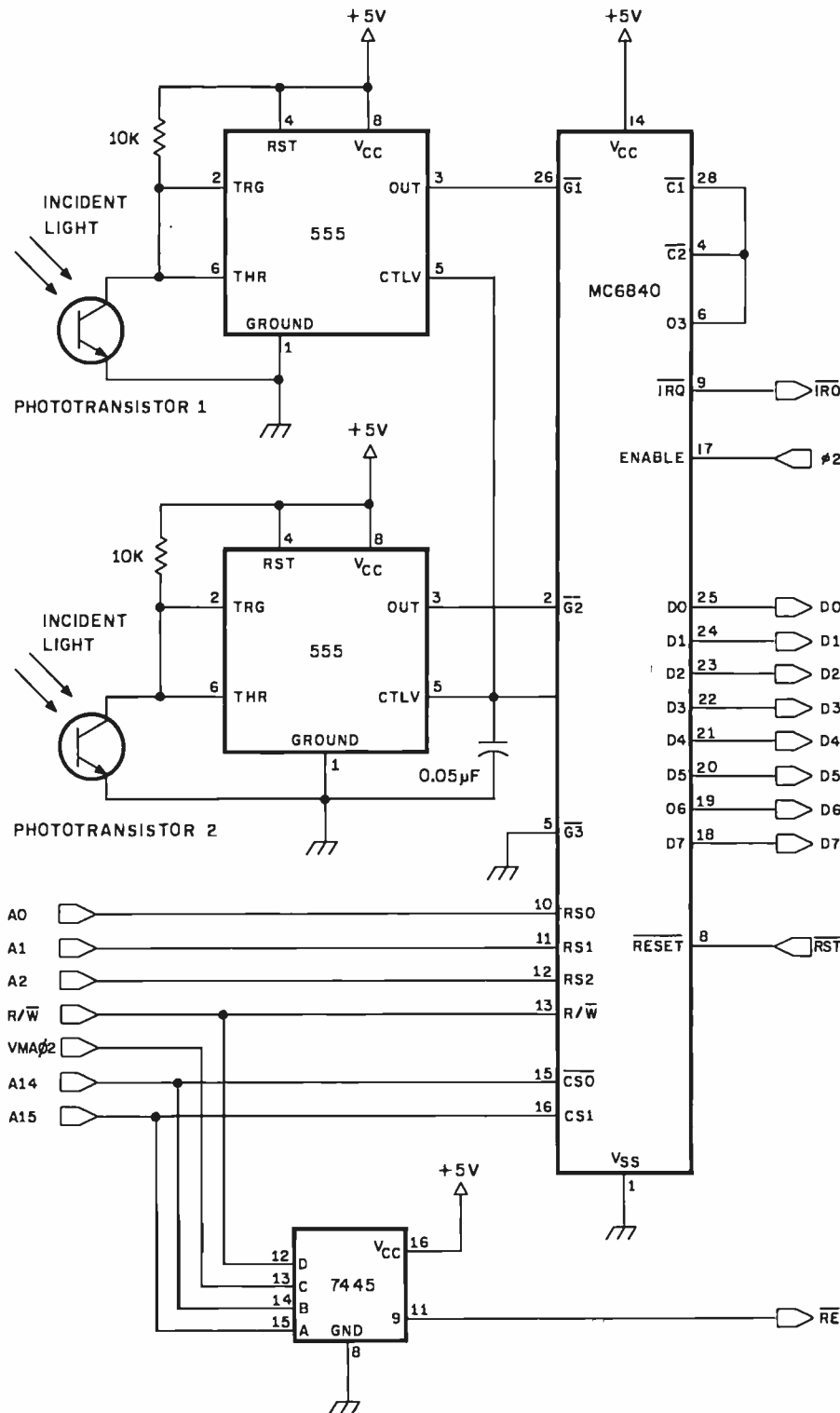
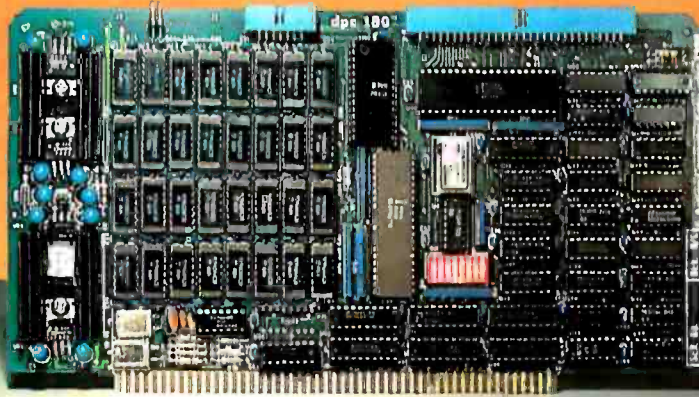
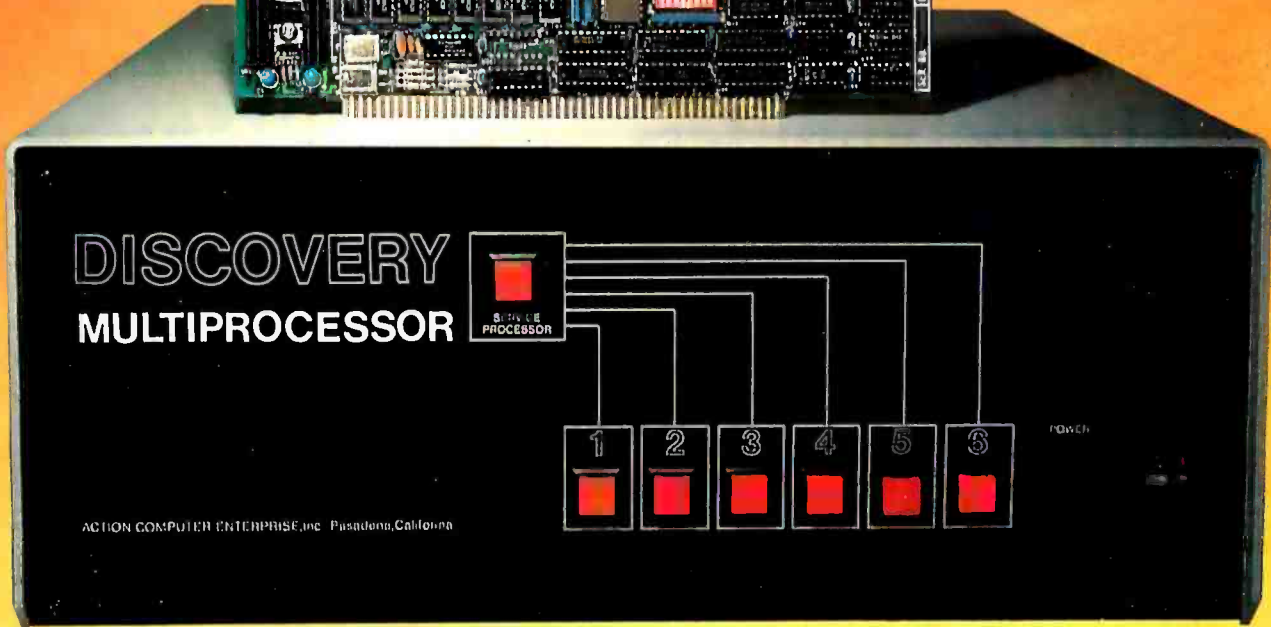


Figure 6: A complete circuit schematic diagram for the two-channel, data-logging, millisecond timer. This is designed to work with the Heath ET-3400 microprocessor trainer.

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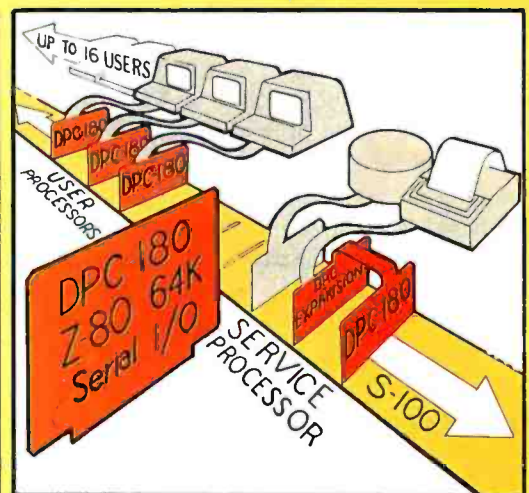
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Microcomputers in Education: A Concept-Oriented Approach

George Wolfe, James Madison University
Harrisonburg VA 22807

In the wake of new technologies, there generally comes an abundance of dreams and possibilities. Inherent in these possibilities is the seed of some new transformation of great or modest proportion. Such a transformation first occurs externally, manifesting itself in the conveniences or specialized abilities the new technology offers. But soon it touches us subjectively and we find ourselves perceiving reality differently. We construct new paradigms to help us understand our changed relationship with the world, and structure new vocabularies of experience.

Familiar examples of such technologies surround us—the electric light bulb, radio and television, satellite communication, medical technology, and nuclear energy. Each of these has altered our way of life to such an extent that any citizen of our culture from a century ago could not have entertained the world view we, by nature, have today. But, the technology that possesses the greatest potential to transform society and human life is just now entering the home: the microcomputer. Unlike some previous technological advances, the computer is not merely a specialized device fulfilling a specialized function. The convenience it provides is less tangible than bringing light into the home or Broadway entertainment into the living room. The computer's role and potential are much more abstract and profound. The new promise it offers is that of AI (artificial intelligence), which we not

only create, but also, via the computer, communicate and interact with.

One of the most constructive fields to apply AI (to capitalize on its capacity to transform) is education. Various applications of microcomputers are already in the classroom and their effect has been found to be highly reinforcing to the learning process. These applications can be placed into the following categories:

- cataloging and processing of information
- learning to program a computer
- using the computer as an instructional tool; ie: CAI (computer-aided instruction)

The first two categories are self-explanatory and may even be somewhat familiar. There is no doubt that the computer can greatly increase the efficiency of a system through data processing, and that skill in computer programming is a growing necessity in our society. The third category may be somewhat less known, but clearly it is growing in use. It involves using computer programs designed to supplement students' assignments in the classroom. Such programs are usually in the form of drills, information exercises, or educational games. They often provide students with a moderate degree of interaction with the computer.

CAI has been defined in various ways and various opinions have been expressed as to its effectiveness. Certainly the value and success of CAI lies in the creative design of the programs and the appropriate setting for their use. Unfortunately, many teachers seem to view CAI as merely an automated drill instructor. Indeed, there is some value in having the computer play this role—it can hold pupils' attention and effectively reinforce their learning. Also, students learn to operate a computer long before any formal programming skill is acquired. But there is one application of CAI which as yet is relatively

About the Author

George Wolfe is a music graduate of Indiana University and has been teaching at James Madison University for the past three years. He is a member of the Association for Integrative Studies and has been privately researching integrative education and the role of the microcomputer in the classroom. Mr Wolfe has also been developing integrative arts related television programs on a grant from the School of Fine Arts and Communications at James Madison University.

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Maximum number of fields/record	100	<u>999</u>	Up to 9 lines for each record	YES <u>Yes(16)</u>
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unexplored. This is the use of the microcomputer to aid students in developing the ability to conceptualize. It is my belief that the transforming value of the microcomputer will be most fully realized through a concept-oriented approach to computer-aided instruction. The purpose of this article is to awaken educators to the solutions concept-oriented computer instruction offers our educational system.

Artificial Intelligence and Specialization

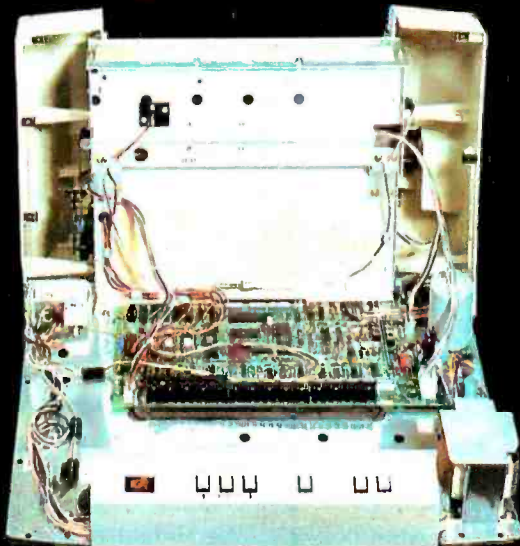
Inherent in the growth of technology is the need for specialization. New information and research, vocational training, and industrial development must accompany advancing technologies. Along with these also comes the expertise necessary to maintain that growth. With the surge of technological and industrial growth in the twentieth century modern education has shifted away from the liberal arts toward pragmatism and specialization. As this trend has increased the classical ideal of a liberal arts education has fallen by the wayside. (See reference 2, page 407.)

While certainly necessary in a technological society, there is a danger which emerges if specialization is carried too far. This danger is dependence and the loss of comprehensive viewpoints. We have seen how a technological society can become dangerously dependent on foreign energy sources needed to drive that society and maintain its standard of living. We have also witnessed how the interaction among nations, motivated by their own individual interests, demands a perspective in world leaders that must be holistic if a stable peace is going to be achieved and sustained. Thus, the many specialized technologies that have brought nations closer together and made them dependent on one another have ironically recreated the need for the Integrated Person; someone who is able to recognize and effectively apply fundamental concepts to numerous, rapidly changing, and adaptively taxing circumstances. Such an individual must necessarily possess a more comprehensive understanding of the various academic disciplines, so that he or she can make decisions that are universally beneficial.

The common belief among educators today is that this *ideal* is impossible to achieve. It certainly appears that way when we examine the flood of information present within every discipline. Education, in keeping pace with technology, has become so oriented toward information gathering and retention that the conceptual links among

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the academic disciplines have been all but lost. The advent of artificial intelligence has the potential to change this, because computer technology provides a means through which information within all disciplines can be effectively handled, processed, and made available. It turns out that mechanical brains manage information better than human brains (ie: a computer's memory and processing capabilities are in many ways superior in efficiency and organization to our own). Thus, the availability of information can be increased in quantity and reliability with microcomputers in the learning environment. The preoccupation of education with information can now be relieved somewhat. Rather than gearing students primarily for absorbing and retaining data, their attention can be directed toward the abilities to conceptualize, abstract, and apply available information creatively. These higher abilities remain uniquely human. We should no longer neglect their formal development for the sake of having students retain enormous amounts of information.

A movement in American education dedicated to promoting a concept-oriented approach to teaching began several decades ago with a small circle of scientists, most of whom had been strongly influenced by general systems theory. Among this group's members were Henry Margenau of Yale University and author-scientist Ervin Laszlo. Their efforts enjoyed a brief period of international recognition during the 1950s and 1960s under the auspices of the Center for Integrative Education. (See reference 1, pages v thru vii.) Their ideas have never been fully realized in the American classroom, but the microcomputer now makes the fulfillment of their approach a definite possibility. The computer is certainly the catalyst through which the integration of knowledge can be achieved in modern education and the direction of teaching changed to include principles and fundamental concepts, as well as specialized information.

Fundamentals of an Integrative Approach

The first and foremost demand of concept-oriented education is the development of thinking skills. Today, we devote much time to cultivating reading and mathematical skills, artistic abilities, and other talents in our students. But we tend to ignore the abilities to think rationally, evaluate circumstances and information accurately, and integrate two or more disciplinary perspectives. As a result, high school and college students often lack the intellectual faculties needed to grasp issues in a sharp and accurate focus.

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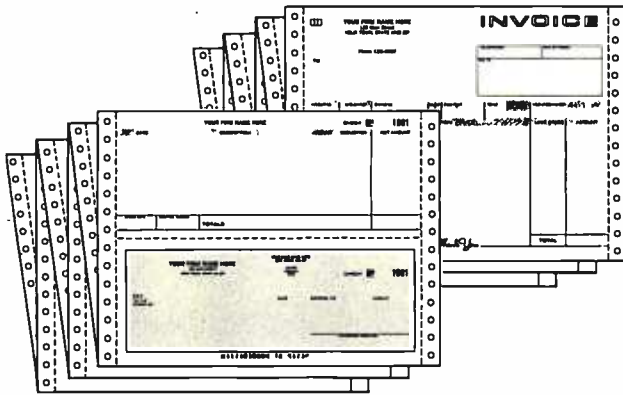
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Education Forum

It is possible, for example, to develop a series of logic programs ranging in difficulty from simple reasoning using concrete ideas, to complex reasoning employing abstract ideas. The relationship between logical and mathematical proof can also be incorporated into such programs. The format could be a kind of logical dialogue between student and computer. For example,

Computer: What do you say to us having a philosophical discussion? I'll start by making a simple statement, and you tell me if you think it is true or false.

"Seeing is believing."

Student: True.

Computer: I take it then, that if you see something, you believe it to be really happening or really there. Is this correct?

Student: Yes.

Computer: OK. So far you are thinking very logically. But now, let me ask you another question.

"Have you ever seen the sun rising in the morning sky?"

Student: Yes.

Computer: Do you know that the sun is not actually rising in the sky? What is actually happening is that the Earth is revolving on its axis, and in doing so, creates the illusion that the sun is moving upward. Now that I have pointed this out, do you still believe the sun is really rising in the sky?

Student: No.

Computer: But do you still see the sun rising in the morning sky?

Student: Yes.

Computer: Well then, you have to reconsider my original statement which was "seeing is believing." You said that this was a true statement, yet you just admitted that even though you have seen the sun rise in the morning sky, it is not really rising. Do you still think that in all cases "seeing is believing."

Student: No.

Computer: Very good! We simply have to recognize that illusions do exist and that seeing something does not always mean that what we are seeing is really happening or really there.... Now consider this next statement.

"The sun appears to be rising in the sky." Is this statement true or false?

Student: True.

Computer: Correct. The word "appears" is what makes the statement true because it suggests that the rising sun is indeed an illusion.

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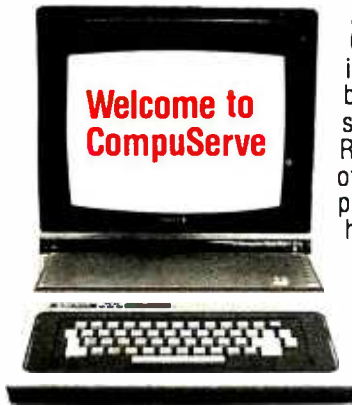
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Education Forum

Another series of programs can be composed to help students learn to discriminate between objectively, rationally, and intuitively derived conclusions. The aim is to develop discernment in the student and provide the time and practice necessary for one to become adept at applying such thinking skills.

Interdisciplinary perspectives can be the theme of still another thinking-model program. Here, the goal is to arrive at the most plausible explanation for something by considering information from various disciplines. For example, students examine explanations based on economic influences, historical factors, or any other perspectives that are appropriate to the subject being considered.

Such a program, in addition to the ones mentioned above, can be designed for educational levels ranging from junior high school through college. (Anyone interested in more information regarding the programs discussed in this article can write the author in care of the Music Department, James Madison University, Harrisonburg VA 22807.)

With thinking skills heightened, we are now ready to pursue the second most important aspect of integrative education, concept development. Concept development often utilizes basic rules and principles, many of which have several exceptions. The idea is for the students to find the exceptions and be able to adapt the principles to suit varying circumstances. To illustrate this, let us compare the steps of an information-oriented approach to a concept-oriented one.

The information-oriented approach is basically an inductive one. That is, we begin by giving out specific facts and data, then we draw conclusions, and finally derive our concepts. (Unfortunately, many teachers today never follow through to the final step of deriving the basic concept!) A concept-oriented approach is deductive rather than inductive. After prerequisite definitions are given, students are taught a generalized concept. From there, students speculate on probable conclusions and hypotheses, then search out the necessary information in an effort to test the conclusions. What the deductive, concept-oriented approach develops is the ability to apply a general concept, and the skills to resourcefully and efficiently locate the information needed to test one's speculative conclusions. To accelerate, simplify, and reinforce this process, the needed information could be made available through a computer retrieval system.

Let us consider how this method can be employed within a discipline through the use of the microcomputer. The following example pertains to basic music theory. The prerequisite information required of the student are knowledge of the definition and labeling of music intervals, the definition of a triad, and how to read treble clef.

Computer: Now I am going to show you how to derive various types of triads by teaching you a simple harmonic concept. This concept is:
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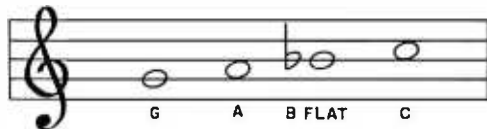


Figure 1: See text for details.

This means that by choosing an interval, and stacking notes on top of one another at the interval you have selected, you can form various types of triads and harmonic textures.

Let us begin by selecting one of the following notes on the treble clef staff shown in figure 1.

Student: A.

Computer: Now choose one of the following intervals:

- second
- third
- fourth
- fifth

Student: Fourth.

Computer: Very good. Now build the triad out of fourths using the note you selected as the

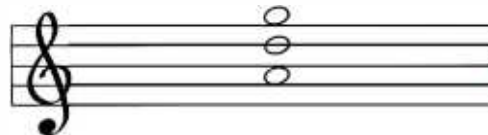


Figure 2: See text for details.

root of the chord. (List the two added notes.)

Student: D and G.

Computer: Correct! (See figure 2.)

Because this triad is built in fourths, it is called a quartal triad. Quartal harmony has been used by many twentieth-century composers. Now check the text file for information on quartal harmony and answer the following questions....

Now choose another interval...(etc)

Computer: This is a basic principle for building triads. Usually, students only learn about tertian harmony (chords built in thirds) in the early years of music theory. But by using this concept, you can jump ahead and learn to write triads which are usually considered advanced...

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A third important element of concept-oriented education is the interdisciplinary transfer of knowledge. Here, we are dealing with unifying relationships among disciplines, usually closely related disciplines. In the arts for example, there are certain fundamental aesthetic elements that are common to media. Among these are contrast, intensity, and proportion. The techniques used to employ these elements in an artwork are different for every medium, but the aesthetic purpose served is essentially the same. Microcomputer programs could be developed to teach such interdisciplinary, isomorphic relationships. If used early enough in a child's education, a network of unity could be structured among the disciplines. Then, even when specialization becomes necessary later on, a holistic perspective would always remain with the student. ■

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2. Meyer, Adolphe E. *An Educational History of the American People*. New York: McGraw-Hill, 1967.

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The phrase "we interrupt this program to bring you an important announcement" is as applicable to computers as it is to radio or television. The interrupt system of a computer stops the program being processed to perform a more important task.

What is an interrupt? It is a computer control-signal input that is sampled by the microprocessor during every instruction cycle. If an external device has *asserted* (activated) the interrupt line, the microprocessor will cease processing the normal flow of instructions, put an *interrupt vector* on the address lines, and load the program counter with the address pointed to by the interrupt vector. The microprocessor can then begin execution of the interrupt-handling program found at this address.

Simply stated, an interrupt is a forced, immediate branch to some specified memory address in response to an externally generated control signal. A computer system will generally use additional hardware to implement a number of possible interrupts, each with its own priority and interrupt-handling routine.

Why Interrupt?

At present, few microprocessor-based systems are interrupt driven. Any program requiring I/O (input/output) operations, or timing functions, must employ a timing loop (a sequence of instructions that takes a known interval to execute) until the operation is complete. As an example, writing eighty characters to a teletypewriter at a rate of 110 bits per second would require about eight seconds. The processor uses most of this time to constantly sample the *transmitter ready* status of the interface involved. In eight seconds, an 8080A microprocessor could process about four million instructions. As you can see, sitting in a status-checking loop is not an efficient processing method.

Now suppose that the transmitter-ready signal from the interface is used to assert the interrupt line to the microprocessor. Whenever the interface is ready to accept another character, the processor is forced to branch to the output routine. It sends the next character, then returns to the main program. For the specific example we are using, this fairly simple

procedure results in making four million additional instruction periods available.

Obviously, in many low-level applications, it really doesn't matter how much time is spent in an I/O loop because the user won't be proceeding with the program until the output is complete. However, in many higher-level applications, such as multiprogramming and high-speed instrumentation programs, it becomes imperative that the processor not be tied up. Interrupt-driven software and hardware become essential. Multiuser, multiprogramming systems become feasible only in an interrupt-driven environment.

Any programming that requires timing or periodic functions can also benefit from the use of interrupts in conjunction with a programmable timer. Tasks such as keyboard scanning or display refreshing are very simple to accommodate using an interrupt system. There is very little impact on the main program task by occasional interrupts, and a little software can replace additional hardware.

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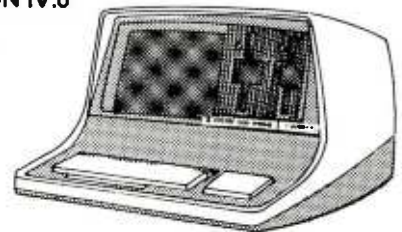
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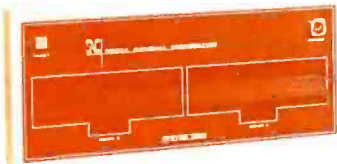
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Technical Forum

Multiple programs can also run under an interrupting, time-sharing system. Each program may be assigned a certain percentage of the total processing time. A timed interrupt and executive routine are used to rotate the processor between programs. The executive program, from which the interrupt branches, acts as a "traffic cop" to give each program its fair share of time.

Multilevel Interruption

A computer system generally has

several interrupting devices. To sort out these interrupts a priority scheme is generally used. The priority scheme assigns each device in the system a priority level, according to its importance. This allows the most important I/O devices to be serviced before those of lower priority. Except in the simplest interrupt implementations, a higher-level interrupt is allowed to interrupt the current routine of a lower-priority interrupt. In this way, several interrupt routines could conceivably be nested in a busy system.

Most microprocessors have only one general-purpose interrupt input, and external hardware must be used to resolve priorities between the various interrupt lines. The hardware may also provide for additional functions, such as individually selectable interrupt levels and nesting of interrupts. The hardware involved in a very simple interrupt system is shown in figure 1a. In this system, once an interrupt occurs, the interrupt system should remain disabled until completion of the interrupt routine. With this very simple implementation a high-level interrupt may not interrupt a lower-level routine once it is in progress.

For an interrupt to be recognized by the microprocessor an *enable interrupts* instruction must have been previously executed by the program. Additionally, some devices will require that a special interrupt register be set with the proper vectoring data. When an interrupt is recognized, the contents of the program counter will be pushed onto the stack, and the start address of the interrupt routine will replace the old program-counter data.

When an interrupt occurs, the return address is saved on the stack, and the processor branches unconditionally to the interrupt routine. The microprocessor will also disable its internal interrupt system whenever an interrupt occurs. Software must enable interrupts again before other interrupts will be recognized by the device.

An interrupt routine should also do some housekeeping to insure a successful return to the interrupted program. First, the contents of all the registers should be saved so that their contents can be restored prior to resuming the interrupted program. Depending upon your hardware, you may need to output the priority level of the current interrupt for comparison with incoming interrupts.

In the case of serial devices, such as terminals or cassette decks, the microprocessor is usually interfacing with a UART (universal asynchronous receiver-transmitter). These devices have signals indicating "receiver ready" and "transmitter ready" to assert interrupt lines. The signals can be used as independent interrupts (one per device) or can

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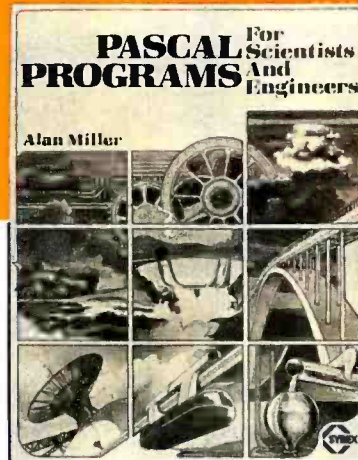
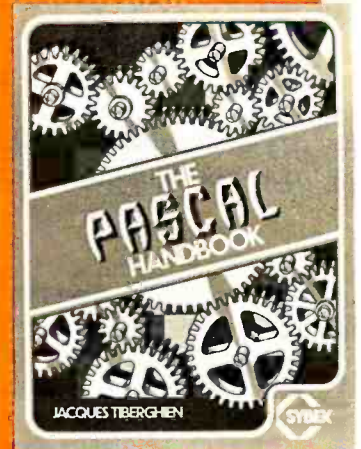
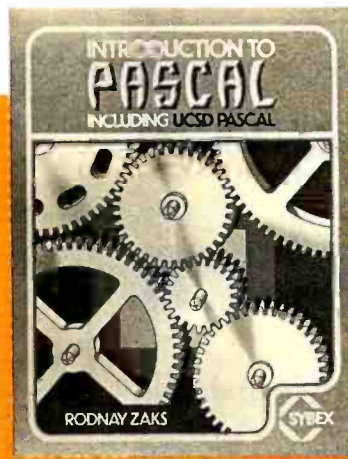
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be combined into a single interrupt. In the latter case, software can examine the device status to determine the required operation. The act of servicing the UART will clear the condition of the signals.

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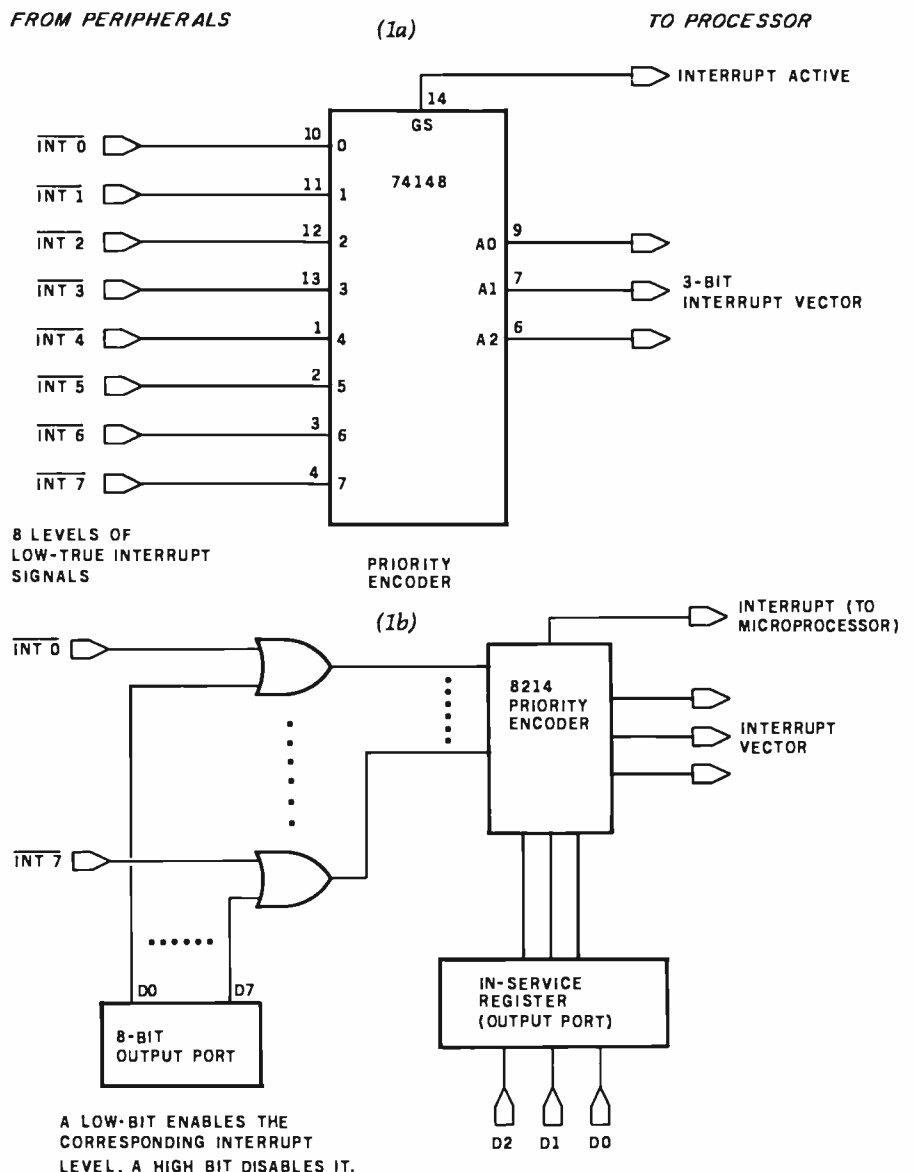


Figure 1: Hardware for handling multiple-level interrupts. This system allows a computer to handle the requests of peripheral devices in order of priority. The arrangement in figure 1a has the capacity to service eight separate priority levels. Each interrupt is completed before others are allowed. A more sophisticated scheme is shown in figure 1b. It has the ability to halt current interrupt service if a higher-level interrupt occurs (when the higher-level interrupt is finished, control is returned to the lower-priority interrupt and its service is completed).

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Z80 Table Lookup

Thomas McCloud, 26572 Hickory Ave, Hayward CA 94544

Among the problems familiar to experienced programmers is that of table lookup: given a value (the argument, or *key*), search through a list of values of the same kind to find a matching entry. Then, once a match is found, extract the corresponding entry (the function, or *result*) from a second list, often of a different kind of data. This article discusses a single table-lookup routine (written specifically for a Zilog Z80 microprocessor) that, given an 8-bit value, finds a corresponding 16-bit value. As such, this article is of primary interest only to Z80 programmers. But it shows them how the special instructions peculiar to the Z80 can be used to good effect.

The routine, ZTL, is shown in listing 1. It achieves a great economy of program size, and a good economy of execution time, by using the special Z80 block-search instruction, CPDR (Compare, Decrement and Repeat). The

similar search instruction, CPIR (Compare, Increment and Repeat), may seem more natural to use. But for the routine presented here, CPDR provides more easily used "leftover information" in the BC register pair.

To show how the routine works, consider the following example. A computer-system monitor is being written. The system user types a single character command, and the system responds by performing an indicated action. The commands are:

- I — Initialize system
- D — Display hexadecimal memory dump
- G — Get a file from external media
- X — Execute a program
- E — Enter hexadecimal data into memory
- B — Set a breakpoint

Some of the commands need additional data, such as the address at which a breakpoint is to be set. However, the only current concern is to identify the command and branch to the address of the corresponding command-handling routine. Listing 2 shows the memory arrangement of the table for ZTL. (Values given for the addresses of the command-handling routines are purely arbitrary.)

The call to use the ZTL routine is shown in listing 3. Listing 4 shows a step-by-step illustration of the contents of each register involved, assuming that the program has extracted a G command from the typed input.

The first two instructions simply copy the contents of the BC register pair (used to hold the byte count) into the DE register pair (to be used later). The next instruction is the Z80 CPDR. It is executed four times in the current example. On the first execution, the G in register A is compared to the B at the location (hexadecimal 12F5) indicated by the HL register pair, the contents of HL are decremented from hexadecimal 12F5 to 12F4, and the byte count is decremented from 6 to 5. Since the bytes compared did not match, and the byte count did not go to zero, the instruction is repeated, using the new values in the HL and BC register pairs.

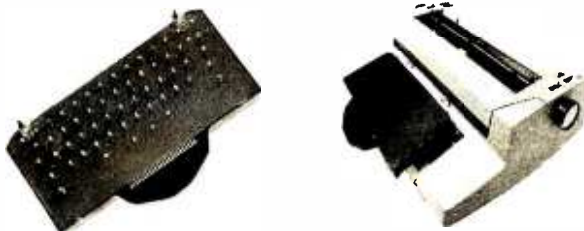
On the fourth execution of the CPDR instruction, the G in register A is compared to the G at the location indicated by the HL register pair (hexadecimal 12F2), the contents of HL are decremented from hexadecimal 12F2 to 12F1, and the byte count is decremented from 3 to 2. Since the bytes compared did match, the instruction is not repeated. Notice that the HL register no longer points to the G in the table; it points one location below the G. This is a nuisance caused by Zilog's choice of a "post-test



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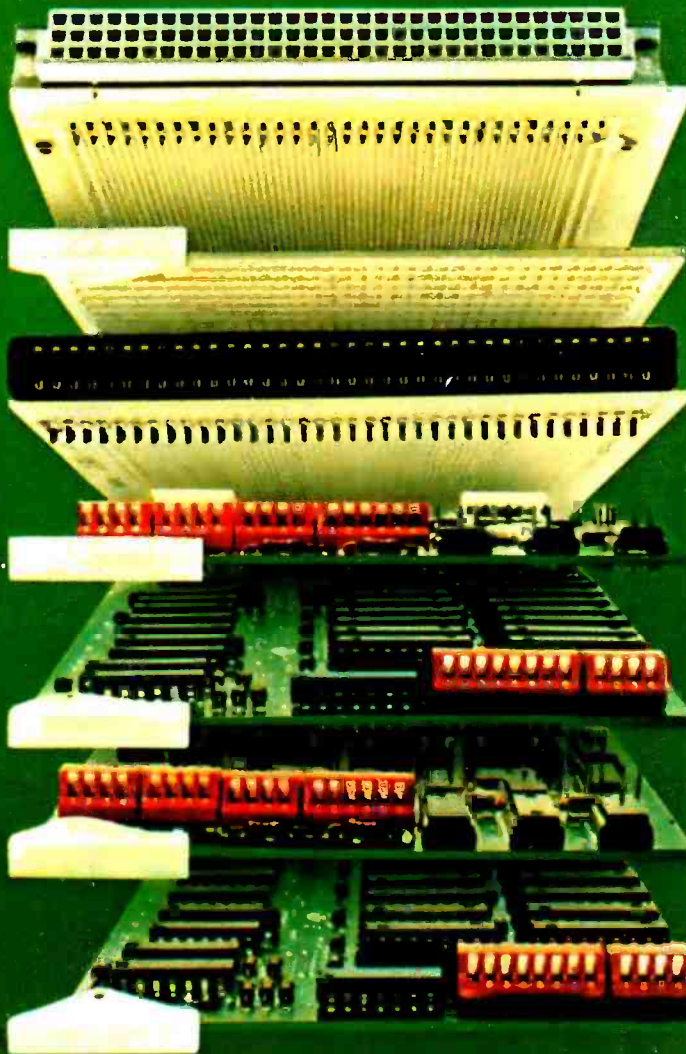
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loop" approach instead of a "pre-test loop." It is not difficult to compensate for it, but it is easy to forget.

The next instruction executed is a RET NZ (return on not zero), which provides an exit when the byte for which a match is sought does not occur in the table. In the current example, this return is not taken. Following the RET NZ is an instruction to increment the contents of the HL register pair. This instruction is used to compensate for the incorrect value stored in the HL register, described above.

The next two instructions compute the address of the first (low-order due to high/low storage reversal) byte of the sought argument—the corresponding entry in the second part of the table. Suppose *B* is the beginning address of the first part of the table, *L* is the length of the first part of the table, and *I* is the position of the sought byte in the table, *I* ranging from 1 to *L*. The second part of the table starts at address $B + L$, and the sought entry starts at address $B + L + (I - 1) \times 2$. At this point in the execution of the routine, BC holds *I* - 1, because the CPDR decrements the byte count once too often, as well as the address in HL. Furthermore, the address in HL is $B + (I - 1)$ (compensated). So, when the routine adds BC to HL:

$$HL = B + (I - 1) + (I - 1)$$

Then, adding the table length *L*, saved in DE:

$$HL = B + (I - 1) + (I - 1) + L$$

so:

$$HL = B + L + (I - 1) \times 2$$

which is the address of the sought argument.

Text continued on page 174

Listing 1: ZTL, a table-lookup routine for the Z80 micro-processor. The use of the Z80's block-search instructions makes this routine short and fast, but some of the microprocessor's idiosyncrasies need compensation.

```

;NAME: ZTL
;PURPOSE: Z80 TABLE LOOKUP
;INPUTS: A = ARGUMENT (BYTE VALUE FOR WHICH
;         WORD VALUE IS TO BE FOUND.)
;         BC = LENGTH OF TABLE ARGUMENT LIST
;         HL = ADDRESS OF LAST TABLE ARGUMENT
;NOTE: TABLE MUST CONSIST OF AN ARGUMENT LIST OF
;      SINGLE-BYTE ENTRIES, FOLLOWED BY A FUNCTION
;      LIST OF CORRESPONDING SINGLE-WORD ENTRIES.
;      (WORDS STORED WITH USUAL LOW-HIGH BYTE
;      INVERSION.)
;OUTPUTS: IF NO MATCH FOUND FOR INPUT:
;         ZERO FLAG OFF (NZ)
;         IF MATCH FOUND FOR INPUT:
;         ZERO FLAG ON (Z)
;         HL = VALUE FROM CORRESPONDING
;         FUNCTION ENTRY
ZTL: EQU $
LD D,B ;COPY LENGTH FROM BC
      (BYTE COUNT) . . .
LD E,C ;. . . INTO DE (TO SAVE FOR LATER)
CPDR ;SEARCH DOWN ARGUMENT ENTRIES
RET NZ ;"NOT ZERO" MEANS NO MATCH
      FOUND
;NOTE THAT NONE OF THE FOLLOWING CHANGES THE
;ZERO FLAG
INC HL ;COMPENSATE FOR CPDR OVERSHOT
ADD HL,BC ;ADD REMNANT OF BYTE COUNT
ADD HL,DE ;ADD ORIGINAL LENGTH
;AT THIS POINT THE HL REGISTER PAIR POINTS TO THE
;DESIRED FUNCTION ENTRY
LD E,(HL) ;PICK UP LOW-ORDER BYTE
INC HL
LD D,(HL) ;PICK UP HIGH-ORDER BYTE
    
```

Listing 1 continued on page 172

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Programming Quickies

Listing 1 continued:

```
EX    DE,HL ;PUT RESULT INTO HL (MORE
      ;USEFUL THERE)
RET      ;DONE
```

Listing 2: Arrangement of the table in memory for use by ZTL.

ADDRESS	DATA
12F0	49 [LETTER "I"]
12F1	44 [LETTER "D"]
12F2	47 [LETTER "G"]
12F3	58 [LETTER "X"]
12F4	45 [LETTER "E"]
12F5	42 [LETTER "B"]
12F6	00 [INITIALIZE ROUTINE AT ADDRESS 0000]
12F7	00
12F8	AA [DISPLAY ROUTINE AT ADDRESS 06AA]
12F9	06
12FA	0B [GET ROUTINE AT ADDRESS 070B]
12FB	07
12FC	12 [EXECUTE ROUTINE AT ADDRESS 0112]
12FD	01
12FE	08 [SET BREAKPOINT ROUTINE AT ADDRESS 0A08]
12FF	0A

Listing 3: Sample of the call to ZTL.

[NOTE: AT THIS POINT IT IS ASSUMED THAT REGISTER A ALREADY CONTAINS THE ASCII CHARACTER "G", EXTRACTED FROM INPUT, FOR WHICH THE TARGET ADDRESS IS TO BE FOUND.]

```
LD    BC,6 ;LOAD LENGTH OF ARGUMENT
      TABLE
LD    HL,12F5H ;ADDRESS OF LAST TABLE ENTRY
;FIND ADDRESS IN FUNCTION TABLE CORRESPONDING TO
;BYTE IN A
CALL ZTL ;Z80 TABLE LOOKUP
JP    (HL) ;GO TO THE ADDRESS SO FOUND
```

Listing 4: Register contents as ZTL executes (see the text for an explanation of the specific example).

INSTRUCTION EXECUTED	REGISTER CONTENTS	TABLE BYTE (HL)
	A Z-FLAG B C D E H L	
ZTL ROUTINE CALLED	47 ?? 00 06 ?? ?? 12 F5	42
LD D,B ;COPY LENGTH FROM BC (BYTE COUNT)...	47 ?? 00 06 00 ?? 12 F5	42
LD E,C ;...INTO DE (TO SAVE FOR LATER)	47 ?? 00 06 00 06 12 F5	42
CPDR ;SEARCH DOWN ARGUMENT ENTRIES	47 ?? 00 05 00 06 12 F4	45
CPDR [INSTRUCTION REPEATS ITSELF]	47 NZ 00 04 00 06 12 F3	58

Listing 4 continued on page 174

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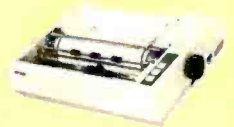
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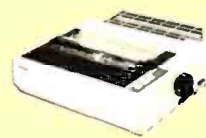
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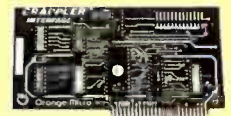
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Programming Quickies

Listing 4 continued:

```

CPDR    [INSTRUCTION REPEATS ITSELF]
        47  NZ    00 03 00 06 12 F2    47
CPDR    [INSTRUCTION REPEATS ITSELF]
        47  Z     00 02 00 06 12 F1    44
RET     NZ ;"NOT ZERO" MEANS NO MATCH FOUND
        47  Z     00 02 00 06 12 F1    44
INC     HL ;COMPENSATE FOR CPDR OVERSHOT
        47  Z     00 02 00 06 12 F2    47
ADD HL,BC ;ADD REMNANT OF BYTE COUNT
        47  Z     00 02 00 06 12 F4    45
ADD HL,DE ;ADD ORIGINAL LENGTH
        47  Z     00 02 00 06 12 FA    0B
LD      E,(HL) ;PICK UP LOW-ORDER BYTE
        47  Z     00 02 00 0B 12 FA    0B
INC     HL
        47  Z     00 02 00 0B 12 FB    07
LD      D,(HL) ;PICK UP HIGH-ORDER BYTE
        47  Z     00 02 07 0B 12 FB    07
EX      DE,HL ;PUT RESULT INTO HL (MORE USEFUL THERE)
        47  Z     00 02 12 FB 07 0B    ??
RET     ;DONE
        47  Z     00 02 12 FB 07 0B    ??
    
```

Text continued from page 170:

The next instructions pick up the low-order byte, increment HL, and pick up the high-order byte of the sought argument word. They are put directly into the DE register

pair by means of the HL register indirect instructions. If the answer is useful in DE, the routine can be ended here with a return; but, since an answer is generally more useful in the HL register pair, the routine as shown includes an exchange of DE with HL.

Finally, the routine ends with a simple unconditional return statement. It is important to note that *none* of the instructions following the CPDR will affect the zero flag. This allows the calling routine to easily determine if a match was found by examining the zero flag. The fact that the 16-bit ADD (without including previous carry) instructions do not set the zero flag is often a nuisance. But in this routine it is an advantage.

Beyond Tables

This article described a simple routine with a great deal of power. The example of usage presented dealt with finding the address of a software routine when given a single character command. However, the same routine can be called whenever you want to find 16 or fewer bits of information from a single 8-bit value. For example, it could be used to interpret single-byte codes used to store 3-digit telephone prefixes. Or it might be useful in a compiler to store a table of kinds of variables and their attributes. Hopefully, you will find that problems of your own can be solved with this simple and efficient routine. ■

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Four Word Processors for the Apple II

The world of word processors has expanded rapidly in the past few years, and it appears to be only the beginning. We have seen a flourish of office automation machines from the big manufacturers, but with few exceptions the small machine software manufacturers have led the way. And, after reviewing some of the word-processing systems designed for microcomputers, we discovered that they have several advantages.

It was a temptation when reviewing these word processors to compare them to their large mainframe brothers. Eventually we stopped resisting that temptation. Both Steve and I have access in our work to such mainframe word processors as those by Wang and Honeywell. The com-

Keith Carlson
43 McDill Rd
Bedford MA 01730

Steve Haber
14 Larchmont Dr
Nashua NH 03062

parison hardly seems fair, but in reality most of the microcomputer word processors offer the features found in their larger brothers: in fact, a few of them are easier to use and learn, while still providing all of the features a user could possibly want. This will be evident in specific reviews.

There are two kinds of word processors: *screen-* or *cursor-oriented*, and *line-oriented*. Cursor-oriented

means that the editing and entry take place at the cursor, which is moved throughout the text. In line-oriented word processors, all text is entered and referred to with line numbers. Neither method appears to have a distinct advantage over the other: they are merely different ways of referencing the text.

Super-Text

Super-Text is a super word processor that, despite minor problems, exhibits some of the power-packed features you would expect in a word processor designed for a much larger machine. Super-Text (from Muse Software) can be easily adapted to your current equipment, as well as any you may acquire in the future.



Photo 1: Apple word processors: the Datacope Scribe, the Rainbow Write-On!, the IUS EasyWriter Professional system, and the Muse Super-Text II. (The cream-colored binder in the upper left corner is for Super-Text I, which has been discontinued by Muse.)

At a Glance

Name

Super-Text II

Type

Word processor

Manufacturer

Muse Software
330 N Charles St
Baltimore MD 21201
(301) 659-7212

Price

\$150

Format

5-inch floppy disk

Language

6502 machine language

Computer

Apple II or II+ with 48 K bytes of memory and one disk drive

Documentation

82 pages, 15.5 by 23 cm (6 by 9 inches); three-ring binder

Audience

Anyone needing a word-processing system

Now proven baZic can be run on any Z80[®] computer under CP/M.[®] baZic is written entirely in Z80 code—runs faster than any other BASIC interpreter. The greater execution speed is significantly advantageous for heavy number crunching, multi-user and multi-tasking operations.

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- baZic as shipped includes 8, 10, 12, and 14 digit precisions, including both software and hardware floating point versions.
- baZic is also available for the Apple II[®] under CP/M with the SoftCard.[™]

OEMs and dealers contact Silverman Associates for details. 4010 Opal Street, Oakland, CA 94609. (415) 428-2954. All other inquiries should be to your dealer or Micro Mike's.

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With the Dan Paymar lowercase adapter (which allows the Apple to display lowercase letters), this processor supports true lowercase.

Super-Text also allows conversion of files for use with the Paymar lowercase adapter. However, it does not allow the reverse, so you must either keep two copies of the text file or always use an Apple II with the lowercase adapter. Most of the other Apple II word processors use reverse-video to represent uppercase letters on the screen. If you don't have a Paymar lowercase adapter, Super-Text places a reverse-video A in front of the character to be capitalized, instead of highlighting the character it-

self. This can be confusing until you get used to it, because the reversed A does not print when you print the file. We found that we had a tendency to compensate for the nonprinting character when lining up text. You have to use the control key as a shift, but Super-Text will support the use of the shift key with a minor modification to the keyboard. (Muse provides the short piece of wire and instructions for the modification.)

Super-Text does not support an 80-column board, but it simulates 80 columns by using a preview mode. This mode allows you to see what your text will look like on paper, with obvious limitations on color, super-/

subscripting, and underlining. (In any case, these limitations are dependent upon the printer that you use.)

Since you can only see the leftmost 40 columns on the screen, the preview mode allows you to move the left margin to the right to see the other half of the document; however, we found the operation awkward to use because the text scrolls past quickly. Still, this arrangement is better than wasting paper to see what you have written.

Super-Text uses the wraparound method of text entry (ie: if a word will not fit on a line, the entire word is automatically moved to the next line). Some word processors use a

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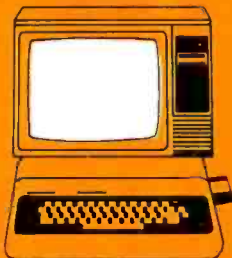


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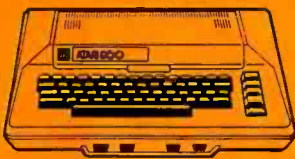
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"hot zone" to prompt for hyphenation, but if you want hyphenation with Super-Text you must perform it manually. By embedding control characters in the text, you can instantly invoke format changes, tab stops, automatic paragraph indentation, word centering, and left margin changes. These control characters appear as reverse video letters. Super-Text formats the text upon printout, so the effects of these control characters are visible only on printout or during preview mode.

The only files Super-Text will accept, other than those written by itself, are Dr Memory files. (Dr Memory is the predecessor of Super-Text.) Muse also has add-on modules that can produce form letters (available for \$100), input files by telecommunication (\$75), and plot graphs (no price quoted).

Super-Text's ability to edit is excellent. The word processor is cursor-oriented, and it gives the user a full set of commands to move the cursor about the text. The cursor scrolls backward or forward by operator choice, and the direction is clearly marked in the lower left-hand corner. The replacement, deletion, insertion, and rearrangement of text processes are all easy to use and understand. However, one minor problem appears with insertion: normally insertion occurs in front of the current cursor location—with Super-Text, it occurs *after* the cursor location. This is unnerving and hard to get used to. Super-Text can also copy blocks of text easily throughout the text file, and it can save and load blocks of text separately, a feature that is especially helpful with "boilerplate" files used in business correspondence.

Find-and-replace operations are easy and efficient. The operations even include a "wild card" notation that will match any number of intervening characters (including none). For example, an attempt to find "COMPUT#WORLD" would match "COMPUTER WORLD" or "COMPUTING WORLD". Super-Text is loaded with prompts that make find-and-replace operations easy for the operator.

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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 excitement 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 (TRS-80 only) Price: \$14.95 Cassette/\$18.95 Diskette
This is simply the best cribbage game available. It is an excellent program for the cribbage player in search of a worthy opponent as well as for the novice wishing to improve his game. The graphics are superb and assembly language routines provide rapid execution.

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. Color, graphics, sound.

POKER PARTY (Available for all computers) Price: \$17.95 Cassette/\$21.95 Diskette
POKER PARTY is a draw poker simulation based on the book, POKER, by Oswald Jacoby. This is the most comprehensive version available for microcomputers. The party consists of yourself and six other (computer) players. Each of these players (you will get to know them) has a different personality in the form of a varying propensity to bluff or fold under pressure. Practice with POKER PARTY before going out to that expensive game tonight! Apple Cassette and diskette versions require a 32 K for larger Apple II.

NOMINOES JIGSAW (Atari, Apple and TRS-80 only) Price: \$16.95 Cassette/\$20.95 Diskette
A jigsaw puzzle on your computer! Complete the puzzle by selecting your pieces from a table consisting of 60 different shapes. NOMINOES JIGSAW is a virtuoso programming effort. The graphics are superlative and the puzzle will challenge you with its three levels of difficulty. Scoring is based upon the number of guesses taken and by the difficulty of the board set-up.

CRANSTON MANOR ADVENTURE (North Star only) Price: \$19.95
At last! A comprehensive Adventure game for the North Star. CRANSTON MANOR ADVENTURE takes you in mysterious CRANSTON MANOR where you attempt to gather fabulous treasures. Lurking in the manor are wild animals and robots who will not give up the treasures without a fight. The number of rooms is greater and the associated descriptions are much more elaborate than the current popular series of Adventure programs, making this game the top in its class. Play can be stopped at any time and the status word on diskette. Requires 32K.

VALDEZ (Available for all computers) Price: \$14.95 Cassette/\$18.95 Diskette
A simulation of suprastar 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 icebergs! For any standard terminal may be used for display.

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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.

STARTREK 3.2 (Available for all computers) Price: \$ 9.95 Cassette/\$13.95 Diskette
This is the classic Star Trek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning who also attack starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and more than when who all. The situation is hectic when the Enterprise is besieged by three heavy cruisers and a starbase S.O.S. is received: The Klingoniest event!

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 casting, 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.

BLACK HOLE (Apple only) Price: \$14.95 Cassette/\$18.95 Diskette
This is an exciting graphics 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 slide jels for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

HODGE PODGE (Apple only, 48K Integer BASIC) Price: \$19.95 Cassette/\$23.95 Diskette
Let HODGE PODGE be your child's babysitter. Pressing any key on your Apple will result in a different and intriguing "happening" related to the letter or number of the chosen key. The program's graphics, color and sound are a delight for children from ages 10 to 9. HODGE PODGE is a non-intimidating teaching device which brings a new dimension to the use of computers in education. HODGE PODGE requires a 48K Apple running with Integer BASIC.

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 4, TEACHER'S PET provides the young student with counting practice, letter-word recognition and three levels of math skill exercises.

SPACE TILT (Apple only) Price: \$10.95 Cassette/\$14.95 Diskette
Use the game paddles to tilt the plane of the TV screen to "float" a ball into a hole in the screen. Sound ahh! 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.

MOVING MAZE (Apple only) Price: \$10.95 Cassette/\$14.95 Diskette
MOVING MAZE employs the game paddles to direct a puck from one side of a maze to the other. However, the maze is dynamically (and randomly) built and is continually being modified. The objective is to cross the maze without touching (or being hit by) a wall. Scoring is by a elapsed time indicator, and three levels of play are provided.

ALPHA FIGHTER (Atari only) Price: \$14.95 Cassette/\$18.95 Diskette
Two excellent graphics and action programs in one! ALPHA FIGHTER requires you to destroy the alien starships passing through your sector of the galaxy. ALPHA BASE is in the path of an alien UFO invasion; let five UFO's fly by and the game ends. Both games require the joystick and get progressively more difficult the higher you score!

INTRUDER ALERT (Atari only) Price: \$16.95 Cassette/\$20.95 Diskette
This is a fast paced graphics game which places you in the middle of the "Dreadnav" having no stolen plans. The dreadnavs have been alerted and are detected whenever you are all. You must find and enter your ship to escape with the plans. Five levels of difficulty are provided. INTRUDER ALERT requires a joystick and will run on 16K systems.

GIANT SLALOM (Atari only) Price: \$14.95 Cassette/\$18.95 Diskette
This real-time action game is guaranteed addictive! Use the joystick to control your path through slalom courses coming both from open and closed gates. Choose from different levels of difficulty, race against other players or simply take practice runs against the clock. GIANT SLALOM will run on 16K systems.

CRYSTALS (ATARI only) Price: \$ 9.95 Cassette/\$13.95 Diskette
A unique algorithm randomly produces fascinating graphics displays accompanied with tones which vary as the patterns are built. No two patterns are the same, and the combined effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari.

CHOMP-OTHELLO (Atari only) Price: \$11.95 Cassette/\$15.95 Diskette
CHOMP-OTHELLO is a truly challenging game in one. CHOMP is similar in concept to NIM, you must bite off part of a cookie, but avoid taking the poisoned portion. OTHELLO is the popular board game set fully utilize the Atari's graphics capability. It is also very hard to beat! This package will run on a 16K system.

GAMES PACK I (Available for all computers) Price: \$9.95 Cassette/\$13.95 Diskette
GAMES PACK I contains the classic computer games of BLACKJACK, LUNAR LANDER, CRAPS, HORSEACE, SWITCH and more. These games have been combined into one large program for ease in loading. They are individually accessed by a convenient menu.

GAMES PACK II (Available for all computers) Price: \$9.95 Cassette/\$13.95 Diskette
GAMES PACK II includes the games CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUABPLUS and others. As with GAMES PACK I, all the games are loaded as one program and are called from a menu.

When you pay \$7.95 or more per program when you can buy a DYNACOMP collection for just \$9.95!
NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY Price: \$9.95 Diskette
DYNACOMP now distributes the 20-volume NSSE library. Most of these diskettes offer an outstanding value for the purchase price. Write for details regarding the contents of this library and quantity (four or more) purchases.

Availability

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. Unless otherwise specified, all programs will run with 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 Level II and Apple (Applesoft) cassette diskette as well as North Star single density (double density computerized diskette). Additionally, most programs can be obtained on standard (IBM format) 8" CP/M floppy disks for systems running under IBMASIC.

BUSINESS AND UTILITIES

MAIL LIST 2.2 (Apple, Atari and North Star diskette only) Price: \$34.95
This program is unmatched in its ability to store a maximum number of addresses on one diskette (minimum of 1100 per diskette, more than 2000 for "double density" systems). Its many features include alphabetic and zip code sorting, label printing, merging of files and a unique keyword seeking routine which retrieves entries by a virtually limitless selection of user-defined codes. A very valuable program!

FORM LETTER SYSTEM (FLS) (Apple and North Star diskette only) Price: \$21.95
Use FLS to create and edit form letters and address lists. Form letters are produced by automatically inserting each address into a predetermined portion of your letter, and the process is completely compatible with MAIL LIST 2.2, which may be used to manage your address files.
FLS and MAIL LIST 2.2 are available as a combined package for \$49.95.

PERSONAL FINANCE SYSTEM (ATARI only) Price: \$34.95
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; 16 optional user codes; data retrieval by month, code or name; 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-line program which maintains information accessible by keywords of three types: Personal (eg: last name), Commercial (eg: plumbers) and Reference (eg: magazine articles, record albums, etc.). In addition to key word searches, there are birthdays, 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 in turn accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

GRAFIX (TRS-80 only) Price: \$12.95 Cassette/\$16.95 Diskette
This unique program allow 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's source listing. Draw a "happy face" call it HIS and then print it from your program using PRINT HIS. This is a very easy way to create and use graphics.

TIDY (TRS-80 only) Price: \$10.95 Cassette/\$14.95 Diskette
TIDY is an assembly language program which allows you to remember the lives 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!

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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 binning 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 spectral 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.

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REGRESSION I, II and MULTILINEAR REGRESSION may be purchased together for \$49.95 (three cassettes) or \$61.95 (three diskettes).

BASIC SCIENTIFIC SUBROUTINES, Volume 1 (Not available for ATARI)
DYNACOMP is the exclusive distributor for the software archived in the text BASIC Scientific Subroutines, Volume I by F. Ruckdeschel (see the BYTE Magazine, Hill advertisement in BYTE magazine, January 1981). These subroutines have been a verified according to chapter, included with each collection is a menu program which selects and demonstrates each subroutine.

- Collection #1: Chapters 2 and 3: Data and function plotting, complex variables
- Collection #2: Chapter 4: Matrix and vector operation
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All three collections are available for \$34.95 (three cassettes) and \$40.95 (three diskettes).
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Even more useful (and amazing) is *autolink*. Autolink allows Super-Text to find and replace across an unlimited number of files. This action can occur in forward, backward, or even circular directions. Simply enclose the next file in colon symbols, place it at the end of the file (or the beginning, for a backward or circular link), and set the autolink flag. Any further find or replace command automatically searches the current file, loads the next, and searches it as well. Needless to say, this is a powerful feature that is unavailable on some of the big word processors.

Another feature that is neglected by some of the larger manufacturers is the split-screen mode. It is fascinating to see such a sophisticated feature in a word processor for a microcomputer. However, we wondered about the value of this feature. What can it be used for? In any case, it exists in Super-Text, and if you *can* use it—so much the better. We suspect it has only dazzle value.

In addition to Super-Text's excellent editing, there is a math mode that performs as a four-function calculator for columnar and embedded numerical data. It features an accumulator with up to fifteen-digit significance, and a decimal point that can be set by the operator. This calculator also adds up columns—even across screens. Once sums are in the accumulator, they can be easily inserted in the text, and even automatically aligned on decimal points.

The printouts look clean and professional, which is dependent, in part, on the printer you use. We used a Centronics 737, which is a "smart" (microprocessor-controlled) printer that looks good even though it is a dot-matrix printer. The printer can do many things by itself, and this is where the adaptability of Super-Text becomes a factor. Right justification is performed by space insertion, and it has the appearance of being evenly proportioned since Super-Text seems to place spaces after punctuation first, and then randomly across the line. Super-Text does not perform true proportional spacing, but the Centronics 737 does this automat-

ically with a proportional type font.

The Centronics responds to certain control characters that are sent to it to control particular features, such as underlining, choice of type font, super-/subscripting, and elongation of text (any type font may be printed as double-width characters). While Super-Text cannot directly control these printer functions, it allows six control characters which can be user-defined. (Four of these are configured for Diablo printers.) Some technical knowledge is required to redefine these control characters, but step-by-step instructions lead you through the process.

Although you can add an assembly-language printer driver to Super-Text, it is usually unnecessary. The first time you use Super-Text, you should configure it for your printer; this data is then saved on disk, and you should never again have to change your printer configuration (unless you get a different printer). The formatting parameters given at configuration time can be easily changed within the text.

Super-Text can use continuous form or single-sheet paper. It is difficult, however, to change back and forth, since you must reconfigure the printer every time that you switch. The operator can stop and start a printout at any time by the touch of a key. Page numbers can be suppressed, and made relative to the beginning of a chapter with the insertion of a control character. Page numbers can also be moved around the page for maximum flexibility. There is no provision that automatically locates the proper line for footnotes. The operator must count up lines for proper placement.

Human engineering is a weak point with Super-Text. The program does provide excellent prompts when necessary, including warnings for dangerous commands (eg: "PRESS # TO DELETE—" for deleting the entire text buffer) and multiple keystrokes to avoid accidental deletion. The problem, however, is that a lot of the control characters are not mnemonic. Also, multiple keystrokes for simple operations abound in Super-Text.

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(This problem can be avoided, as demonstrated by Write-On!, another word processor designed for Apple II.) Some functions can be "undone" by using the escape key, but since most of the action takes place instantly, it is difficult to undo these commands. This is not the fault of Super-Text.

Text can be easily recovered from a "crash." If you find yourself in the Apple II monitor (denoted by an asterisk at the beginning of the line), simply type "3D0G", hit the return key, and then "CALL 4096", followed by the return key. You are placed back in Super-Text! We have yet to enter a file that exceeds the capacity

of the text buffer in Super-Text, so we don't know what happens when it fills up. The manual states that the processor will warn you when the buffer is almost filled.

Super-Text appears to use its own disk operating system, but it does use BLOAD and BSAVE to load and save text files. These operations are quick and easy. The fact that Super-Text can't be copied is probably the biggest problem. Perhaps Muse has realized how inconvenient this is, because it has provided two disks of the program. We understand its reluctance to put a copyable program on the market, but we feel that there are other ways to avoid piracy. One solu-

tion is to create a disk that can be copied a limited number of times but that produces uncopyable copies. In any event, there is a replacement policy, but there is also a \$10 media replacement charge.

Super-Text documentation comes in the form of an instruction manual. As a teaching tool, this manual is insufficient. The features are explained well, and some are supplemented with examples from the Super-Text disk. However, no quick reference card is provided, and it is sorely needed. The commands summarized at the end of each chapter explain the modes, but this is not enough, since you must leaf through the manual

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until you have memorized all of the commands. There are no listings of the program, but as it can't be modified this makes little difference. In all fairness, the program provides for any modification you might want to make, so listings are unnecessary.

Super-Text is a very good word-processing program, and it generally works very well, especially after the user has adapted to the processor's particular methods. We won't give numerical ratings, as too much depends on the user's needs, but we'll give you a hint. We prepared part of this article with the Super-Text word processor.

Write-On!

Write-On!, like Super-Text, varies little between versions. The additional features of Write-On! II include preset script margins, personalized form letter capabilities using data files, data-file editing and input, and a system for preformatting text files for the printer. Write-On! II can also convert other files into data files.

Write-On! (from Rainbow Computing) is, for the most part, written in BASIC, and it lacks the speed of Super-Text or the Datacope Scribe. Therefore, it is almost a necessity to preformat text files for the printer. Unlike Super-Text, however, the added features are worth the price: in fact, the ability to print personalized form letters justifies the expense.

The following comments apply to both versions of Write-On!, unless otherwise noted.

Write-On! is a *super* word processor, but that name was already taken. Although it lacks some of the flexibility of the other word processors, it provides a full range of commands to process text.

Write-On! supports display of lowercase letters through the use of the Paymar lowercase adapter. It would appear that Mr Paymar and his adapter have become a standard with Apple. [Paymar had the field to himself for some time, but other companies (particularly Lazer Systems) are also producing lowercase products for the Apple II....GW] The shift key can be enabled by modifying

the keyboard, as mentioned above, but Rainbow Computing does not provide the wire—just the instructions. Without the shift modification, Write-On! uses reverse video and the ESC (escape) key to denote a capital letter. The shift lock is enabled by hitting the ESC key twice.

Write-On! does not support an 80-column board, and since it does its formatting when it prints out, there is no provision for viewing a text file in its final form on the screen. There is a feature in Write-On! II that allows print image files to be saved on disk, but the main purpose of these files is

At a Glance

Name

Write-On! I and II

Type

Word processor

Manufacturer

Rainbow Computing
9719 Reseda Blvd
Northridge CA 91324
(213) 349-5560

Price

Write-On! I, \$99.95
Write-On! II, \$150

Format

5-inch floppy disk

Language

Applesoft BASIC with some 6502 machine-language subroutines

Computer

Apple II or II+ with Language Card or ROM Applesoft, 48 K bytes of memory, and one disk drive

Documentation

67 pages, 22 by 28 cm (8.5 by 11 inches); three-ring binder; Quick Reference Card

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to speed up output to the printer. (The files display gibberish when loaded and viewed on the Apple screen.)

The processor uses the wraparound technique to divide words, so touch typists can enter text quickly and easily. Unfortunately, there is no provision for hyphenation. (This seems to be the rule rather than the exception in word processors for microcomputers.) Write-On! uses control symbols embedded in the text to control tabs, text width, margins, page numbering, text centering, and paragraph indentation. These symbols take the form of "backslash-some characters-backslash" and they are also highlighted on the screen.

Write-On! will accept files not written by itself. Understandably, the process is slower than loading its own files, but the feature does exist. After we tried this command, we found that the files had to be text files in thirteen-sector format. The files that Super-Text saved would not even show up with the CATALOG com-

mand because Super-Text uses BLOAD to save its files. The ability to edit previously created text files is an important consideration when you convert from one word processor to another.

Write-On! performs its editing chores with ease and speed. The processor is line-oriented, and although I feel it is more difficult to work with, this is largely a matter of personal preference. An asterisk appears to the left of the line that is currently operating. The replace and find commands are facilitated by machine code, so they are even quicker. Blocks of text can be moved, copied, deleted, or saved easily. Write-On! does not have an autolink command for editing, so you cannot edit across files (as you can with Super-Text) but it does have a merge command similar to that in Datacope's Scribe. Text from a disk file can be inserted anywhere in the text that you are currently editing. Overall, the editing commands are easy to learn and use.

The standard Apple DOS (disk

operating system) is used. However, text files are loaded and saved using BLOAD and BSAVE, which reduces waiting time considerably. The saving and loading commands are clear and understandable, and have prompts that lead the user through the process. If you are a programmer, you can modify this function quite easily, because Write-On! is completely modifiable and copyable. There are some machine-language subroutines for *find* and *replace* functions, but those subroutines work well so there is little need to change them. The program runs in 48 K-byte machines only, but there is adequate room for lengthy files. The manual doesn't tell you what happens if the text buffer fills up, but we never encountered that problem.

There does appear to be a problem where output is concerned: there is no provision for a machine-language driver (sometimes used to drive a nonstandard printer). When initially configured, Write-On! only asks what slot your printer is in. In addi-

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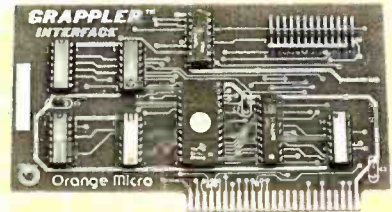
TEXT COMMANDS

Let CTRL-G Ring Printer Bell
Output High Bit
Turn on Video Screen, Set Line Length to 40
Don't Append LF's onto CR's
Set Left Margin to n
Set Page Length to n
Set Right Margin to n
Dump Text Screen to Printer
Don't Output High Bit
Change to New Command Character

Change Back to Command Character
Turn off Video. Set Line Length to n

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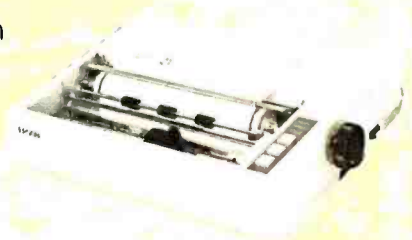
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tion, it is not very adaptable to particular features of different printers. Although Write-On! has several features such as underlining and boldface, it needs some user-defined control characters because it does not provide for such conditions as different type fonts, super-/subscripting, different color ribbons, or proportional spacing. It will justify to the right margin, and it does a good job of it. The text doesn't look thin in any particular spot.

Write-On! changes easily from sheet to continuous form. Page numbers can be moved to any position on the page, and numbering can be suppressed. While we were investigating page numbering, we encountered a mystery: Write-On! only allows an absolute page number, yet the manual, which was written with Write-On!, has chapter-relative page numbers (eg: 3 - 4). It seems there is a command that allows a string to be printed to the left or the right of the page number. The chapter must have been inserted as that string and then

changed at the beginning of every chapter. This is still mysterious, however, because the manual makes no mention of it. (Except for the EasyWriter Professional word processor, none of these word processors have provisions for footnoting, and Write-On! is no exception.) Write-On! also provides predefined titles. You can define up to twenty titles, which will appear at the beginning of each page.

Write-On! II even provides for form letters using data files. You can build a file of personal or company names, or addresses, and then insert them into a form letter upon printout. This is a tremendously powerful and useful feature (especially for the price). As if this is not enough, Rainbow includes a data-file converter program that takes files from mailing lists and general ledgers and automatically converts them to the proper data-file format. If you want to insert data while your text is printing, Write-On! will accept input from the keyboard and print it where you have

embedded the special control character. It even provides for a string that will print on the screen to prompt for the proper information. These are undoubtedly the most powerful features found in a microcomputer-based word processor.

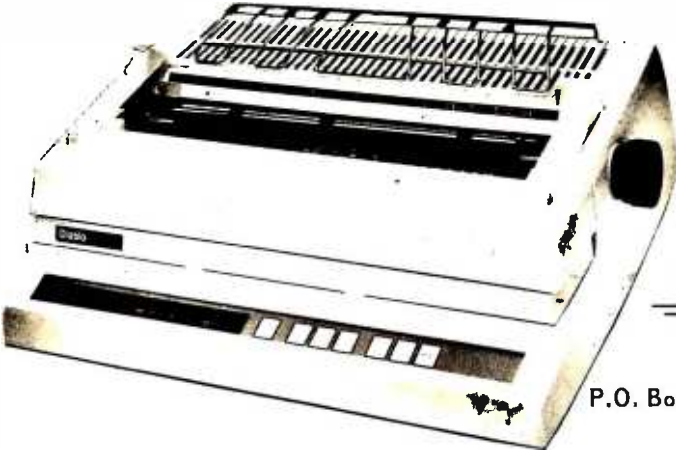
The human engineering in Write-On! is superb. All of the commands are mnemonic and provoke little confusion. Most of the commands use only one keystroke, thus simplifying matters even further. Although the print module is separate from the editor program, its use is simplified by prompts and a menu selection. All of the editing and printing commands are prompted, and error traps are included so that it is difficult to inadvertently destroy several hours of typing.

Along with the excellent human engineering, Write-On! provides superlative documentation. This documentation leads the user by the hand; explanations of the various features are clear and concise, and even the complex operations make sense the

Text continued on page 196

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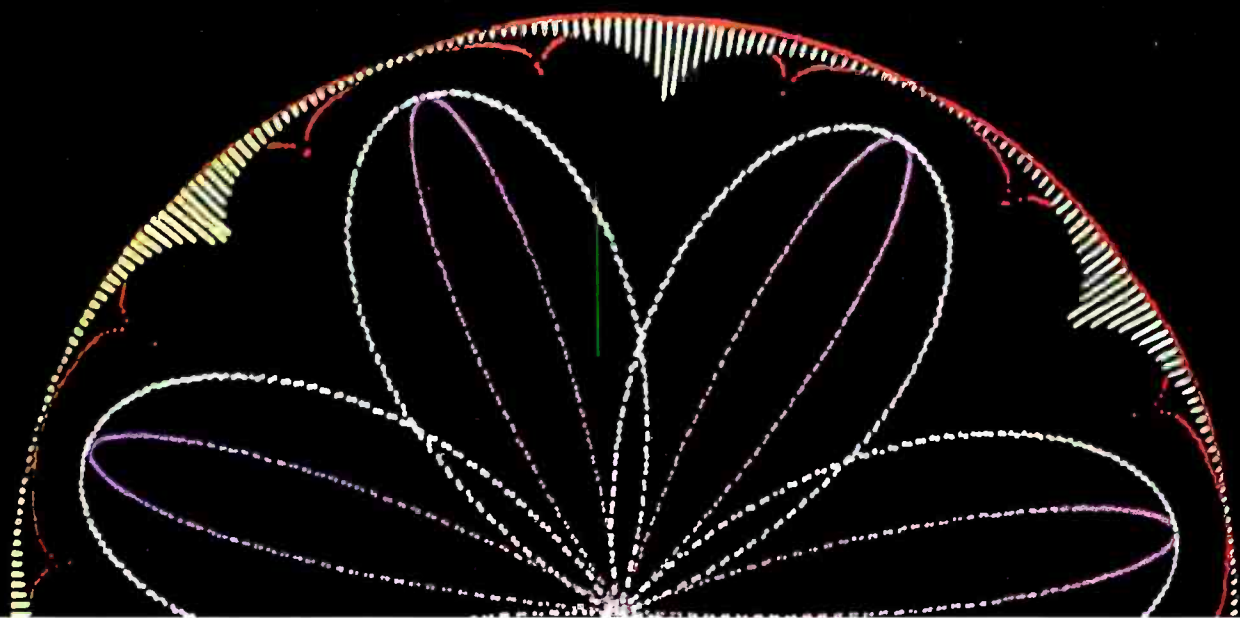
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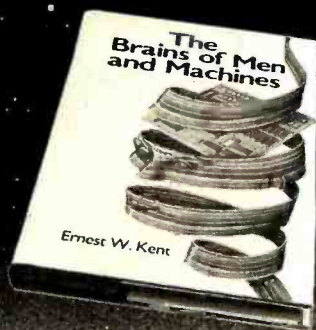
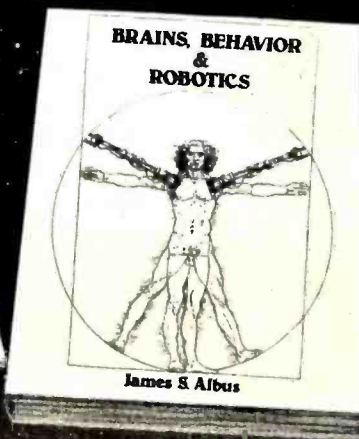
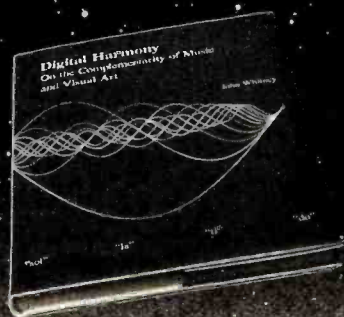


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Visual Magic...



While Inversions delights the eye and enchants the mind, Digital Harmony lays the foundation for a whole new field of audiovisual art made possible by microcomputers. Both books pioneer new forms.



AVAILABLE FALL 1981

DIGITAL HARMONY

by John Whitney

A new synthesis of sight and sound

Digital Harmony lays the foundation for the whole new field of audio-visual art made possible by microcomputers. John Whitney, a pioneer of the special effects technology used in STAR WARS and 2001: A SPACE ODYSSEY, explains the special union of computer graphics and music. His computer-generated visual art graphically depicts the laws of harmonic motion common to all music.

Digital Harmony includes a complete description of Whitney's computer, peripherals, and film techniques. Colorful illustrations are included, as well as the program listings that generated them. The descriptions are sufficient for anyone to begin to explore this new territory as a composer and computer experimenter - transforming the small computer into an ideal instrument for creating compositions in aural and visual art.

John Whitney is on the Faculty in the Department of Art at the University of California, Los Angeles.

ISBN 0-07-070015-X
240 pages
hardcover
over 50 color photographs

\$21.95

INVERSIONS: A Catalogue of Calligraphic Cartwheels

by Scott Kim
Foreword by Douglas Hofstadter
Backward by Jef Raskin

Surprising symmetries in design and letterforms

Illusion... calligraphy... visual magic - Scott Kim's new book, *Inversions*, delights the eye and enchants the mind. Filled with intriguing designs, words that read the same right-side up and upside down, words within words, and unexpected symmetries, these compositions create a fresh way to look at the alphabet. The text includes the visual principles of symmetry, lettering, and problem solving that are basic to these images. The author also draws parallels to related exercises in perception in such diverse areas as art, music, word play, and mathematics. Scott Kim's original inversion designs first appeared in *Omni* magazine, inspiring an overwhelming reader response. An irresistible challenge, invertible writing appeals to everyone who loves beauty in mathematics and design.

Scott Kim is a doctoral student in Computer Science at Stanford University and is a concert pianist and composer.

ISBN 0-07-034546-5
128 pages
softcover
over 50 illustrations
available summer 1981

\$8.95

BRAINS, BEHAVIOR, AND ROBOTICS

by James S. Albus

Robotics design and applications

This computer-oriented guide explores how the brain functions primarily as a computer device for generating and controlling behavior. The author assesses behavior as a product of three hierarchies of computing modules:

- memory modules
- behavior-generating modules
- sensory-processing modules

A section on artificial intelligence ties this hierarchical model to vital computer science techniques such as planning, problem-solving, machine vision, natural language understanding and knowledge representation. A closing section on robotics discusses the design considerations in constructing a robot control system fashioned after this model of the brain, and explores the current and potential use of robots in our environment.

Dr. James S. Albus is Project Manager with the National Bureau of Standards.

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THE BRAINS OF MEN AND MACHINES

by Ernest W. Kent

Human models for computer design

When the "Brains of Men and Machines" series of articles first 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.

It is one of the rare books that transcends disciplinary boundaries. In it the ever-increasing relationship between man and machine is freshly examined - a relationship, Professor Kent concludes, that is today being reexamined in the light of man's own neurological self-image.

Dr. Ernest W. Kent is a Professor of Physiological Psychology and Psychopharmacology at the University of Illinois at the Chicago Circle Campus.

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The BYTE BOOK Collection

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Dr. Fred Ruckdeschel is a Principal Scientist with Dynacomp, Inc.

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THE BYTE BOOK OF PASCAL

Blaise W. Liffick, Editor

A powerful, structured language

Based on articles, language forums, and letters from BYTE magazine, this work is a valuable software resource. Pascal continues to be popular as a structured programming language. Written for both potential and established users, this book introduces the Pascal language and examines its merits and possible implementations. Featured are two versions of a Pascal compiler, one written in BASIC and the other in 8080 assembly language; a p-code interpreter written in both Pascal and 8080 assembly language; a chess-playing program; and an APL interpreter.

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How to implement FORTH on your Z80

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Ron Loeliger is a Senior Analyst with Intermetrics, Inc.

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BEGINNER'S GUIDE FOR THE UCSD PASCAL SYSTEM

by Kenneth L. Bowles

The most popular Pascal version explained by its creator

Written by the originator of UCSD Pascal System, this informative book is an orientation guide to the UCSD Pascal System. For the novice, this book steps through the System, bringing the user to a sophisticated level of expertise. Once familiar with the System, the reader will find the guide an invaluable reference tool for creating advanced applications. The package offers programs which may be run without alteration on:

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Dr. Kenneth L. Bowles is Director of the Institute for Information Systems, University of California, San Diego.

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by Thomas Dwyer and Margot Critchfield



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Dr. Thomas Dwyer is a Professor of Computer Science at the University of Pittsburgh.

Margot Critchfield is a doctoral student in Foundations in Education at the University of Pittsburgh.

ISBN O-07-018492-5
343 pages
softcover
78 illustrations

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BEYOND GAMES: SYSTEM SOFTWARE FOR YOUR 6502 PERSONAL COMPUTER

by Kenneth Skier



Creating programs for the Apple, Atari, Challenger and PET computers

At last, a complete programming guide-book for owners of personal computers utilizing the 6502 microprocessor. A self-contained course in structures programming and top-down design, this book presents a powerful set of tools for building an extended monitor, disassembler, hexadecimal dump routine, and text editor programs. Programs are thoroughly explained, with clear instructions for modifications.

Kenneth Skier is a Systems Programmer for Wang Laboratories, Inc., and a Lecturer at MIT.

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BYTE June 1981 193

CIARCIA'S CIRCUIT CELLAR

by Steve Ciarcia



Practical uses for home computers

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by Steve Ciarcia



More practical uses for home computers

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- building a computer controlled home-security system
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by Henry D'Angelo



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Dr. Henry D'Angelo is the Associate Dean of the College of Engineering and Professor of Manufacturing Engineering at Boston University.

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by Steve Ciarcia



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- easy expansion to include a video terminal
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- serial and parallel ports
- hexadecimal display
- audio cassette mass storage

Readers can modify the system to meet personal needs.

Steve Ciarcia is a Computer Consultant, Electrical Engineer, and author of "Ask Byte" and "Ciarcia's Circuit Cellar" columns in *BYTE* magazine.

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MINDSTORMING

In most contemporary educational situations where children come into contact with computers the computer is used to put children through their paces, to provide exercises of an appropriate level of difficulty, to provide feedback, and to dispense information. The computer programming the child. In the LOGO environment the relationship is reversed: The child, even at preschool ages, is in control: The child programs the computer. And in teaching the computer how to think, children embark on an exploration about how they themselves think. Thinking about thinking turns the child into an epistemologist, an experience not shared by most adults.

Logo Computer Systems, Inc. is a new company that has been formed to develop and disseminate the LOGO methodology. During the next few months it will be announcing a line of products: hardware, software, written materials, training services.

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Text continued from page 190:

first time. Examples, both in the manual and in text-file form on the reverse side of the disk, accompany the tutorial narrative. Finally, there is a quick reference sheet near the back of the manual that explains every command (our version is on 14-by-11-inch printout paper, but Rainbow plans to reduce it to an 8½-by-11-inch card).

The manual also includes a question and answer sheet that tries to anticipate any problems, and a reader service card on which you can describe any problem not covered by the question and answer sheet and send to Rainbow for an answer. If you'd rather not wait for the return of the reader service card, you can call Rainbow, and they will try to solve your problem over the phone. No listings of the program are provided, but this is unnecessary as you can load and list it yourself. The program is not a marvel of documented programming, but then BASIC is not known for its accessibility.

Write-On! is amazingly error-free, and it ran the first time we put it on the computer. It can also be easily converted to the new 16-sector format. One of us thinks that Write-On! is his choice of all the word processors that we reviewed. The only reason we didn't use it to prepare this review is that it won't support all of the features of the Centronics 737, which was the printer we used for our final copy.

The Datacope Scribe

The Datacope Scribe (from Datacope) is the only word processor we reviewed that requires the Dan Paymar lowercase adapter (which provides true lowercase and uppercase letters on the monitor's screen). One would hope that use of the adapter would eliminate use of inverse characters. However, this word processor uses inverse characters to indicate the various editing functions, such as centering, underline, or new page or paragraph. All of the word processors we reviewed use inverse characters for various reasons (e.g. special character representing new paragraph). Inverse characters and

special characters are items that we will have to live with, at least for now. The Datacope Scribe does, however, provide a feature that allows us to view the text without all the special control characters: this will be described later in the review.

The Datacope Scribe utilizes two techniques found in several of the word processors for the Apple II: use of the ESC key for shift and use of Control-A for shift lock. The word processor accommodates touch typists and eliminates the need to worry about margins. Hyphenation is indicated by a hyphen when you execute the "implementation" command (the command that causes the word processor to execute all the other commands you have given it). Scribe then prompts for your approval (press RETURN). If you wish to change the location of the hyphen, press either of

The Datacope Scribe Is the only word processor described that requires the Dan Paymar lowercase adapter.

the arrow keys until the hyphen is where you want it, then press RETURN.

Tab stops are input through the use of control-Y. Each time a control-Y is pressed, an inverse ^ appears on the screen. This prints the next character at the next tab position (as given by the values in the tab position table). The word processor supports line centering, underlining and indentation.

The Datacope Scribe has the ability to specify, during input, locations where keyboard input is desired during printing. This feature is nice for adding personal touches to form letters or addresses to letters. Text files on a disk other than the one being worked on must be appended to the current file (i.e. they cannot be inserted into the middle of the file). This requires that you preplan in detail before you enter text.

Editing is accomplished with cursor control and additional support from buffer (text-blocks) movements. The Datacope Scribe includes on-line reference guides that will assist the novice during entry and edit modes. These guides provide information on the various control keys and functions. By using the customize program, these guides may be removed from the word processor to make room for more text.

After the text has been entered and edited, the define mode should be

At a Glance

Name
Datacope Scribe

Type
Word processor

Manufacturer
Datacope
PO Drawer AA
Hillcrest Station
Little Rock AR 72205

Price
\$79.95

Format
5-inch floppy disk

Language
6502 machine language

Computer
Apple II or II+ with Language Card or ROM Applesoft; 48 K bytes of memory, and one disk drive

Documentation
34 pages, 22 by 28 cm (8.5 by 11 inches); booklet form, pre-punched for three-ring binder

Hardware Required
Dan Paymar lowercase adapter and a printer

Audience
Anyone needing a word-processing system

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The **MICROCOMPUTER REFERENCE HANDBOOK** reviews in detail more than 130 microcomputer systems from over 50 major microcomputer suppliers, including some of the latest Japanese manufacturers. It is designed to aid both first time and experienced computer users in choosing a single-board microcomputer or microcomputer system to suit their application. It is presented in four parts.

PART I. Chapters 1 to 3 include a wealth of useful information on microcomputer theory including peripheral and software capability. Succeeding Chapters provide additional microcomputer information under the following headings: *BASIC Language Summary; Guidelines for the Selection of Microcomputers in Commercial Applications; Microcomputers and Word Processing, Big Future for Desktop/Personal Computers* (containing comments by IDC, a leading industry information resource); *Future Trends in Microprocessing and Microcomputing; Communications and Networking with Microcomputers; Microcomputers in Education; and Microcomputing For The Home Hobbyist.*

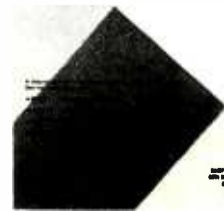
PART II. Covers a range of microcomputer software from independent vendors. Products discussed are broken down into the five major system types: CP/M-based; Apple Systems; Commodore Systems; Radio Shack TRS-80 Systems; and the 6800-based models. The different programs described include operating systems, high-level languages, utilities and a wide variety of application packages.

PART III. Provides a 2 to 5 page summary on more than 130 different microcomputers and microcomputer systems from over 50 suppliers. These summaries describe hardware, software, peripherals, pricing and head office location. The different microcomputer suppliers covered include, in manufacturer order:

- APF • AI Electronics Corp. • Archives • Alpha Microsystems • Altos • Apple • Atari • CADO • California Computer Systems • Commodore • Compucolor • Compucorp • Cromemco • Data General • Datapoint • Diablo Systems • Digilog • Digital Equipment • Durango • Exidy • Findex • Hewlett-Packard • IBM • IMS • Intel • Intelligent Systems • Intertec • MicroDasy's Millie • Micro V Corp. • Micromation • Mitsubishi • Motorola • Panasonic • QASAR • National Semiconductor • North Star • Ohio Scientific • Onyx • Pertec • Radio Shack • Sinclair ZX80 • Smoke Signal • SORD • SWTPC • Tektronix • Texas Instruments • Vector Graphic • Wang • Zenith • Zilog ... plus others.

PART IV. Includes a summary on a selection of terminals and printers for microcomputers. Both visual display and keyboard printing terminals are discussed as well as a number of low and high-speed character printers.

MICROCOMPUTER
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HANDBOOK



If you are interested in keeping abreast of this very important segment of the market or are planning to purchase a microcomputer for home, office or factory use then this Handbook is of vital interest to you. For just \$25 (or \$20 with introductory offer) it can save you up to six months of your own research, time and effort. The publication is printed 10.75" x 8.2" and contains over 250 pages. This publication will be available in May.

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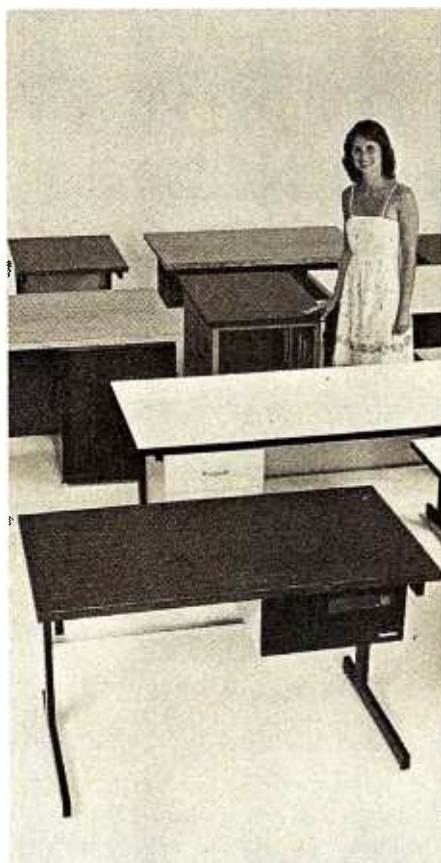
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used to define the main format of the final printed text product. This feature allows you to set several parameters associated with printed output: left and right margin positions, number of lines per page, tab positions, single or double spacing between paragraphs and lines, justified right margin (yes/no), and page numbering (yes/no). Up to eight tab settings are provided. When you finish defining the format, use the implement command to prepare for viewing and/or printing. The view command enters the view mode, which displays the text on the monitor in the final output form. Of course, the view mode is limited by the Apple's 40-column display.

The Datacope Scribe is available in both DOS 3.2 and 3.3 versions, and the DOS 3.2 version will work on a DOS 3.3 Apple if you use the BASICS floppy disk first. The Datacope Scribe cannot be copied with standard copy programs. Should you develop disk problems, the processor can be replaced up to ninety days after purchase, with proof of purchase.

EasyWriter

The EasyWriter and EasyWriter Professional word processors have much in common. Anyone who changes to the Professional version should have little difficulty making the transition. Unlike Super-Text and Write-On!, however, there is a noticeable change between EasyWriter and EasyWriter Professional. EasyWriter uses Apple's 40-column display, while the Professional version uses any one of the three most popular 80-column video cards (M & R Sup'R'Terminal, Videx, or Double-Vision). This difference may be the deciding factor when you decide which version to buy. The serious user, most likely a professional, will probably purchase the video card and EasyWriter Professional and write off the cost as a business investment. The home user, unless she or he already has the video card, will purchase the 40-column version.

Both versions begin by offering a menu of activities. The Professional

version begins with the disk commands, whereas the original version displays the menu for the editor. The Professional version has added the ability to append disk files during input, which is not possible with the 40-column EasyWriter. The ability to append "glossary"-type files is just one example of the changes made to EasyWriter between versions. Input is much easier with the Professional version, because the 80-column display uses true uppercase and lowercase characters. The original EasyWriter uses the standard inverse characters for uppercase characters (as do most of the other word processors for the Apple). One nice feature about

At a Glance

Name

EasyWriter and EasyWriter Professional

Type

Word processor

Manufacturer

Information Unlimited Software
281 Arlington Ave
Berkeley CA 94707

Price

EasyWriter, \$99.95; EasyWriter Professional, \$250

Format

5-inch floppy disk

Language

FORTH (threaded 6502 machine language)

Computer

Apple II or II+ with 48 K bytes of memory and one disk drive

Documentation

50 pages, 15.5 by 23 cm (6 by 9 inches); three-ring binder

Hardware Required

Videx, M & R Sup'R'Terminal, or DoubleVision 80-column board (for Professional system only)

Audience

Anyone needing a word-processing system

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 ** PMC Product of Personal Microcomputer, Inc.

COMPARE THE FEATURES AND PERFORMANCE			
FEATURES	LNW80	PMC-80**	TRS-80* MODEL III
PROCESSOR	4.0 MHZ	1.8 MHZ	2.0 MHZ
LEVEL II BASIC INTERP.	YES	YES	LEVEL III BASIC
TRS80 MODEL I LEVEL II COMPATIBLE	YES	YES	NO
48K BYTES RAM	YES	YES	YES
CASSETTE BAUD RATE	500/1000	500	500/1500
FLOPPY DISK CONTROLLER	SINGLE/DOUBLE	SINGLE	SINGLE/DOUBLE
SERIAL RS232 PORT	YES	YES	YES
PRINTER PORT	YES	YES	YES
REAL TIME CLOCK	YES	YES	YES
24 X 80 CHARACTERS	YES	NO	NO
VIDEO MONITOR	YES	YES	YES
UPPER AND LOWER CASE	YES	OPTIONAL	YES
REVERSE VIDEO	YES	NO	NO
KEYBOARD	63 KEY	53 KEY	53 KEY
HUMERIC KEY PAD	YES	NO	YES
B/W GRAPHICS, 128 X 48	YES	YES	YES
HI-RESOLUTION B/W GRAPHICS, 480 X 192	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (NTSC), 128 X 192 IN 8 COLORS	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (RGB), 384 X 192 IN 8 COLORS	OPTIONAL	NO	NO
WARRANTY	6 MONTHS	90 DAYS	90 DAYS
TOTAL SYSTEM PRICE	\$1,915.00	\$1,840.00	\$2,187.00
LESS MONITOR AND DISK DRIVE	\$1,450.00	\$1,375.00	---

LNW80

- BARE PRINTED CIRCUIT BOARD & MANUAL \$89.95

The LNW80 - A high-speed color computer totally compatible with the TRS-80*. The LNW80 gives you the edge in satisfying your computation needs in business, scientific and personal computation. With performance of 4 MHz, Z80A CPU, you'll achieve performance of over twice the processing speed of a TRS-80*. This means you'll get the performance that is comparable to the most expensive microcomputer with the compatibility to the world's most popular computer (TRS-80*) resulting in the widest software base.

FEATURES:

- TRS-80 Model I Level II Software Compatible
- High Resolution Graphics
 - RGB Output - 384 x 192 in 8 Colors
 - NTSC Video or RF MOD - 128 x 192 in 8 Colors
 - Black and White - 480 x 192
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- 500/1000 Baud Cassette
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- Easy plug in installation requiring no etch cuts, jumpers or soldering
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- LNW80 "Video parts set" LNW80-2 \$31.00
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this display is that only the letter displayed in inverse is made uppercase.

EasyWriter displays the least amount of extraneous information with the text of all the word processors covered in this review. Shift is accomplished by pressing the ESC key once; twice for shift lock. The Professional version also uses the ESC key, but allows for the wire between the shift key and 16-pin game I/O port (the game paddle connector) for easier use by a touch typist.

The method of ending paragraphs has also been improved. The original EasyWriter uses two shift-Ms, whereas the Professional uses only a return. The original version used one shift-M to end a line. The Professional's reference manual warns the typist to use the return only to start new paragraphs.

Paragraphs may be formatted to automatically indent through the use of special embedded commands, which are placed between text lines. These commands may appear more than once, thus providing the oppor-

tunity to change indentation formats several times in any document. Both versions of EasyWriter support the centering of lines of text, but the method of implementation varies. The original version uses the em-

EasyWriter has the least amount of extraneous information displayed with text.

bedded command technique, while the Professional uses a special editing tool that will be described later.

The 40-column version does not provide a method for viewing the text in final form, but the Professional's 80-column display is the image of the output. And since it is the direct image, an added capability is provided to align text, both after input and prior to printing. Through the use of "additional commands" (which

have their own menu screen), the Professional version allows you to realign margins, center lines of text, set and reset tabs, and, for use with printers such as Qume, Diablo, and Spinwriter, vary spacing between letters.

The Professional EasyWriter can translate files from the original 40-column version for use with the 80-column display. Both versions use various control keys to scroll up or down by page or line. Left or right movement on any line is performed with the Apple's normal arrow keys.

Editing is a pleasure with either version. Global search and block movement of text is supported in both versions, but global replace is supported only in the Professional. After you have finished editing, output can be tailored to each document, or you can rely on the default values. The original version accomplishes tailoring with embedded commands; the Professional version uses the additional commands to realign text (as described above), as well as optional

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TCS-ALL4CM



Software Manual
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embedded commands.

The provision for titling and numbering pages is one of the best we have seen for the Apple. The placement of titles and page numbers is limited only by your imagination.

Other advantages specific to EasyWriter Professional are suggestions and instructions for adding footnotes (the only word processor we reviewed that had such suggestions); capability of being linked to EasyMailer for processing of bulk mailings, and ability to transfer EasyWriter files over phone lines to other computers located anywhere in the world. (EasyMover and EasyMailer are separate programs and not part of EasyWriter. They can be obtained from Information Unlimited Software.)

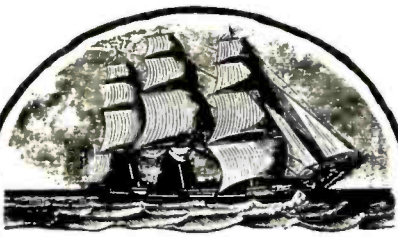
Special printer characteristics are supported by both versions. Those printers that are capable of underlining, boldface printing, and super-/subscripting are conveniently accommodated.

EasyWriter's reference manual was input directly into an Addressograph Multigraph typesetting machine using the proportional spacing option. Even on a printer without proportional spacing, the text spacing is pleasing to the eye.

Many of the EasyWriter features are appealing from the human engineering aspect. Most of the commands on the menu are easy to remember and require only one key to invoke a command. The use of CTRL (control) keys is basically confined to cursor movements during editing.

Before it clears text or deletes files, EasyWriter requests verification: "ARE YOU SURE?" Insert operations can be confusing as to when the insertion mode is exited. (Datacope Scribe has probably done the best job of avoiding confusion on insert operations.)

EasyWriter manuals generally provide good, detailed explanations of the various features. Both manuals attempt to lead the user through the capabilities of the EasyWriter by presenting information that teaches its use and interlacing it with details of the various features.



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Program	Titles	Global Search and Replace	Merge from Disk	Form Letters with Data Files	User-Defined Control Characters	Displays Lowercase (with adapter)	Requires Use of 80-Column Display Board	Print Multiple Files	Search Across Files	Supports Shift Key (with keyboard modification)	Split Screen	Wild-Card Search	Quick Reference Card	Chapter-Relative Page Numbers	Copyable	Uses Standard DOS	Preview Mode	Footnote
Write-On! I	Y	Y	Y	N	N	Y	N	Y	N	Y	N	N	Y	Y ³	Y	Y	N	N
Write-On! II	Y	Y	Y	Y	N	Y	N	Y	N	Y	N	N	Y	Y ³	Y	Y	N	N
Super-Text II	N	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y	N	N	Y	N
Scribe	N	N	Y	N	Y	Y ¹	N	N	N	Y	N	N	Y ²	Y	N	N	Y	N
EasyWriter	Y	N	N	N	Y	N	N	Y	N	N	N	Y	Y	N	Y	Y	N	N
EasyWriter Professional	Y	Y	Y	N	Y	Y	Y	Y	N	Y	N	Y	N	N	N	N	Y ⁴	Y

¹Requires Paymar lowercase adapter
²On-line quick reference
³Indirectly provided
⁴Print image appears on 80-column screen

Table 1: Feature comparison of four popular word-processing programs for the Apple II.

Conclusions

Choosing a word processor is similar to deciding on a microcomputer. Each has special features (see table 1), and none of the products have all the features.

If you want a word processor that performs math operations, the Super-Text II program is for you. If you're looking for a word processor that you can modify, and you know only BASIC, then Write-On! should satisfy your requirements. If you already have one of the 80-column cards, perhaps you should choose the EasyWriter Professional version. If you are looking for a workhorse processor that will handle bulk mailings,

then the EasyWriter Professional linked with EasyMailer is also for you, although Super-Text may meet this demand, and, with some pushing, Write-On! could meet the lower end of these requirements. DataCope Scribe has some very nice features, and if you only wish to process text and can live without a find-and-replace feature, the processor will fulfill your needs.

About this time, you may be thinking, "This is a typical review that says all the products are great." Possibly this is true, but we speak with some experience as we used all of the processors while preparing this article. Each met our needs, and performed

basic text processing in less than an hour.

A few years ago, such power in a small package, and at this price, was only a dream. And even today, some of the larger systems don't have equivalent features. ■

Acknowledgments

We would like to acknowledge David A Lingwood for his "Word Processor Guidelines," presented in Call-Apple, September 1980, page 19.

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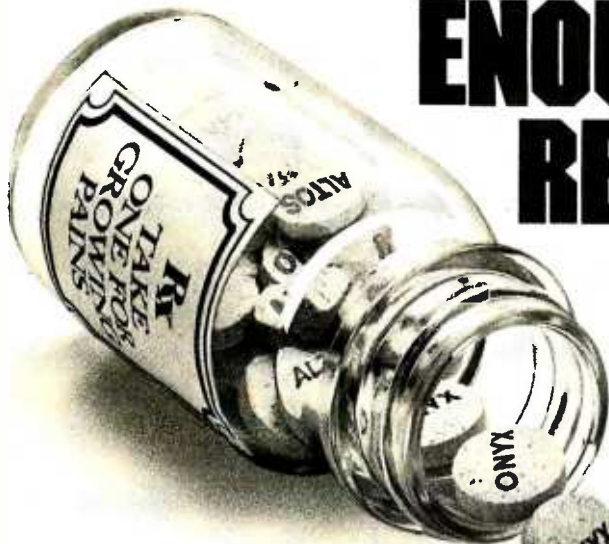
Credit cards: Immediate service. free 24 hr phone - we will credit invoice. Checks, M.O.'s: Ten workday hold. CA res: Add tax



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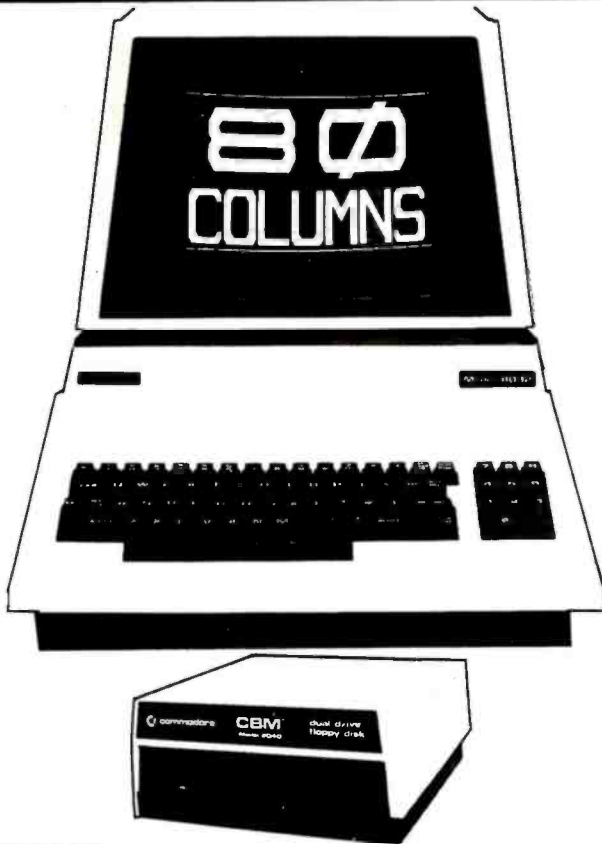
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1 in Graphics Mode

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KEYBOARD

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HARDWARE SPECIFICATIONS

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974K Bytes storage on two 5.25" diskettes (ss)
Tracks 70
Sectors 17-21
Soft sector format
IEEE-488 interface
Combination power (green) and error (red) indicator lights
Drive Activity indicator lights
Disk Operating System Firmware (12K ROM)
Disk Buffer (4K RAM)

FIRMWARE

DOS version 2.0
Sequential file manipulation
Sequential user files
Relative record files
Append to sequential files
Improved error recovery
Automatic diskette initialization
Automatic directory search
Command parser for syntax validation
Program load and save

**CBM 8050
Dual Price \$1795**

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News and Speculation About Personal Computing

Conducted by Sol Libes

IBM and Matsushita To Join Forces? Matsushita, the giant Japanese electronic conglomerate that markets Panasonic and Quasar products in the US, recently admitted that it had been approached by IBM in regard to manufacturing a personal computer for the US market. It's been rumored for some time that IBM is planning to market a Japanese-made personal computer in the US. Although Matsushita officials released no details regarding their talks with IBM, another report that Matsushita has already designed and built a personal computer has prompted some observers to theorize that the unit will bear the IBM name when it is marketed in the US later this year.

How Are The Personal-Computer Makers Doing? Tandy Corporation, Radio Shack's parent company, continues to have an outstanding growth record. Tandy's sales for the 1979-1980 fiscal year rose to \$1.4 billion, up from the previous year's \$1.2 billion. Its income has increased 35% since it joined the microcomputer business, which now totals 13% of its overall sales.

This year Tandy expects to add 400 more stores to its fold of nearly 8000. In the US, there will be 250 more stores and 50 computer centers. Tandy plans to open 100 outlets overseas. Foreign sales currently account for 25% of its total sales.

Each Radio Shack store stocks more than 2600 items. The largest portion of a store's sales is parts and accessories (23%), with radios, tape recorders and phonographs second (19%), other audio components third (17%), and toys and microcomputers tied for fourth place (13%). Citizen's Band radios (10%) and telephones (5%) constitute the remaining sales.

Tandy leads the field in microcomputer sales. It sold over 200,000 computers last year for a total of \$180 million.

Tandy's gross sales for the final half of calendar year 1980 were \$869 million, and profits were \$80 million, compared with \$739 million and \$60 million for the same period the previous year. The upward trend continues: sales this past January shot up to \$141 million, from \$112 million the year before.

You can still purchase a TRS-80 Model I in England. The Model I was pulled from US shelves in January because it did not comply with the Federal Communications Commission's radio-frequency-interference regulations. Also in England, TRS-80s are sold through independent computer stores as well as through Tandy-owned TRS-80 Computer Centers. So, the same dealer selling Apple IIs and Commodore PETs has TRS-80s on the display shelf. Some dealers also carry the Video Genie EG3000, the Far-Eastern copy of the TRS-80.

Apple Computer Inc also chalked up record sales and income last year. Sales for the last quarter of 1980 were

up 246%, and profits were up 180%. The demand for Apple products in the first quarter of 1981 was greater than anticipated, but the company considers it unlikely that this growth will continue into the second quarter of the year.

Apple revealed that the commissions required to sell its stock last year came to \$93.3 million, or \$1.30 a share. The stock initially sold for \$20 to \$25 a share; it peaked at a high of \$35, and it's currently selling in the neighborhood of \$25 a share.

Apple has had problems getting its Apple III computer into production. Announced in May 1980, the first Apple IIIs were not shipped until January 1981, and then only in limited quantities.

Commodore International's sales for the last quarter of 1980 were \$45 million, up from \$31 million for the same period in 1979. Commodore has announced plans to construct a \$5 million plant in the Philadelphia area to build its microcomputer systems. Commodore expects to hire 250 to 400 people for the operation and open it before year-end.

Sinclair Research, maker of the low-cost ZX80 personal computer, claims that it is number three in units shipped, behind Radio Shack and Apple.

Mattel's keyboard-equipped Intellivision personal-computer system seems to be bumping up against the same sort of buyer resistance that Texas Instruments encountered with its TI 99/4. Consumers

are put off by the keyboard unit's \$700 list price, plus \$300 for the game-playing "master" component—total cost \$1000. That's several hundred dollars more than the TRS-80 Color Computer, the Commodore VIC, and even Texas Instruments' TI-99/4. Further, Mattel has had delivery problems: it had originally intended to introduce the system in 1979. Intellivision's marketing is mainly through department stores.

First Personal Computer With Built-In Winchester-Disk Drive: Vector Graphic Inc has unveiled the first personal-computer system with a built-in Winchester-type hard-disk drive. The Model 3005 houses a video monitor, keyboard, S-100 motherboard, Z80 processor, 64 K bytes of programmable memory, a video interface called Flashwriter, a dual-mode disk controller, a Seagate Technology 5-inch Winchester drive, and up to three quad-density 5-inch floppy-disk drives. The system with one floppy-disk drive costs \$7950.

Tandy Files Suit Against Competitor: Tandy Corporation has brought suit against Personal Microcomputers Inc (PMC), Mountain View, California. Tandy accuses PMC of conspiracy and infringement on the design of the Radio Shack TRS-80 personal computer. Included in the suit are five manufacturers and dealers for Personal Microcomputers' PMC-80 personal computer. The PMC-80 is hardware- and

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Requires 48K RAM, NorthStar Basic or CP/M & CBASIC2 or Microsoft Basic 80.
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software-compatible with the TRS-80 Model I. Tandy is demanding damages and an injunction. Tandy claims that the PMC-80 contains "input/output programming copied from the plaintiff's TRS-80," and that the "defendants have marketed said microcomputer under the name PCM-80, which is confusingly similar to Tandy's registered trademark TRS-80."

Chess Game Has Robot Arm: The newest model of the popular Boris computer chess game has a robotic arm that moves and captures chess pieces. Called "Boris Handroid," it features the Boris 2.5 chess program that won the 1979 European Microcomputer Chess Championship. Sensors in the chessboard detect the human opponent's moves, and Boris Handroid responds by moving its piece. The game costs \$1495 with the arm or \$295 without.

UCSD Pascal Version 6.0 Being Tested: Softech Microsystems' new 4.0 version of UCSD (University of California, San Diego) Pascal is being tested at selected user sites. Softech has not yet set a release date. The new version adds multitasking and upgraded screen-handling functions. Four new p-code instructions have been added, which will create problems for version 3 users.

The UCSD Pascal compiler translates Pascal statements into a series of p-code (pseudocode) instructions, which are then interpreted during execution by a p-code-interpretor program, except on the Western Digital (WD) Pascal Microengine, which executes p-codes according to hardware microcode. The p-code system allows the UCSD

Pascal system to operate the same way on many different systems.

Western Digital has not yet decided on how it will upgrade machines currently in the field to work with the new p-codes. WD notes that its control-store memory still has about 25% free space; therefore, an "outboard" control store on the main computer board could be added, rather than changing the entire control store.

Update On 32-Bit Microprocessors: The International Solid-State Circuits Conference (ISSCC) met in New York last February and heard presentations on two 32-bit microprocessors and some disclosures on a third.

Intel released further details on its 32-bit iAPX432 processor. It is Intel's first departure from previous architecture and instruction sets, so there is no software compatibility with its 8086 (16-bit) and 8085 (8-bit) microprocessors. Each of the iAPX432's three integrated circuits has four lines of sixteen pins. There are two general processors and an I/O (input/output) processor. The iAPX432 can link to 8086s and existing peripheral and memory integrated circuits. Intel is boasting performance of up to 2 MIPS (million instructions per second).

It took five years to engineer the iAPX432, and the company estimates that \$25 million was spent on the project. Intel expects to sell at least 10,000 sets in the first year of production, which is projected for 1982. The initial price for the set will be \$1500. Intel started shipping evaluation sets in February and is offering a board-level evaluation kit for \$4250.

Intel claims that each of the three integrated circuits contains about 200,000 tran-

sistors. Two chips operate as a pipeline pair: the 43201 processor, which contains the instruction decoder, and the 43202, which is the microexecution unit. The 43203 is the I/O processor. It provides an interface from the I/O subsystem to the protected-access environment of the central system. Each I/O subsystem uses an 8- or 16-bit microprocessor to control I/O, independent of the central system. An address space of more than 4 gigabytes (4×10^9 bytes) and a virtual memory-address space of a terabyte (10^{11} bytes) is supported.

A protection scheme is provided to limit access to programs. The iAPX432 can perform floating-point operations on 32-, 64-, and 80-bit numbers. Hardware failures can be detected by interconnecting identical iAPX432 processors in a self-checking arrangement.

The system uses compiled Ada code as its machine language. The language interpreter is contained in a 64 K-byte microcode ROM (read-only memory).

Intel has also released an Ada cross-compiler for the iAPX432. The compiler runs on a DEC (Digital Equipment Corporation) VAX-11/780 or an IBM 370. It costs \$30,000. A \$50,000 hardware link is needed to download the compiled code to Intel's 54250 development board.

With the iAPX432, Intel appears to have a two-year jump on its competition. At the conference, Hewlett-Packard (HP) disclosed that it is in the early stages of development on a 32-bit microprocessor. HP claims to have built and tested a single chip with 450,000 transistors [which is about what Intel has in its set of three integrated circuits]. It operates with an 18 MHz clock and is microprogrammed in 9 K 38-bit

words in an on-board ROM. HP will have four other peripheral devices: an I/O controller, a memory controller, a 128 K-bit program memory, and a 512 K-bit ROM. The device is still being developed and no production commitment or product use has been determined.

Texas Instruments announced that early next year it will unveil a 99000 processor. TI refuses to disclose details, but it appears that the 99000 will have 32-bit addressing without 32-bit processing.

Chairperson Andrew Allison and his IEEE (Institute of Electrical and Electronics Engineers) working group is developing a bus standard to accommodate microprocessors from 8 to 32 bits in word length. The standard will have a 32-bit multiplexed address- and data-path compatible with 32-, 16-, and 8-bit microprocessors. It will allow up to thirty-two bus masters and multitasking via a serial interprocessor link that may use interrupt arbitration. A maximum initial clock rate of more than 10 MHz will be specified.

Floppy-Disk Densities Increasing: Ten years ago, IBM introduced an 8-inch disk drive capable of storing 400 K bytes of data (unformatted) on one side of a floppy disk. Shortly afterwards, double-density encoding schemes that allowed up to 800 K bytes of storage were introduced. Then in 1976, IBM came up with the double-sided drive, which increased data storage up to 1.6 megabytes. That same year Shugart Associates introduced a drive using a 5-inch floppy disk that could store 110 K bytes on a single-sided single-density disk. Later double-density double-sided (DDDS)

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Includes fused, constant voltage power supply (+8V at 25 Amps, +16V at 3 Amps, and -16V at 3 Amps); 20 slot shielded/active terminated motherboard; and rugged all-metal enclosure with AC outlets on rear, heavy-duty line filter, circuit breaker, low noise fan, and reset switch. Rack mount version includes slides for easy pull-out from rack frame.

Also available: COMPUTER ENCLOSURE 1. Same as above, but less power supply and motherboard. \$289 desktop, \$329 rack mount.

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32K RAM 20-32 (extended addressing and bank select).....	\$559	\$699	\$799
128K RAM 21.....	price upon request		

NEW! 64K RAM 17. Amazingly low power in a 64K fully static RAM board: draws less than 2.0 Watts typical, 4.0 Watts guaranteed max! It's fast, too; no wait states with 6 MHz Z-80* CPUs, or up to 10 MHz with 8086/88 family CPUs. Uses IEEE extended addressing protocol; also, user may turn off 2K windows from E000 to FFFF in order to accommodate memory-mapped peripherals/disk controllers. (The CompuPro disk controller can use the full 64K since it is not memory-mapped.) \$1095 Unkit, \$1395 A/T, \$1595 CSC. 48K version also available: \$1048 A/T, \$1198.50 CSC.

HIGH SPEED S-100 CPU BOARDS

CompuPro CPU boards meet all IEEE 696/S-100 specifications (including timing). CPU 8085/88 uses two processors, an 8085 and 8088, to provide both 16 and 8 bit capability with a standard 8 bit bus.

8 Bit CPU Z (with Z80A* CPU).....	\$225 Unkit, \$295 A/T (both operate at 4 MHz), \$395 CSC (with 6 MHz CPU).
8 Bit CPU 8085 (5 MHz).....	\$325 Unkit, \$325 A/T, \$425 CSC (6 MHz)
16/8 Bit CPU 8085/88.....	\$295 Unkit, \$425 A/T (both operate at 5 MHz); \$525 CSC (with 6 MHz 8085, 6 MHz 8088).

OTHER S-100 BUS PRODUCTS

Interfacer 1 (dual RS-232 serial ports).....	\$199 Unkit, \$249 A/T, \$324 CSC
Interfacer 2 (3 parallel + 1 serial port).....	\$199 Unkit, \$249 A/T, \$324 CSC
Interfacer 3 - 5 (5 serial ports).....	\$599 A/T, \$699 CSC
Interfacer 3 - 8 (8 serial ports).....	\$699 A/T, \$849 CSC
Spectrum color graphics board.....	\$299 Unkit, \$399 A/T, \$449 CSC
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6 slot motherboard w/ edge connectors.....	\$89 unkit, \$129 A/T
Memory Manager Board.....	\$59 unkit, \$85 A/T, \$100 CSC
Active Terminator Board.....	\$34.50 Kit, \$59.50 A/T
2708 EPROM Board (2708s not included).....	\$85 Unkit, \$135 A/T, \$195 CSC
Mullen Extender Board.....	\$59 Kit, \$79 A/T
Mullen Relay/Opto-Isolator Control Board.....	\$129 Kit, \$179 A/T

Most CompuPro products are available in Unkit form, Assembled/Tested, or qualified under the high-reliability Certified System Component (CSC) program (200 hour burn-in, more). Note: 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.

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floppy-disk drives were introduced that could store up to 440 K bytes (unformatted).

Recently, Shugart announced 5-inch drives in which track density was increased from 48 tpi (tracks per inch) to 96 tpi, allowing up to 1 megabyte on a DDDS drive. However, increasing the track density on 8-inch drives is more difficult because the larger disks have deformation problems that result in errors. Drive and disk makers are trying to overcome the problems by changing the disk materials and drive designs. The current objective is to increase track density to 96 or 100 tpi by early next year. It is felt that 200 tpi is feasible with different materials.

Manufacturers are trying to obtain densities of 3 and 6.5 megabytes on 5-inch floppy disks and 5 to 10 megabytes on 8-inch floppies. The 3- and 5-megabyte densities appear to be achievable in the near future; however, reaching 10 megabytes on an 8-inch disk is expected to take longer to achieve.

In the meantime, PerSci Inc has taken the wraps off an 8-inch floppy-disk drive with a storage capacity of 2.5 megabytes. It's the same size as a standard 8-inch drive, but uses four read/write heads to access both sides of two DDDS disks.

IBM To Build Josephson Computers: IBM is going to construct an experimental computer entirely based on exotic Josephson-junction devices. This will be the first of its kind, and IBM hopes to have it up and running in five years. The 5000-circuit processor, with 400 K bits of programmable memory, is expected to have a 2 ns cycle time and will be no larger than 18 by 20 by

41 mm. Josephson-junction transistors are superconductive and can switch in less than 10 ps (picoseconds). They consume very little power (usually 500 nW) and typically require a +1 V power supply.

Such a computer could be fifty times faster than current high-speed computers. Engineers have hypothesized that a Josephson-junction-based computer could have a nonvolatile solid-state magnetic memory, and, because of the greatly reduced resistance within its super-cool liquid-helium immersion, thin connectors could be used. Additional attributes could include no crosstalk between devices and immunity to thermal noise. Problems are anticipated in testing and debugging because of the thermal stresses placed on the devices.

If the project is successful, IBM expects to pack a 300,000-circuit processor (about the capacity of an IBM 3033) with 256 K bytes of cache memory and 64 megabytes of main memory into a cube less than 15 cm on a side.

Random Rumors: DEC (Digital Equipment Corporation) is working on a personal computer designed to compete with the Apple III. It's expected to be introduced by year's end. Word is that DEC tried to buy Apple some time ago but was snubbed. . . . Observers expect Apple to introduce a dual-density dual-sided disk system with 600 K bytes of storage for the Apple II and III. You can expect a 5-inch Winchester disk drive with 5-megabyte capacity to hit the shelves by late summer. Apple is considering dropping the present version of the Apple III in favor of a new model that's more busi-

ness-oriented. The new model will probably contain a hard-disk drive instead of a floppy-disk drive. Apple is scheming an upgraded Apple II with a faster microprocessor and expanded memory size. . . . The Source timesharing system is preparing to sell a low-cost (\$600) terminal with built-in modem and printer port; it has a folding keyboard for portability. . . . Texas Instruments is about to introduce a small low-cost robot arm. . . . Hewlett-Packard is preparing an under-\$2000 system, maybe for this year. . . . ADDS (Applied Digital Data Systems) says that it will soon introduce a dumb terminal priced one-third less than current models. . . .

Random News Bits: Zenith Radio Corporation has a special video display for automobile dashboards. . . . RCA has received a patent for a technique that stores up to 100 gigabits (ie: 100 billion bits) on a laser disk intended for video. A complete encyclopedia can be stored on such a disk. . . . Sears Roebuck will open five computer stores. If they are successful, Sears Roebuck will sell computers nationwide. . . . Marker Ski Bindings has a binding with a built-in microprocessor. The battery-powered unit costs \$200 and must be custom programmed for the skier. . . . Ohio Scientific's new Challenger BP-HD personal computer has a Votrax voice-synthesizer output system and a voice-input system. It requires a 10-megabyte Winchester disk to function. . . . The Votrax SC-01 Voice Synthesizer Chip is now available from the MicroMint of Woodmere, New York. The Votrax division of Votrax will not sell the device in quantities of less than five.

. . . Zilog has reduced the price of the 16-bit Z8002 microprocessor from \$45 to \$19.90, in OEM quantities of 1000. . . . Intel may reduce its prices for the 8088 and 8086. . . . IBM has a 32-bit microprocessor up and running in its labs. . . . Apple recently purchased its distributor in Great Britain, and now has well over 1000 employees. . . .

Miniaturization Continues: Semiconductor manufacturers keep on packing more capability onto a single wafer of silicon. Intelligent controllers, especially, are benefiting from such efforts. Two of the most recent products are the National Semiconductor INS8073 and the Zilog Z8 system. The Zilog product line includes a microprocessor, designated Z8671, which contains a limited-BASIC interpreter and debugging monitor in on-board read-only memory. Steve Ciarcia is using the Z8671 to build a complete computer system measuring 4 by 4½ inches with serial and parallel I/O ports and 4 K bytes of user memory. Users can program process-control and monitoring functions using the BASIC interpreter. (See next month's "Ciarcia's Circuit Cellar.")

Know Your Dealer: Sources at Radio Shack report the company has been receiving a large number of complaints because of confusion over warranty service on TRS-80s. The problem stems from the fact that Radio Shack does not honor warranties on computers purchased from dealers who are not authorized by Radio Shack. A large number of unauthorized dealers have appeared in the past year—most offering extremely low mail-order

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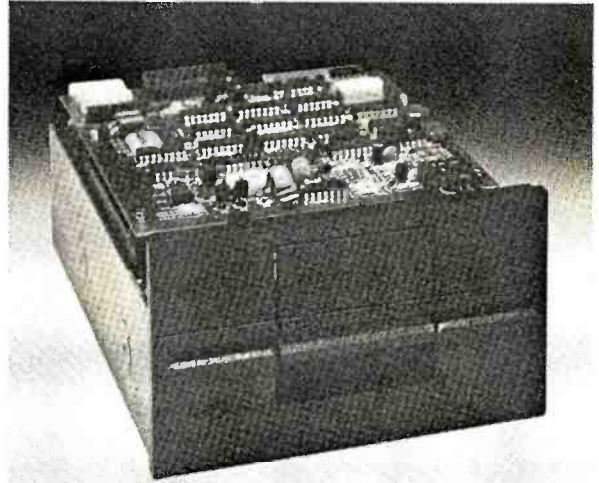
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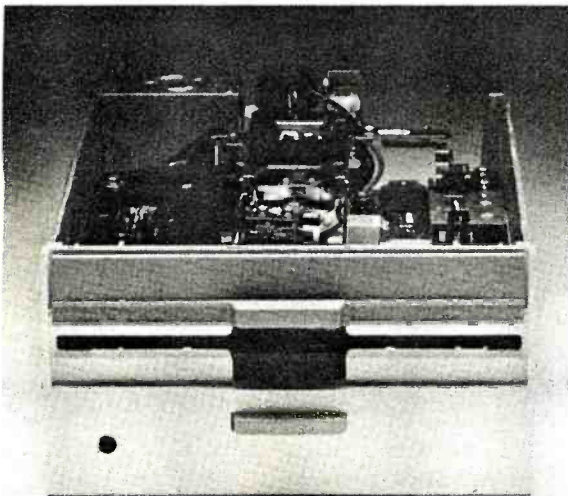
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Product Specifications

Performance Specifications • Capacity: Unformatted: 437.5K or 500K bytes; Qume Formatted: 286.7K or 327.7K bytes • Recording Density: 5456 BPI • Track Density: 48 TPI • Cylinders: 35 or 40 • Tracks: 70 or 80 • Recording Method: FM or MFM • Rotational Speed: 300 RPM • Transfer Rate: 250K bits/second • Latency (avg.): 100 ms • Access Time: Track-to-track 12 ms; Settling 15 ms • Head Load Time: 50 ms



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Performance Specifications • Capacity: Unformatted: 1.6 Mbytes/disk; IBM Format: 1.2 M/bytes/disk • Recording Density: 6816 BPI • Track Density: 48 TPI • Cylinders: 77 • Tracks: 154 • Recording Method: MFM • Rotational Speed: 360 RPM • Transfer Rate: 500K bits/second • Latency (avg.): 83 ms • Access Time: Track-to-track 3 ms; Settling 15 ms; Average 91 ms • Head Load Time: 35 ms • Disk: Diskette 2D or equivalent

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prices on TRS-80 systems.

A Radio Shack spokesman said the company is attempting to close the pipeline to unauthorized dealers but declined comment on how the dealers are obtaining the equipment. He stressed that the majority of mail-order dealers are authorized and advertise the fact, but consumers are cautioned to be sure before ordering. If you need service on units purchased from unauthorized vendors, you'll have to pay full labor and parts rates.

DEC Drops LSI-11 Prices: Digital Equipment Corporation has lowered the prices on the 16-bit LSI-11 microcomputer products by almost 29%. Obviously, DEC is eager to compete with the new Intel 8086-, Zilog Z8000-, and Motorola 68000-based systems now

coming on the market. In fact, the new prices compete well with 8-bit microcomputer systems. A complete LSI-11 system with 32 K bytes of programmable memory and I/O interfaces, assembled in a cabinet, lists for \$2090. Also, the DEC RT-11 and FORTRAN package is now only \$640—\$40 more than the cost of a Microsoft CP/M FORTRAN package.

Packet Repeater Goes On The Air: The nation's first digital simplex packet-radio repeater (KA6M, Menlo Park, California) for amateur radio use has gone into operation. A similar system went into operation earlier in Vancouver, British Columbia, Canada. The station serves as a packet repeater and beacon. It receives a message or block of

data and, after verification, retransmits that message on the same frequency. The message may have some address or control bytes altered. The repeater extends the range and coverage of fixed and mobile stations. It is the first step in what promises to be a nationwide network of interconnected computer systems that allow toll-free communications.

Ethernet Acceptance Spreading: Ethernet, the local networking system, appears to be emerging as the de facto network standard. Although created by Xerox, Intel and DEC have agreed to support it with integrated circuits and system interfaces. Now Zilog has acknowledged that it will implement Ethernet interfaces

on its microcomputer systems. This is particularly noteworthy because Zilog is an Exxon subsidiary, and Exxon has announced its intention to develop a local-network system. Zilog's previously announced networking system Znet will still be supported by the company, in addition to the Ethernet interface.

Hewlett-Packard has made public that it will include Ethernet interfaces in some of its products. Digital Research intends to provide an Ethernet-to-CP/M software package.

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 self-addressed stamped envelope.

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by Julian Simon, 3rd revised edition, 536 pages, 1981

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CP/M: A Family of 8- and 16-Bit Operating Systems

Dr Gary Kildall
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This article is about microprocessors and CP/M: where they came from, what they are, and what they're going to be. Where they came from is history, what they are today is fact, and what they will become is, like any projection of technology, pure "science fiction" speculation. CP/M is an operating system developed for microcomputers. But as microprocessors changed, CP/M and its related programming tools evolved into a family of portable operating systems, languages, and applications packages.

The value of computer resources has changed dramatically with the introduction of microprocessors. Three major events have precipitated a revolution in computing: hand-threaded core memory has been replaced by mass-produced semiconductor memory; microprocessors have become plentiful; and IBM decided that the punched card is obsolete. Low-cost memory and processors have reduced the cost of computer systems to a few hundred dollars, but IBM's specification of the floppy disk standard has made the small computer system useful.

In the early days of the 8080 microprocessor, a small company called Shugart Associates was taking shape up the street from Intel. Shugart Associates, along with a number of other companies, viewed the floppy disk as more than a punched card replacement: at that time the primary

low-cost storage medium was paper tape (used in applications ranging from program development to word processing). At a cost of \$5, a floppy disk held as much data as two hundred feet of paper tape, and a disk drive retailed for only \$500—an unbeatable combination. Memory, processor, and floppy-disk technology improved, and by the mid-1970s, a floppy-based computer could be purchased for about one quarter of a programmer's annual salary. Quite simply, it was no longer necessary to share computer resources.

Since that time, microprocessors have been applied to a variety of

The 16-bit version of CP/M is basically the same as the 8-bit version, with the addition of memory management and enhancements to the file system.

computing needs beyond replacement of low-end minicomputers. Due to applications such as machine-tool movement and sensing, data acquisition, and communications, current interest lies in real-time control. In a real-time operating system, process

management can be separated from the I/O (input/output) system (which is not required in many applications). Real-time facilities allow the execution of interactive processes according to priority, and their addition or deletion in a simple fashion. This results in a custom operating system designed to solve a particular problem. In contrast to timesharing, real-time operating systems have minimal "interrupt windows" in which external interrupts are disabled. Real-time operating systems such as the Intel RMX and National Starplex packages provide this level of support.

The emerging interest in local networks poses a new challenge to designers of operating systems. Recently, Intel, DEC (Digital Equipment Corporation), and Xerox formed an alliance to promote Ethernet, a packet-switching network intended to provide point-to-point data transfer in an office environment. (In a packet-switching network, data from several slow-speed sources, such as user terminals, is collected over local lines by a single network node, which then periodically transmits the data to its destination at a much higher speed, in groups called packets.) In terms of evolution and potential, Ethernet is today what floppy disks were a decade ago. This inexpensive office network performs such tasks as the transfer of a form letter from data storage at one location to a memory typewriter in another part of the

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The Emergence of Software as a Problem-Solving Tool

Microprocessors are a natural consequence of our technology. I recently visited the British Science Museum, where two particularly interesting historical developments were on display. The first exhibit chronicled the development of the finely machined iron and brass steam engines, complete with magnificent gauges, gears, whistles, and valves, that founded the Industrial Revolution.

The second exhibit displayed progress in computing, beginning with Charles Babbage's inventions of the early 1800s. What did these exhibits have in common? They showed machines built with the same technology: Babbage's analytic engine might easily be mistaken for a small steam engine!

I followed the sequence of displays, from Babbage's difference and analytic engines to great brass calculators and early punch cards, past relay and vacuum tube processors to unit record equipment, then to transistor and random-logic computers and semiconductors and, finally, to a single Intel 8080 microprocessor.

Examined in this way, the technological momentum was obvious. Microprocessors are a direct result of our pattern of refinement through engineering. Just as a Boeing 727 is a refined version of the original Wright Brothers' invention, the microprocessor is a conse-

quence of "fine tuning" by scientists and engineers who strive to understand, simplify, and add function to mankind's tools. There were several conspicuous spaces waiting to be filled following the 8080 display.

In public television's "Connections" series, James Burke claimed that we are a society filled with machines that do everything: sew materials for our clothes, carry us from coast to coast, and print millions of newspapers daily. But the most important machines in our society do absolutely nothing by themselves. These multifunctional devices provide a variety of services depending upon our needs, and herein lies the essential advantage: in the past, we identified a need and built a machine to satisfy that need; today, technology provides us with a single machine that we can instruct, through a program, to solve almost any problem. Where are the "Thomas Edisons" who used to build machines? Most are now inventing programs.

The evolution of our electronics industry typifies refinement through engineering. Beginning with electrical and electronic switches, we began manufacturing general-purpose function chips: put a value x on the input pins, define the function f by setting voltage levels on a second set of pins, and the result, $f(x)$, magically appears on the output pins. Many

examples of such integrated circuits exist, ranging from three-state logic gates to arithmetic/logic units.

With the introduction of microprocessors, the function f may be defined through instructions in a read-only memory allowing, in principle, the implementation of any function using a single device. A design that once required connecting resistors, capacitors, and logic gates has developed into a program that instructs a multipurpose machine to perform the same function. Controlling a stoplight and balancing a checkbook are now equivalent problems: both require the invention of a program.

Refinement through engineering: does this not also apply to software? To properly frame the answer, remember that the primary purpose of a computer is to be useful. Therefore, the application program is really the only important result of a software-engineering activity. Our primary goal in refining software tools is to provide the means for rapid and accurate generation of simple, understandable, and effective application programs. We do this through three levels of software support: system languages, operating systems, and application languages. These tools form an inverted pyramid underlying application software.

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7 DEPRSL	Straightline depreciation
8 DEPRSY	Sum of the digits depreciation
9 DEPRDB	Declining balance depreciation
10 DEPRDDB	Double declining balance depreciation
11 TAXDEP	Cash flow vs. depreciation tables
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13 CHECKBK1	Checkbook maintenance program
14 MORTGAGE/A	Mortgage amortization table
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18 RRCONST	Rate of return on investment with constant inflows
19 EFFECT	Effective interest rate of a loan
20 FVAL	Future value of an investment (compound interest)
21 PVAL	Present value of a future amount
22 LOANPAY	Amount of payment on a loan
23 REGWITH	Equal withdrawals from investment to leave 0 over
24 SIMPDISK	Simple discount analysis
25 DATEVAL	Equivalent & nonequivalent dated values for oblig.
26 ANNUDEF	Present value of deferred annuities
27 MARKUP	% Markup analysis for items
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29 BONDVAL	Value of a bond
30 DEplete	Depletion analysis
31 BLACKSH	Black Scholes options analysis
32 STOCVAL1	Expected return on stock via discounts dividends
33 WARVAL	Value of a warrant
34 BONDVAL2	Value of a bond
35 EPSEST	Estimate of future earnings per share for company
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45 SIMPLEX	Linear programming solution by simplex method
46 TRANS	Transportation method for linear programming
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49 CVP	Cost-volume-profit analysis
50 CONDPFOT	Conditionality profit tables
51 OPTLOSS	Opportunity loss tables
52 FQJQJQ	Fixed quantity economic order quantity model

59 WACC	Weighted average cost of capital
60 COMBAL	True rate on loan with compensating bal. required
61 DISCBAL	True rate on discounted loan
62 MERGANAL	Merger analysis computations
63 FINRAT	Financial ratios for a firm
64 NPV	Net present value of project
65 PRINDLAS	Laspeyres price index
66 PRINDPA	Paasche price index
67 SEASIND	Constructs seasonal quantity indices for company
68 TIMETR	Time series analysis linear trend
69 TIMEOV	Time series analysis moving average trend
70 FUPRINF	Future price estimation with inflation
71 MAILPAC	Mailing list system
72 LETWRT	Letter writing system-links with MAILPAC
73 SORT3	Sorts list of names
74 LABEL1	Shipping label maker
75 LABEL2	Name label maker
76 BUSBUID	HOME business bookkeeping system
77 TIMECLCK	Computes weeks total hours from timeclock info.
78 ACCTPAY	In memory accounts payable system-storage permitted
79 INVOICE	Generate invoice on screen and print on printer
80 INVENT2	In memory inventory control system
81 TELDIR	Computerized telephone directory
82 TIMUSAN	Time use analysis
83 ASSIGN	Use of assignment algorithm for optimal job assign.
84 ACCTREC	In memory accounts receivable system-storage ok
85 TERMSPAY	Compares 3 methods of repayment of loans
86 PAYNET	Computes gross pay required for given net
87 SELLPR	Computes selling price for given after tax amount
88 ARBCOMP	Arbitrage computations
89 DEPRSF	Sinking fund depreciation
90 UPSZONE	Finds UPS zones from zip code
91 ENVELOPE	Types envelope including return address
92 AUTOEXP	Automobile expense analysis
93 INSFILE	Insurance policy file
94 PAYROLL2	In memory payroll system
95 DILANAL	Dilution analysis
96 LOANAFDD	Loan amount a borrower can afford
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54 FQEQQPB	As above but with quantity price breaks
55 QUEUECB	Cost-benefit waiting line analysis
56 NCFANAL	Net cash-flow analysis for simple investment
57 PROFIND	Profitability index of a project
58 CAP1	Cap. Asset Pr. Model analysis of project

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building. When modifications are completed, the letter is typed locally or sent to a laser (or other) printer that is a shared network resource.

Most timesharing systems handle a network through simple file transfers between the machines (*nodes*) in the net, but real refinements occur when the operating system itself is distributed among the nodes. File access is provided by one *server* node, while a computing function is performed by another. To the user, a *requester* node appears as a powerful computing facility, even though it may consist of only a local microprocessor, a console, and a limited amount of memory.

What refinements have been made to operating systems? Our models have been simplified; we understand primitive operations required for reliable process synchronization in real-time systems, and the human-oriented interface in interactive subsystems has been improved. We will, no doubt, continue to refine our models for timesharing and real-time

operating systems, but the most exciting new operating system technology will develop around emerging network hardware.

Application Languages

Application languages form the top level of support for application programming. How does this level of language differ from other language levels? First and foremost, an application language contains the operations and data types suitable for expressing programs in a particular problem environment. FORTRAN (*FORmula TRANslation*), for example, was designed in the late 1950s for scientific applications; FORTRAN programs, therefore, consist primarily of algebraic expressions operating upon binary floating-point numbers expressed in scientific notation. However, FORTRAN contains only primitive file-access facilities and no decimal arithmetic, making it unsuitable for commercial data processing. COBOL (*COmmon Business Oriented Language*) has the commercial

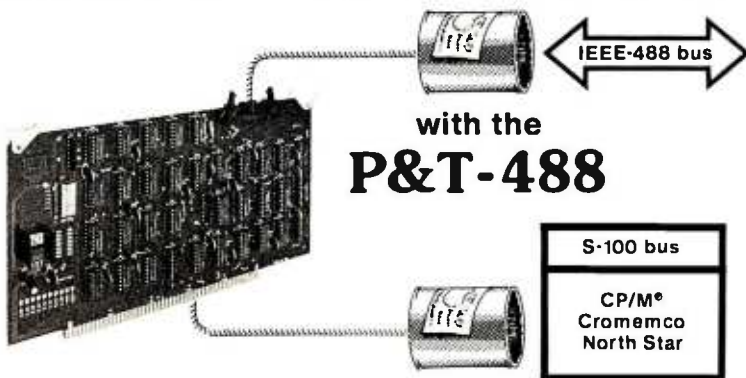
facilities, but it excludes scientific features such as a complete transcendental-function library.

In contrast to system languages that run on a given machine, these application languages would ideally contain no machine-dependent features. An application language is either poorly designed or ill-suited for a particular problem if the programmer is forced to use extra-lingual constructs to access lower-level functions of the operating system or machine. The language must be a standard, without the necessity for various locally defined language extensions. An extended standard language is of limited value since the extensions are unlikely to exist in other implementations.

The evolution of PL/I (*Programming Language/One*) provides a good example of refinement in application languages. PL/I is not a new invention: rather, it was defined by a committee of IBM users in 1960 as a combination of ALGOL (*ALGO-rithmic Language*), FORTRAN, and COBOL, with a liberal sprinkling of new facilities. ALGOL's principal contribution was block structure and nested constructs, while FORTRAN contributed scientific processing and COBOL added commercial facilities. This combination produced a large, unwieldy language with twists and nuances that can trap the unwary programmer. Nevertheless, PL/I was quite comprehensive, and it served as the basis for uncounted numbers of application programs on large systems. One noted use of PL/I was in the implementation of the Multics operating system at MIT under Project MAC.

In 1976, an ANSI (American National Standards Institute) committee produced a standard language definition for PL/I. The standard is an implementation guide for compiler writers, and it precisely defines the form and function of each PL/I statement. Aware that PL/I was too large and complicated, the committee produced a smaller version for minicomputers, called Subset G. This new language excluded the redundancies and pitfalls of full PL/I but retained the

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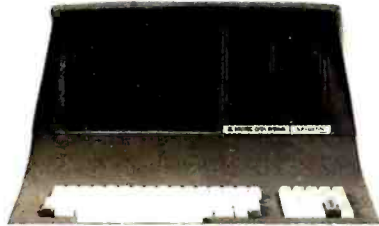
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useful application programming features. Recently approved by ANSI, Subset G has given new life to PL/I, with manufacturer support for the Data General Eclipse and MV/8000 computers, Prime computers, Wang machines, and DEC's popular VAX computer.

Strangely, the refinements found in application languages follow those of hardware and operating systems. Large, cumbersome languages have been rejected in favor of simple, Spartan programming systems that are consistent in their design. The resulting languages are easier to implement, simpler to comprehend, and allow straightforward program composition.

PL/M: The Base for CP/M

In 1972, MAA (Microcomputer Applications Associates), the predecessor of Digital Research, consulted with the small, aspiring microprocessor division of a semiconductor memory company called Intel Corporation. MAA defined and implemented a new systems-programming language, called PL/M (*Programming Language for Microcomputers*), to replace assembly-language programming for Intel's 8-bit microprocessor. PL/M is a refinement of the XPL compiler-writing language which is, in turn, a language with elements from Burroughs Corporation's ALGOL and the full set of PL/I.

The first substantial program written by MAA using PL/M was a paper-tape editor for the 8008 microprocessor, which later became the CP/M program editor, called ED. PL/M is a commercial success for Intel Corporation and, although licensing policies have limited its general accessibility, it has become the standard language of the Intel microprocessor world, with implementations for the 8080, 8085, and 8086 families.

MAA also proposed a companion operating system, called CP/M (*Control Program for Microcomputers*), which would form the basis for resident PL/M programming. The need for CP/M was obvious: 8080-based computers with 16 K bytes of main memory could be combined with

System Languages

A system language is a high-level machine-dependent programming language used to implement so-called "system software," including operating systems, text editors, debuggers, interpreters, and compilers. In the early days of computing, virtually all system software was implemented in assembly language. One revolutionary machine, the Burroughs B5500, used a variant of ALGOL-60 as its only system-programming tool and appeared in the early 1960s. The machine was a commercial success against the other major mainframes, proving that assemblers were no longer necessary. Many successful system languages followed Burroughs' ALGOL, including the C language, produced at Bell Laboratories in the late 1960s, which served as the basis for the UNIX operating system.

A system language, by definition, matches the architecture of a particular machine or class of machines; all facilities of the machine are accessible in the language, and the language contains no non-trivial extensions beyond the basic machine capabilities. The benefit is that a compiler for the system language is easy to implement and transport from machine to machine, as long as the architecture of each machine is similar. Further, a system language requires little runtime support since application facilities, such as extensive I/O (input/output) processing, are not generally embodied in the language.

Refinements in system languages are made by increasing their usability. Their acceptance as replacements for assembly languages is encouraging. Today, one can publicly admit that system software is implemented in a high-level language without implying that it must be rewritten in assembly language to be effective.

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- SOUNDEX Made Simple
- BASIC Comparisons: The Conclusion of the SBASIC* series
- Zoso Strikes Again—And His Target Strikes Back
- From the CP/M* Users Group: Volume 49, Including Some Useful RATFOR Programs

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Operating Systems

Operating systems, too, have become more refined. But why do we have operating systems at all? In the 1960s we used expensive mainframes with power-hungry central processors and magnetic-core memory. Downtime for complicated card readers, printers, and backup data-storage devices was high, requiring constant maintenance. A card-oriented "batch" operating system provided two functions. First, it allocated processor time, memory, and peripherals to application programs in an attempt to utilize each expensive component to its fullest. Second, common I/O subroutines were a part of the operating system to avoid duplication in each application program. In the early 1960s, batch operating systems began to incorporate online terminals that allowed the programmer to interact with the program—this is

where things became interesting. With an online terminal, a program could write a prompt message, read the data entered by the operator, and write a response almost instantly.

The crude terminal systems evolved into today's timesharing computers, where program interaction is the primary function, with batch processing in the background. General Electric and Digital Equipment Corporation led the way with BASIC-based 235 and multilingual PDP-10 computers. Countless timesharing operating systems followed, including IBM's interactive APL and CP/CMS, along with UNIX from Bell Laboratories. These timesharing systems were the forerunners of personal computing: all assumed that the hardware was too expensive to dedicate, so each terminal became an emulation of a single computer.

Shugart's new (at that time) floppy-disk drives to serve as development systems. For the first time, it was feasible to dedicate a reasonably powerful computer to the support of a single engineer. But the use of PL/M on larger timesharing computers was considered sufficient, and the CP/M idea was rejected.

The CP/M Family

CP/M was, however, completed by MAA in 1974. It included a single-user file system designed to eliminate data loss in all but the most unlikely situations, and used recoverable directory information to determine storage allocation rather than a traditional linked-list organization. The simplicity and reliability of the file system was an important key to the success of CP/M: file access to relatively slow floppy disks was immediate, and disks could be changed without losing files or mixing data records. And because CP/M is a Spartan system, today's increased storage-media transfer rates simply improve overall response. The refinements found in CP/M are based on its simplicity, reliability, and a proper match with limited-resource computers.

By the mid-1970s, CP/M added a new philosophy to operating system design. CP/M had been implemented on several computer systems, each having a different hardware interface. To accommodate these varying hardware environments, CP/M was decomposed into two parts: the invariant disk operating system written in PL/M, and a small variant portion written in assembly language. This separation allowed computer suppliers and end users to adapt their own physical I/O drivers to the standard CP/M product.

Hard-disk technology added yet another factor. CP/M customers required support for disk drives ranging from single 5-inch floppy disks to high-capacity Winchester disk drives. In response, CP/M was totally redesigned in 1979 to become *table-driven*. All disk-dependent parameters were moved from the invariant disk operating system to tables in the

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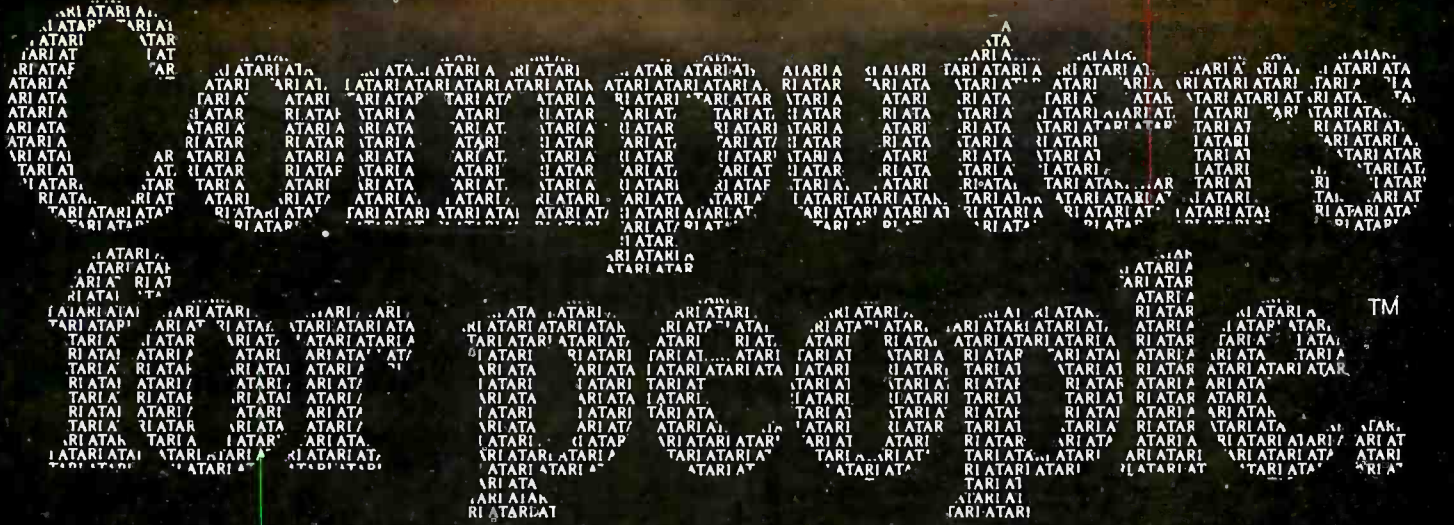
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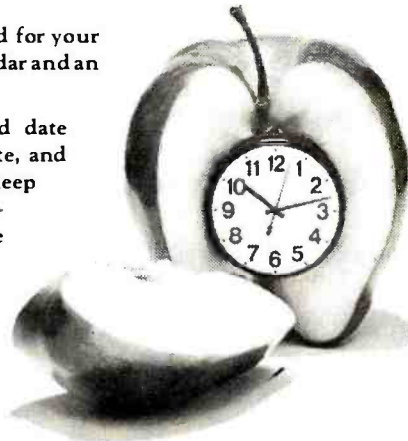
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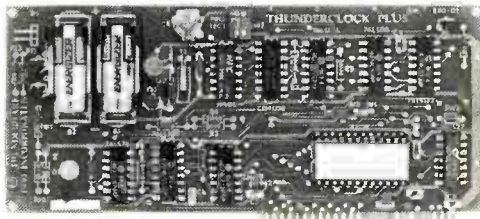
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the process. You can, for example, send the name of a disk file to the spooler and, while the file is being printed, edit another file in preparation for compilation. The spooler and editor share processor time to complete their respective tasks. In general, many such processes share processor time and system resources.

MP/M process communication is performed through *queues* (or waiting lines) managed by the nucleus. The spooler, for example, reads file names from an input queue posted by another process (which reads spooler command lines from

the console). When the spooler is busy printing a file, additional file names may enter the input queue in a first-in first-out order.

Process synchronization through queuing mechanisms is commonplace, but MP/M treats queues in a unique manner, simplifying their use and decreasing queue management overhead. Queues are treated as files: they are named symbolically so that a queue can be added dynamically. Like files, queues have queue control blocks that are created, opened, deleted, written, and read. In fact, the set of queue operations closely

matches the file functions of CP/M so that MP/M provides a familiar programming environment.

The implementation of queues is transparent to an operator or system programmer, but it is important to MP/M's effective operation on limited-resource computers. Queues are implemented through three different data structures, depending upon the message length. So-called "counting semaphores" count the occurrence of an event with message length zero, and are implemented as 16-bit tallies. Single-byte messages are processed using a circular buffer. Similarly, queues containing addresses are processed using circular buffers. In all other cases, MP/M uses a general linked list, which requires additional space and processing time. It is this sensitivity to the capabilities of limited-resource computers that makes MP/M effective: while real-time operating systems often incur 25 to 40% overhead, MP/M has been streamlined to increase available compute time by 7% over single-user CP/M.

Like CP/M, MP/M is separated into variant and invariant portions. The file-system interface is identical to that of CP/M, with the addition of user-defined functions to handle non-CP/M operations (such as control of the real-time clock). Field-reconfiguration of MP/M allows a variety of device protocols including CP/M-style busy-wait loops, polled devices, and interrupt-driven peripherals. In fact, the variety of interface possibilities makes the MP/M implementer a true system-software designer, since a fine-tuned MP/M system may operate considerably faster than its initial implementation.

What are the refinements found in MP/M? First, it is a state-of-the-art operating system based on current process-synchronization technology and microprocessor real-time system design philosophies. Process communication is conceptually simple and requires minimal overhead. Finally, it is the only operating system of its type that can be field-tailored to match almost any computer configuration.

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CP/NET

CP/NET, introduced in late 1980, leads a series of network-oriented operating systems that distribute operating system functions throughout a network of nonhomogeneous processors. CP/NET connects CP/M requesters to MP/M servers through the use of an arbitrary network protocol. Similar to CP/M and MP/M, CP/NET consists of the invariant portion, along with a set of field-reconfigurable subroutines that define the interface to a particular network. For purposes of CP/NET, this interface need only provide point-to-point data-packet transmission. Since the actual data transmission media are unimportant to CP/NET, any one of the number of standard protocols can be used, from low-speed RS-232C through high-speed Ethernet. Physical connections are also arbitrary, allowing active hub-star, ring, and common-bus architectures.

The invariant portions of CP/NET operate under a standard CP/M system to direct various system calls over the network to an MP/M server. The MP/M server, in turn, responds to network requests by simulating the actions of CP/M. This simulation is transparent to an application program: any program operating under standard CP/M operates properly in the network environment.

Suppose, for example, you wish to store common business letters in a central data base under MP/M and access these letters from a CP/M-based word processor. You begin by assigning one local disk drive to the MP/M master, using the CP/NET interface. You then direct your word processing system to read the particular letter on the assigned drive, causing the data to be obtained from the server rather than from the local disk. After local update using your word processor, you can print the result on your local printer or optionally assign your listing device to the network for printing at the MP/M server.

CP/NET is accompanied by three related network operating systems: CP/NOS, MP/NET, and MP/NOS. CP/NOS is, in effect, a diskless

CP/M, which can be stored in read-only memory, and that operates with a console, memory, and network interface. MP/NET, on the other hand, is a complete MP/M system with an embedded network interface that, like CP/NET, allows local devices to be reassigned to the network. MP/NET configurations allow MP/M systems as both requesters and servers with CP/M requesters. Finally, MP/NOS contains the real-time portion of MP/M without local disk facilities. Like CP/NOS,

MP/NOS performs all disk functions through the network.

The interface protocol is publicly defined so that non-MP/M or non-CP/M systems can participate in network interactions. A server interface for the VAX 11/780, for example, is under preparation so that it can perform I/O functions for a large number of MP/M and CP/M requesters.

The principal advantage of CP/NET is that all CP/M-compatible software becomes immediately available for operation in the network en-

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vironment, solving the problem that builders of network hardware face: the total absence of application software. Although the promise is there, networking is in its infancy, and CP/NET is truly a software package awaiting the evolution of suitable hardware.

PL/I: The Application Language

In 1978, Digital Research investigated the final level of software support: application languages. One such language was to be supported throughout the operating system product line, and the choice would have to be a multipurpose language. Further, the language would have to be an international standard to promote the generation of software by independent vendors. Standard Pascal seemed a logical choice but was rejected for several reasons. First, Pascal is an ALGOL derivative with scientific orientation. Commercial facilities in the standard language are absent: decimal arithmetic, file processing, string operations, and error-exception handling were essential. Further, separate compilation and initialization of tables were not in the language. There was a temptation to extend Pascal in order to include these features, but these extensions would have defeated the benefits of standardization.

PL/I Subset G was the obvious choice. It satisfied scientific and commercial needs and, because of subset restrictions, was consistent and easy to use. The project was a bit daring, however, because Subset G was unknown in the computer community. PL/I was viewed as a large IBM-oriented language with huge, inefficient compilers that required tremendous runtime support.

The Digital Research implementation of Subset G was started in mid-1978 and completed two years later. The compiler is a three-pass system written in PL/M. The first two passes are machine independent and produce symbol tables and intermediate language suitable for any target machine. The third pass is largely machine dependent and is dedicated to code optimization and final ma-

chine-code production. The compiler is accompanied by a linkage editor (compatible with the Microsoft format), a program librarian, a set of runtime subroutines, and a relocating macro assembler.

Thus, PL/I completes the final level of the inverted pyramid of support tools. The message should be clear to the application programmer: it is not the system language or the operating system which is important in the production of a final application. Rather, it is the availability of a standard, widely accepted application language that can provide program longevity. Once expressed in PL/I Subset G, the program can be transported through the CP/M family of operating systems to a variety of minicomputer systems. Digital Research has a long-term commitment to PL/I support for popular operating systems and processors.

New Processor Architectures

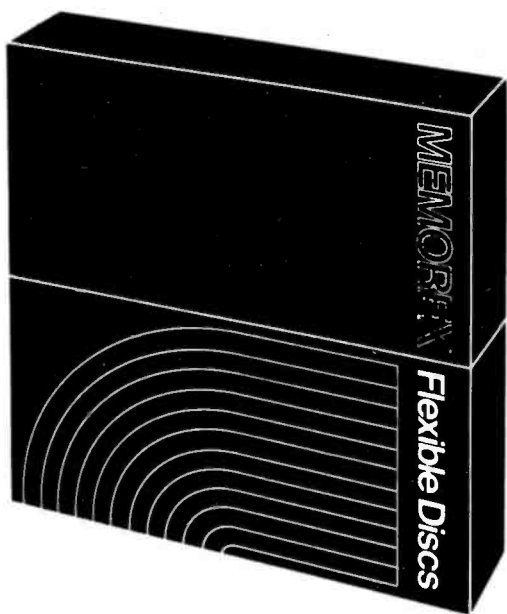
We've spent little time discussing processor refinements. What is happening to our software tools as we augment our 8-bit machines with the more powerful 16-bit processors? Will 16-bit processors replace 8-bit machines, or are they simply a temporary phenomenon in the transition to 32-bit machines?

There are several considerations when answering these questions. First, 8-bit machines are economical to produce, their software systems are mature, and they satisfy the needs of a substantial computer base. Therefore, we can safely assume that 8-bit machines are here to stay. Newer 16-bit machines are marginally faster, but they have substantially more address space. To use this additional address space, the computer must contain more memory, which increases the computer system cost.

As system costs increase, the margin between low-end minicomputers and high-end microcomputers diminishes, placing microcomputer hardware and software manufacturers such as ourselves in direct competition with major minicomputer manufacturers. The 16-bit machines, by their nature, introduce memory segmentation problems that are not

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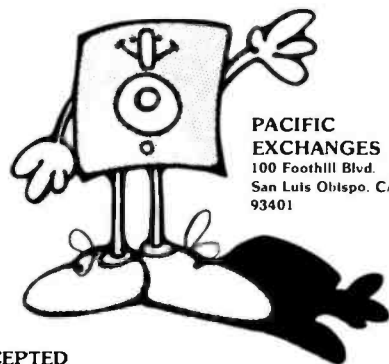


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present in 32-bit processors.

Finally, we should note that 16-bit minicomputers are already outmoded, and all serious manufacturers are pushing 32-bit machines. This leads to the following conclusion: if we are tracking the minicomputer world, we can assume that the future will be with the 32-bit processors.

Currently, however, 32-bit machines are not available in quantity. Even when they are available, there will be delays while manufacturers tool up for production. At the moment, the 16-bit processors offer an intermediate solution. Digital Research has provided initial support for Intel's 16-bit machines—iAPX-186 and iAPX-286—which are versions of its 8086 product line. Intel provided PL/M-86, rehosted from the 8080 line, which was used by Digital Research to generate CP/M-86 and MP/M-86. In both cases, the fundamental design remains basically the same as that of the 8-bit version, with the addition of memory management and enhancements to the file system that match new computing resources.

A familiar program environment is retained so that program conversion is simplified.

CP/NET and related network software will be available sometime this year. Intel's 8087 (an arithmetic coprocessor for the 8086) is of particular interest since it directly supports binary and decimal operations, which substantially increase PL/M-86 execution speed.

In addition to the 8086, the CP/M family will be adapted to the 16-bit machines that prove popular, with special interest in the 32-bit architectures as they become available. During this development and rehosting, however, the 8-bit processors will continue to be supported with new tools and facilities, since this constitutes, without doubt, our best customer base for some time to come.

Software Vendors

We've concerned ourselves with three levels of software tools that support the most important level: the application programs. A major reason for CP/M's popularity is the general

availability of good application software. At last count, there were about 500 commercially available CP/M-compatible software products.

Through the combined efforts of CP/M distributors, independent vendors, and CP/M users, we are participating in a software commodity market with quality and variety that is unequaled by any minicomputer or mainframe manufacturer. The large CP/M customer base allows a vendor to produce and support a software package at low end-user cost. This increases the customer base, drawing more vendors with lower-cost good-quality products. This cyclic effect is, today, solving the "software crunch."

The tools are available, and it is the responsibility of independent software vendors to continue developing their own specialized markets. In this way, computer software technology will reach virtually all application areas where low-cost, reliable computing is required. Refinements? My friend, they're up to you. ■

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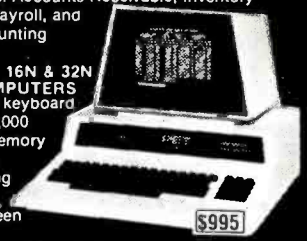
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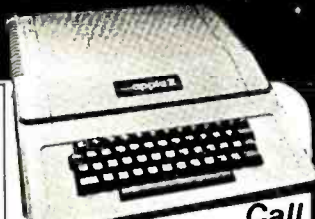


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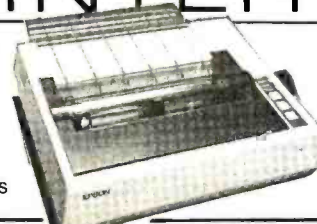
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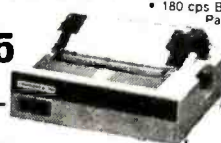
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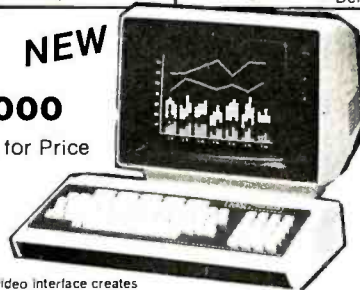
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LIST—A Source-Listing Program for the C Language

Jeff Taylor, The Toolsmith
POB 22511, San Francisco CA 94122

Most UNIX-system utilities read from a standard input device and write to a standard output device. The Whitesmiths C compiler shows its heritage by doing the same. Until it informs you, for example, that there is a semi-

colon missing on some line, you don't notice that the source listing isn't being printed. LIST is a program to print source listings. (See listing 1.) Each line is labeled like the compiler's error listing. The version presented here is a system note, and you will probably want to add more features.

About the Author

Jeff Taylor is the owner of The Toolsmith, a software house. He received his bachelor's degree and did graduate work in electrical engineering, specializing in computer science, at the University of California, Davis.

LIST reads the files named on command line and writes the listing to the standard output. If the files are not named, input is taken from the standard input. The standard input and output default to the user's terminal but can be redirected to or from other devices or files, such as the line printer. Each file's listing starts a new page. At the top of each page is the file's name, the page number, and the date. Obtaining the date from the operating system depends upon your equipment; the code shown is for RT-11. The function DATE returns the number of bytes in the date and puts the date's character string in its single argument.

The C language allows an #include statement. The preprocessor of the compiler replaces the #include statement with the contents of the file it names. As an option, LIST can insert the contents of the file after the #include statement. The -n flag on the command line turns on #include processing for nonheader files. The -h option includes header files. Header files are those with the extension .H (such as STD.H, which is the standard header file supplied by Whitesmiths). The depth to which #include can be nested depends on your stack size. Listing 1 was printed by the command:

```
list -n > lp: list.c
```

where lp: is the line printer. The #include processing was performed excluding header files. The angle brackets (< and >) indicate redirection of the standard input and output, respectively.

The subroutine PAGINATE uses a technique that is described in *Principles of Program Design* by M A Jackson. If each print line could be read from a scratch

Text continued on page 246

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Same as 550E plus block mode. 8 function keys, and protected fields, reverse video fields, half intensity fields, blinking fields.

550 Options

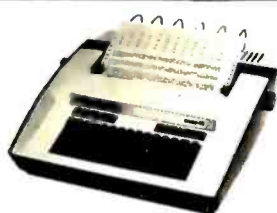
20mA Current Loop Interface \$70

Non-Glare Screen \$25

2nd page of memory (550S only).. \$100

HARDCOPY TERMINALS

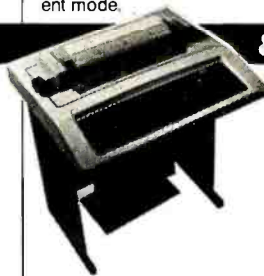
& PRINTERS



**Teletype
Model 43**

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Corporation

Teletype Model 43 KSR with RS232
and Connector Cable \$999
30 CPS. Dotmatrix. 132 cols. Truedescenders on lower case. Excellent print quality for dot matrix printer. Pin feed.



DEC LA120

Digital Equipment
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DEC LA120 ... \$2388

180 CPS. Dot matrix. Upper/lower case. 1K buffer. Designed for 1200 baud communications. 30 character answerback message. Adjustable line spacing. Adjustable character sizes including double sized characters. Settable horizontal and vertical tabs. Top-of-form capability. RS232.



Digital
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DEC LA34DA ... \$939

30 CPS. Dot matrix. Upper/lower case. 4 character sizes. Up to 217 cols per line. 6 lines per inch settings. Friction feed. Settable tabs. RS232.

DEC LA34AA \$1095

30 CPS. Dot matrix. Upper/lower case. 8 character sizes including double size characters. 6 lines per inch settings. Up to 217 cols per line. Friction feed. Settable horizontal and vertical tabs. Top-of-form capability.

Options for LA34AA and LA34DA

Tractor Feed Mechanism \$114

Numeric Keypad w/ Function Keys.. \$69

Pedestal..... \$100

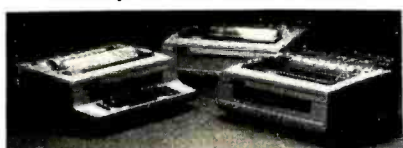
Paper Out Sensor \$25

APL Capability with APL Keycaps .. \$499

2K Buffer with Text Editor and 1200 Baud
Communications Capability \$499

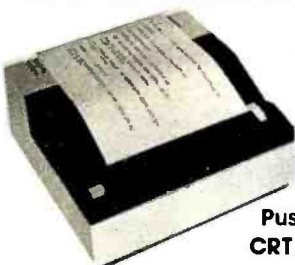
NEC Corporation

NEC Spinwriter 5510 & 5520



5520 KSR Spinwriter \$3088
55 CPS. Impact printer. Selectric print quality. Changeable print fonts. 110, 300 and 1200 baud data rate. Numeric keypad. Friction and tractor feed.

5510 Spinwriter \$2754
55 CPS. Impact printer. Selectric print quality. Changeable print fonts. 110, 300 and 1200 baud data rate. Friction and tractor feed.



Perkin-Elmer
Corporation

**Pussycat 650/655
CRT Screen Printer**

650/655 Pussycat CRT Screen Printer. \$899
100 CPS. Extremely compact and quiet. 110 to 9600 baud rate. 2K buffer. Ideal for producing rapid, reliable hardcopy of your CRT screen display. Can be added to any CRT with our interface option.

Leasing rates and lease/purchase plan information is available on request.

All equipment is shipped with a 10 day money back guarantee.

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System Notes

Listing 1: The program LIST. Normal operation produces a listing with pagination, top and bottom margins on each page, and a header on each page.

```
list.c                               Page: 1           24 October 1980

list.c      1: #include <std.h>
list.c      2: #include <local.h>
list.c      3: /* lister - list 'c' source files
list.c      4: */
list.c      5:
list.c      6: FIO stdin;          /* standard input buffer */
list.c      7:
list.c      8: BOOL n_flag = NO;
list.c      9: BOOL h_flag = NO;
list.c     10:
list.c     11: #include "diagn.c"
diagn.c     1:
diagn.c     2: /* diagnostic - spit out error message */
diagn.c     3: diagnostic(fatal,args)
diagn.c     4:   BOOL fatal;
diagn.c     5:   TEXT *args;
diagn.c     6:   {
diagn.c     7:     FAST TEXT **a;
diagn.c     8:
diagn.c     9:     for(a = &args; *a != NULL; ++a)
diagn.c    10:       write(STDERR,*a,lenstr(*a));
diagn.c    11:     write(STDERR,"\n",1);
diagn.c    12:     if(fatal)
diagn.c    13:       exit(NO);
diagn.c    14:   }
list.c     12:
list.c     13: #include "pagin8.c"
pagin8.c    1:
pagin8.c    2: #include "date.c"
date.c      1:
date.c      2: /* date - return current date, if any in "buf" */
date.c      3: BYTES date(buf)
date.c      4:   FAST TEXT *buf;
date.c      5:   {
date.c      6:     BYTES itob();
date.c      7:     COUNT emt();
date.c      8:     FAST TEXT *b = buf;
date.c      9:     TEXT *cpystr();
date.c     10:     union _date {
date.c     11:       COUNT all;
date.c     12:       struct {
date.c     13:         unsigned year:5;
date.c     14:         unsigned day:5;
date.c     15:         unsigned month:5;

list.c                               Page: 2           24 October 1980

date.c     16:       };
date.c     17:     } tmp;
date.c     18:     static TEXT *months[] = {"January","February","March","April","May","June",
date.c     19:       "July","August","September","October","November","December"};
date.c     20:
date.c     21:     tmp.all = emt(0374,012<<8); /* system call */
```

Listing 1 continued on page 238

ALL THESE FEATURES... IN THIS SMALL SPACE... AT THIS LOW PRICE!

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Greater computer power . . . fewer separate components . . . larger capability . . . simpler to operate . . . modular maintenance . . .

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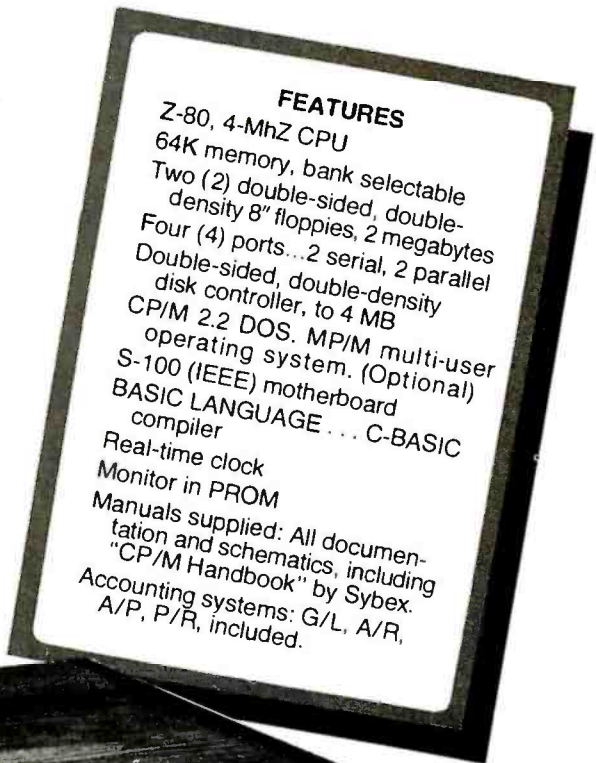
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64K memory, bank selectable
Two (2) double-sided, double-density 8" floppies, 2 megabytes
Four (4) ports...2 serial, 2 parallel
Double-sided, double-density disk controller, to 4 MB
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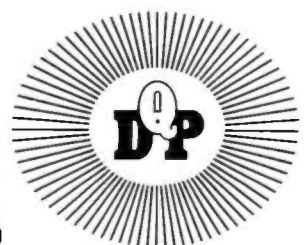
Z-80 is a trademark of Zilog Corp.

CP/M and MP/M are trademarks of Digital Research Corp.

Quasar Data Products

10330 Brecksville Road, Brecksville (Cleveland), Ohio 44141
Phone: 216/526-0838 / 526-0839

Telex: 241596



System Notes

Listing 1 continued:

```

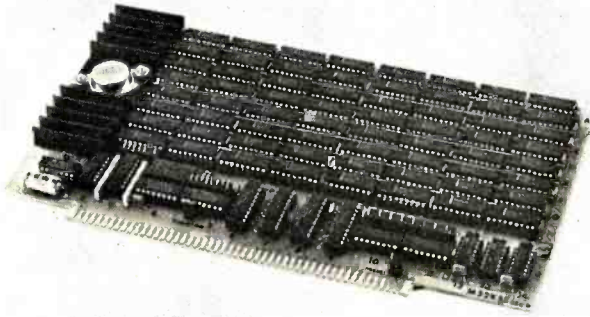
date.c      22:  if(tmp.all == 0)      /* no date */
date.c      23:      return(0);
date.c      24:  buf += itob(buf,tmp.day,0); /* day of month */
date.c      25:  buf = cpystr(buf," ",months[tmp.month-1]," ",NULL); /* month of year */
date.c      26:  buf += itob(buf,tmp.year+1972,0); /* year A.D. */
date.c      27:  return(buf-b);
date.c      28:  }
pagein8.c   3:
pagein8.c   4: /* skip - output "n" blank lines */
pagein8.c   5: COUNT skip(n)
pagein8.c   6: FAST COUNT n;
pagein8.c   7: {
pagein8.c   8: FAST COUNT t = n;
pagein8.c   9:
pagein8.c  10: while(t-- > 0)
pagein8.c  11:     putchar('\n');
pagein8.c  12: return(n);
pagein8.c  13: }
pagein8.c  14:
pagein8.c  15: #define MARGIN1 3 /* top of page to title line */
pagein8.c  16: #define MARGIN2 2 /* title line to body */
pagein8.c  17: #define MARGIN3 2 /* body to bottom of page */
pagein8.c  18:
pagein8.c  19: TEXT *title = NULL;
pagein8.c  20: int page_size = HARD_PAGE; /* lines per page */
pagein8.c  21:

```

Listing 1 continued on page 240

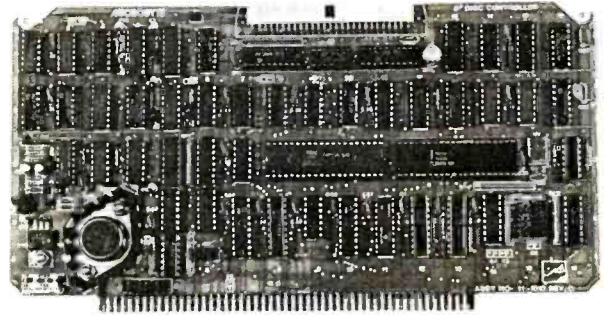
<p>HARD DISK MULTIPLEXOR WITH 10 MEG HARD DISK FOR THE TRS-80* Mod II</p> <p>NOW YOU CAN HAVE THAT LARGE COMMON DATA BASE!!</p> <ul style="list-style-type: none"> • Allows up to 4 Mod II's to connect to a single controller — up to 4 hard disk drives per controller. Users may access the same file simultaneously (first-come first-served). • Uses Cameo controller and standard 10-megabyte cartridge (hard) disk drives along with RACET Hard/Soft Disk System (HSD) software. • Access times 3 to 8 times faster than floppy. Mixed floppy/hard disk operation supported • Compatible with your existing TRSDOS programs! All BASIC statements are identical. • A single file may be as large as one disk. Alternate mode allows 24-million byte record range. Directory expandable to handle thousands of files. • Includes special utilities — backup and copies, HPURGE for multiple deletions, HDCS directory catalog system, and Hard Disk Superzap. FORMAT utility includes options for specifying sectors/gran, platters/drive, logical disk size, etc. <p>HARD DISK DRIVE & CONTROLLER \$5995 RACET HSD Software \$400 Call for multiuser pricing. Dealers call for OEM pricing.</p> <p>INFINITE BASIC (Mod I & III Tape or Disk) Mod I \$50.00, Mod III \$60.00 Extends Level II BASIC with complete MATRIX functions and 50 more string functions. Includes RACET machine language sorts! Sort 1000 elements in 9 seconds!! Select only functions you want to optimize memory usage.</p> <p>INFINITE BUSINESS (Requires Infinite BASIC) Mod I & III \$30.00 Complete printer pagination controls — auto headers, footers, page numbers. Packed decimal arithmetic — 127 digit accuracy +, -, *, /. Binary search of sorted and unsorted arrays. Hash codes.</p> <p>BASIC CROSS REFERENCE UTILITY (Mod II 64K) \$50.00 SEEK and FIND functions for Variables, Line Numbers, Strings, Keywords. 'All' options available for line numbers and variables. Load from BASIC — Call with 'CTRL'R' Output to screen or printer!</p> <p>DSM Mod I \$75.00, Mod II \$150.00, Mod III \$90.00 Disk Sort/Merge for RANDOM files. All machine language stand-alone package for sorting speed. Establish sort specification in simple BASIC command File. Execute from DOS. Only operator action to sort is to change diskettes when requested! Handles multiple diskette files! Super fast sort times — improved disk I/O times make this the fastest Disk Sort/Merge available on your TRS. (Mod I Min 32K 2-drive system. Mod II 64K 1-drive. Mod III 32K 1-drive)</p>	<p>★★ NEW ★★ DISCAT (32K 1-drive Min) Mod I, III \$50.00 This comprehensive Diskette Cataloging/Indexing utility allows the user to keep track of thousands of programs in a categorized library. Machine language program works with all TRSDOS and NEWDOS versions. Files include program names and extensions, program length, diskette numbers, front and back, and diskette free space.</p> <p>★★ NEW ★★ KFS-80 (1-drive 32K Min — Mod II 64K) Mod I, III \$100.00; Mod II \$175.00 The keyed file system provides keyed and sequential access to multiple files. Provides the programmer with a powerful disk handling facility for development of data base applications. Binary tree index system provides rapid access to file records.</p> <p>★★ NEW ★★ MAILLIST (1-drive 32K Min - Mod II 64K) Mod I, III \$75.00; Mod II \$150.00 This ISAM-based maillist minimizes disk access times. Four keys — no separate sorting. Supports 9-digit zip code and 3-digit state code. Up to 30 attributes. Mask and query selection. Record access times under 4 seconds!!</p> <p>★★ NEW ★★ LPSPOOL (32K 1-drive Min) Mod I \$75.00 LPSPOOL — Add multi-tasking to permit concurrent printing while running your application program. The spooler and despooler obtain print jobs from queues maintained by the system as print files are generated. LPSPOOL supports both parallel and serial printers.</p> <p>UTILITY PACKAGE (Mod II 64K) \$150.00 Important enhancements to the Mod II. The file recovery capabilities alone will pay for the package in even one application! Fully documented in 124 page manual! XHIT, XGAT, XCOPY and SUPERZAP are used to reconstruct or recover data from bad diskettes! XCOPY provides multi-file copies, 'Wild-card' mask select, absolute sector mode and other features. SUPERZAP allows examine/change any sector on diskette include track-0, and absolute disk backup/copy with I/O recovery. DCS builds consolidated directories from multiple diskettes into a single display or listing sorted by disk name or file name plus more. Change Disk ID with DISKID. XCREATE preallocates files and sets 'LOF' to end to speed disk accesses. DEBUGII adds single step, trace, subroutine calling, program looping, dynamic disassembly and more!!</p> <p>DEVELOPMENT PACKAGE (Mod II 64K) \$125.00 Includes RACET machine language SUPERZAP, Apparal Disassembler, and Model II interface to the Microsoft 'Editor Assembler Plus' software package including uploading services and patches for Disk I/O.</p>
<p>CHECK, VISA, M/C, C.O.D., PURCHASE ORDER</p> <p>TELEPHONE ORDERS ACCEPTED (714) 637-5016</p> <p>*TRS-80 IS A REGISTERED TRADEMARK OF TANDY CORPORATION</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <p style="text-align: center;"> RACET COMPUTES 1330 N. Glassel, Suite 'M' Orange, CA 92665 </p> </div>	

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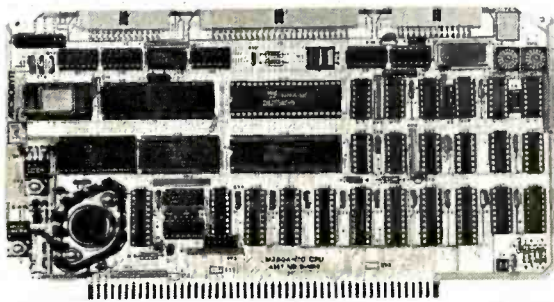
32K STATIC MEMORY BOARD

- Fully S100 bus compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO
- Uses Intel low-power 2141L-4 4Kx1 Static RAM
- 2 MHz or 4 MHz operation
- Gold contacts for higher reliability
- Thermally designed heat sink (board operating temperature 0-70 °C)
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- 4K hardware or software selectable
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- Will operate with or without front panel
- Compatible with Alpha Micro, with extended memory management for selection beyond 64K
- No DMA restriction
- Low power consumption 800mA
- Fully warranted for 120 days from date of shipment



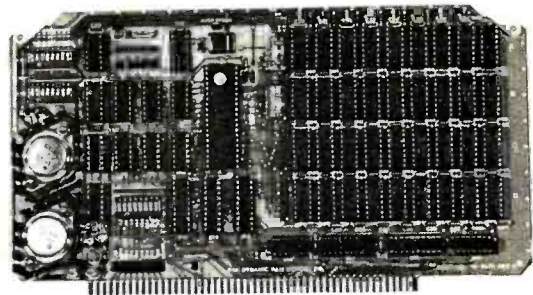
DISK CONTROLLER

- DMA to within 16M byte of memory
- State-of-the-art NEC765 LSI Controller
- IEEE-S100 compatible
- DMA arbitration allows use of multiple boards within a system
- PLL data recovery for totally reliable operation
- Write pre-comp switched at mid-disc for reliable double density operation
- Supports up to four (4) drives
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- Single density/double density operation
- 8" standard drives
- Separate V_{CC} supply for data recovery to eliminate possible noise problems



Z-80A I/O

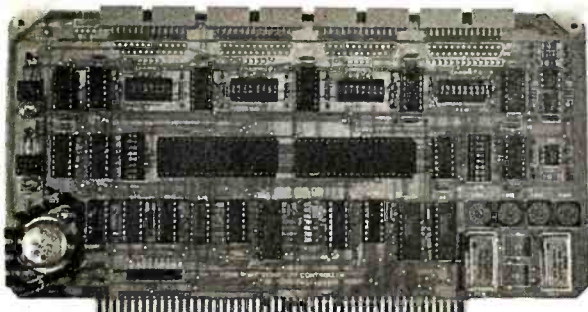
- A complete single board Z-80A CPU with serial/parallel interface
- Fully compatible with the proposed IEEE S-100 Bus Standard
- Z-80A CPU (4MHz version of the Z-80)
- 158 instructions—superset of and upward compatible from the 8080's 78 instructions
- Up to 4K of on board Eprom with optional Z-80 monitor program — 1K(2708), 2K(2716) or 4K(2732)
- Full vectored interrupt capability
- 2MHz or 4MHz operation is jumper selectable
- Selectable auto-wait state insertion for extending M1*, MREQ*, IORQ* and/or on board ROM
- Dual RS-232 serial I/O ports using the Z80A-DART with individual baud rate selection (16 baud rates from 50-19,200 baud)
- Up to 24 bit parallel I/O port—fully programmable Intel 8255A
- Up to 8 separate counter/timers using 2 Z-80A CTC



64K DYNAMIC RAM BOARD

- Fully S-100 bus compatible/Alpha Micro compatible
- 64K x 8 bit dynamic RAM
- Low power; + 8VDC @ 700 ma
+ 16VDC @ 100 ma
- 16VDC @ 25 ma
- Built-in-parity with LED indicator and vector interrupt
- Memory addressable in four 16K banks
- Hidden refresh
- Gold contacts for high reliability
- 72-hour Burn-in
- Memory mapped via DIP switch
- Built-in programmable write-protect
- Programmable control port for parity and bank control

MICROBYTE has the products — from memory boards to complete S-100 systems, and we offer the rest of the value cluster — call today for the whole story on how you can become a Microbyte dealer.



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- Quad RS-232C Serial Ports, One 20mA Current Loop Port
- Fully IEEE S-100 Bus Compatible
- Asynchronous Communications with Z80A-Dart(TM) or Synchronous Communications with Z80A-SIO/0(TM)
- Full Set of Modem Control Signals, including RI (Ring Indicator)
- Easily Configurable to Any Type of Terminal Interface
- I/O Servicing Environments: (1) Polled; (2) Bus Vector; (3) Z80 Mode 2 Vector
- Off-Board Interrupt Daisy Chain Capability
- Special Receive Conditions: (1) Framing Error; (2) Parity Error; (3) Receiver Overrun Error
- Baud Rates Selected Individually from 50 Baud to 300K Baud
- 72 Hour Burn-In

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System Notes

Listing 1 continued:

```
pagin8.c      22: /* paginate - separate stream of buffers into pages */
pagin8.c      23: paginate(buf)
pagin8.c      24:     TEXT *buf;
pagin8.c      25:     {
pagin8.c      26:     BYTES date(),itob(),lenstr(),putlin();
pagin8.c      27:     static int line;      /* line number within page */
pagin8.c      28:     static int page = 0;
pagin8.c      29:     TEXT tmp[20];
pagin8.c      30:
pagin8.c      31:     if(page != 0) /* M. A. Jackson's program inversion technique used */
pagin8.c      32:         goto resume;
pagin8.c      33:     /* read */
```

list.c . Page: 3 24 October 1980

```
pagin8.c      34:     while(buf != NULL) { /* while(!end_of_file) */
pagin8.c      35:         ++page;
pagin8.c      36:         line = skip(MARGIN1);
pagin8.c      37:         if(title != NULL) { /* output title, page # & date */
pagin8.c      38:             putlin(title,lenstr(title));
pagin8.c      39:             putlin("\t\t\t\t\t Page: ",12);
pagin8.c      40:             putlin(tmp,itob(tmp,page,0));
pagin8.c      41:             putlin("\t",1);
pagin8.c      42:             putlin(tmp,date(tmp));
pagin8.c      43:             line += skip(MARGIN2);
pagin8.c      44:         }
pagin8.c      45:         while(buf != NULL && line < page_size-MARGIN3) {
pagin8.c      46:             putlin(buf,lenstr(buf));
pagin8.c      47:             ++line;
pagin8.c      48:             /* read */
pagin8.c      49:             return;
pagin8.c      50: resume: ;
pagin8.c      51:         }
pagin8.c      52:         skip(page_size-line);
pagin8.c      53:         line = 0;
pagin8.c      54:     }
pagin8.c      55:     page = 0;
pagin8.c      56: }
list.c        14:
list.c        15: #include "incl.c"
incl.c        1:
incl.c        2: /* include - include file in s */
incl.c        3: COUNT include(file,ftn)
incl.c        4:     FAST TEXT *file;
incl.c        5:     COUNT (*ftn)();
incl.c        6:     {
incl.c        7:     FAST COUNT return_code;
incl.c        8:     TEXT *buybuf();
incl.c        9:     FAST FIO *fd;
incl.c       10:     FIO *fclose(),*fopen();
incl.c       11:
incl.c       12:     return_code = NO;
incl.c       13:     fd = (FIO *) buybuf(&stdin,sizeof(FIO));
incl.c       14:     if(fopen(&stdin,file,READ) == NULL)
incl.c       15:         diagnostic(NO,"can't open ",file,NULL);
incl.c       16:     else {
```

```
incl.c      17:      return_code = (*ftn)(file);
incl.c      18:      fclose(&stdin);
incl.c      19:      }
```

list.c Page: 4 24 October 1980

```
incl.c      20:      cpybuf(&stdin,fd,sizeof(struct fio));
incl.c      21:      free(fd);
incl.c      22:      return(return_code);
incl.c      23:      }
list.c      16:
list.c      17: #include "filem.c"
filem.c      1:
filem.c      2: TEXT *prefix = "";      /* include prefix */
filem.c      3:
filem.c      4: /* get_name = extract file name from line */
filem.c      5: BYTES get_name(line,file)
filem.c      6: TEXT *file,*line;
filem.c      7: {
filem.c      8: TEXT *delim;
filem.c      9: BYTES cpybuf(),instr(),lenstr(),n;
filem.c     10:
filem.c     11: while(*line == ' ' || *line == '\t')
filem.c     12: ++line;
filem.c     13: if(*line == '\u')
filem.c     14: n = lenstr(file);
filem.c     15: else {
filem.c     16: n = 0;
filem.c     17: if(*line == '/') {
filem.c     18: delim = "\n";
filem.c     19: ++line;
filem.c     20: }
filem.c     21: else if(*line == '<') {
filem.c     22: delim = "\n";
filem.c     23: ++line;
filem.c     24: n = cpybuf(file,prefix,lenstr(prefix));
filem.c     25: }
filem.c     26: else
filem.c     27: delim = "\t\n";
filem.c     28: n += cpybuf(file+n,line,instr(line,delim));
filem.c     29: *(file+n) = EOS;
filem.c     30: }
filem.c     31: return(n);
filem.c     32: }
list.c      18:
list.c      19: #include "detab.c"
detab.c      1:
detab.c      2: /* detab - replace tabs with blanks */
detab.c      3: BYTES detab(s,d)
detab.c      4: FAST TEXT *s,*d;
```

list.c Page: 5 24 October 1980

```
detab.c      5: {
detab.c      6: FAST BYTES i;
```

Listing 1 continued on page 266

EAST COAST

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12 Meeting St.
Cumberland, RI 02864

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1-401-722-1027



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CA. TOLL FREE 1-800-322-1873



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INTERFACES: IEEE \$55, TRS*80 \$35,
APPLE INTERFACE + CABLE \$90,
RS*232 \$70



ANADEx
\$1299



16K ATARI 800
\$779



DIABLO 630
\$2145
Tractor option \$245

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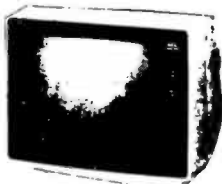
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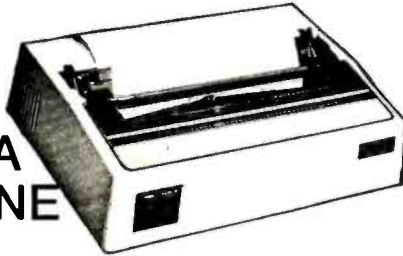
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System Notes

Listing 1 continued:

```
detab.c      7:
detab.c      8:   for(i = 0; *d == *s; ++s)
detab.c      9:     if(*s == '\t')
detab.c     10:       do
detab.c     11:         *d++ = ' ';
detab.c     12:         while(++i%8);
detab.c     13:       else {
detab.c     14:         ++i;
detab.c     15:         ++d;
detab.c     16:       }
detab.c     17:   return(++i);
detab.c     18: }
list.c      20:
list.c      21: /* check_include - do possible include processing */
list.c      22: check_include(line)
list.c      23:   FAST TEXT *line;
list.c      24:   {
list.c      25:   FAST BYTES n;
list.c      26:   TEXT file[MAXFILE+1];
list.c      27:   int list();
list.c      28:
list.c      29:   for( ; iswhite(*line); ++line) /* skip leading blanks */
list.c      30:     ;
list.c      31:   if(cmpbuf(line,"#include ",9)) {
list.c      32:     n = get_name(line+9,file);
list.c      33:     if(cmpbuf(&file[n-23],".h",2)) { /* header file */
list.c      34:       if(h_flag)
list.c      35:         include(file,&list);
list.c      36:     }
list.c      37:     else { /* non-header file */
list.c      38:       if(n_flag)
list.c      39:         include(file,&list);
list.c      40:     }
list.c      41:   }
list.c      42: }
list.c      43:
list.c      44: /* list - label and print lines of "file" */
list.c      45: list(file)
list.c      46:   TEXT *file;
list.c      47:   {
list.c      48:   BYTES getlin(),itob();
list.c      49:   TEXT *alloc(),*buf,*line,temp[4];
```

list.c

Page: 6

24 October 1980

```
list.c      50:   FAST BYTES l,t;
list.c      51:   FAST COUNT line_number = 0;
list.c      52:   #define BORDER MAXFILE+7 /* assumes < 1000 lines */
list.c      53:
list.c      54:   buf = alloc(HARD_WIDTH+1,0);
list.c      55:   line = alloc(MAXLINE+1,0);
list.c      56:   fill(buf,BORDER,' ');
list.c      57:   buf[BORDER-2] = ':';
list.c      58:   cpybuf(buf,file,lenstr(file));
list.c      59:   while(l = getlin(line,MAXLINE)) {
list.c      60:     line[lmin(l,HARD_WIDTH-BORDER)] = EOS;
```

Listing 1 continued on page 246



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System Notes

Listing 1 continued:

```
list.c      61:      t = itob(temp,++line_number,0);
list.c      62:      cpybuf(buf+BORDER-2-t,temp,t);
list.c      63:      detab(line,buf+BORDER);
list.c      64:      paginate(buf);
list.c      65:      if(n_flag || h_flag)
list.c      66:          check_include(line);
list.c      67:      }
list.c      68:  }
list.c      69:
list.c      70:  POOL main(ac,av)          /* handles program arguments */
list.c      71:      BYTES ac;
list.c      72:      TEXT **av;
list.c      73:  {
list.c      74:      FAST TEXT *s;
list.c      75:      TEXT buf[MAXLINE+1],*getflags();
list.c      76:
list.c      77:      if(s = getflags(&ac,&av,"h,i+n,p#",&h_flag,&prefix,&n_flag,&page_size))
list.c      78:          diagnostic(NO,"bad flag:",s,NULL);
list.c      79:      if(ac <= 0) {
list.c      80:          list("");
list.c      81:          paginate(NULL);
list.c      82:      }
list.c      83:      else {
list.c      84:          do {
list.c      85:              title = *av;
list.c      86:              include(title,&list);
list.c      87:              paginate(NULL);
list.c      88:          } while(++av.--ac!);
list.c      89:      }
list.c      90:  }
```

Text continued from page 234:

file, this is what the subroutine would look like in pseudocode:

```
read line;
while(not end of file) {
  do page header;
  while(not (end of file || bottom of page)) {
    print line;
    read line;
  }
  do page footer;
}
```

For efficiency and simplicity, a *pointer* to each line is *passed* to PAGINATE instead of read from a file. A NULL pointer indicates end-of-file. The usual method is to turn the code inside out around the read statements. Jackson advocates keeping the structure the same and replacing each read statement by an assignment to a state variable, a return statement, and a label. The state variable serves as a "bookmarker," so that execution can resume where it left off. A switch statement at the subroutine entrance will jump to the proper label on the next call. This technique may not be well received by the more fanatical GOTOless programming advocates, but this

was the first paginate subroutine I have written that worked perfectly on the first try. In PAGINATE, the page counter is used as the state variable. If PAGE equals 0, then execution continues at the first read statement; otherwise, it jumps to the read in the innermost loop.

LIST did not spring full-blown from an exhaustive design process but evolved over a period of time. As with most computer efforts, I had only a general idea of the requirements—features were added, removed, and generalized. The header-file exclusion option originally only affected the standard header file STD.H. Functions were moved around within the code to tighten up the structure or to generalize a subroutine. Concatenating the file name, line number, and source line was originally done in PAGINATE. Moving it out allowed PAGINATE to be used in other programs. Several extensions are being contemplated, but the cost (in time) to implement them exceeds the cost of not having them. Being able to exclude an include file by name (`-x filename`) would be useful on large programs with a lot of previously developed code. When the preprocessor conditional compilation statements `#if` and `#ifdef` are used, it's practical to have LIST handle them correctly. Each of these extensions would, however, require more time to implement than the existing program. ■

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The UNIX Operating System and the XENIX Standard Operating Environment

Robert B Greenberg
XENIX Product Manager
Microsoft
10800 NE Eighth, Suite 819
Bellevue WA 98004

Never has there been a greater demand for software that is easy to use and maintain, and independent of the hardware on which it runs. As the price of software rapidly outpaces that of computers, the need to increase software productivity and reduce duplication of effort has become paramount.

Microsoft's XENIX operating system offers one solution to the software crisis developing in the microcomputer world. Unlike the operating systems offered for 8-bit machines, the XENIX system is a powerful multiuser timesharing system with hundreds of utilities and is the basis for a highly productive software development environment and a general-purpose applications system.

The XENIX operating environment combines two key elements: the design of the widely acclaimed UNIX operating system and the inclusion of the major high-level languages that are standard within the 8-bit microcomputer world (see figure 1). Microsoft's transport of the XENIX system to major 16-bit microprocessors has made it the first hardware-independent operating system.

The heart of the XENIX system is the UNIX operating system developed at Bell Laboratories and licensed by Western Electric. The UNIX system's elegant design combines power, flex-

ibility, and simplicity, and its vast array of software utilities greatly increases productivity. Thus, the UNIX system is an ideal candidate to serve as a solution to the software crisis.

Microsoft plans to make the XENIX operating system (which is an enhanced version of the UNIX system) into a commercial standard. And, in addition to supporting and enhancing the operating system

The XENIX system is one approach to solving the software crisis developing in the microcomputer world.

proper, Microsoft will adapt high-level languages, such as its BASIC interpreter and compiler, FORTRAN, Pascal, and COBOL, and other software tools, such as data-base management and communications software, to run under the XENIX operating system.

To understand the elegance of the basic UNIX design and the further enhancements in the XENIX system, we must take a closer look at the software. In this article, I will describe the main features in the UNIX operating system, discuss some of its strengths and weaknesses, and conclude with a discussion of the evolution of the XENIX operating environ-

ment from the UNIX operating system, and how it can help solve critical software issues. First, a historical overview.

Origins of the UNIX OS

The UNIX operating system was originally developed at Bell Laboratories by Ken Thompson, an employee engaged in various programming research projects. With access to an abandoned DEC PDP-7 computer that had no software, Thompson decided in 1969 to write a set of programs that would aid him in software research. Over a period of several years, and with the help of fellow researcher Dennis Ritchie, this set of programs evolved into a full operating system. By 1972, it was recoded for the DEC PDP-11 computer in a newly designed high-level language, called C. The system gained recognition within the Labs and their parent company, Western Electric.

Word of the quality of Thompson and Ritchie's UNIX operating system spread rapidly. Universities, in particular, expressed interest in obtaining UNIX, and in 1973, Western Electric agreed to distribute the system to nonprofit organizations and promptly licensed several dozen educational institutions, including Columbia University, the University of Alberta (Canada), The Children's Museum (Boston), Princeton University, and Harvard University. By 1975, UNIX had become sufficiently popular in the academic world to justify the

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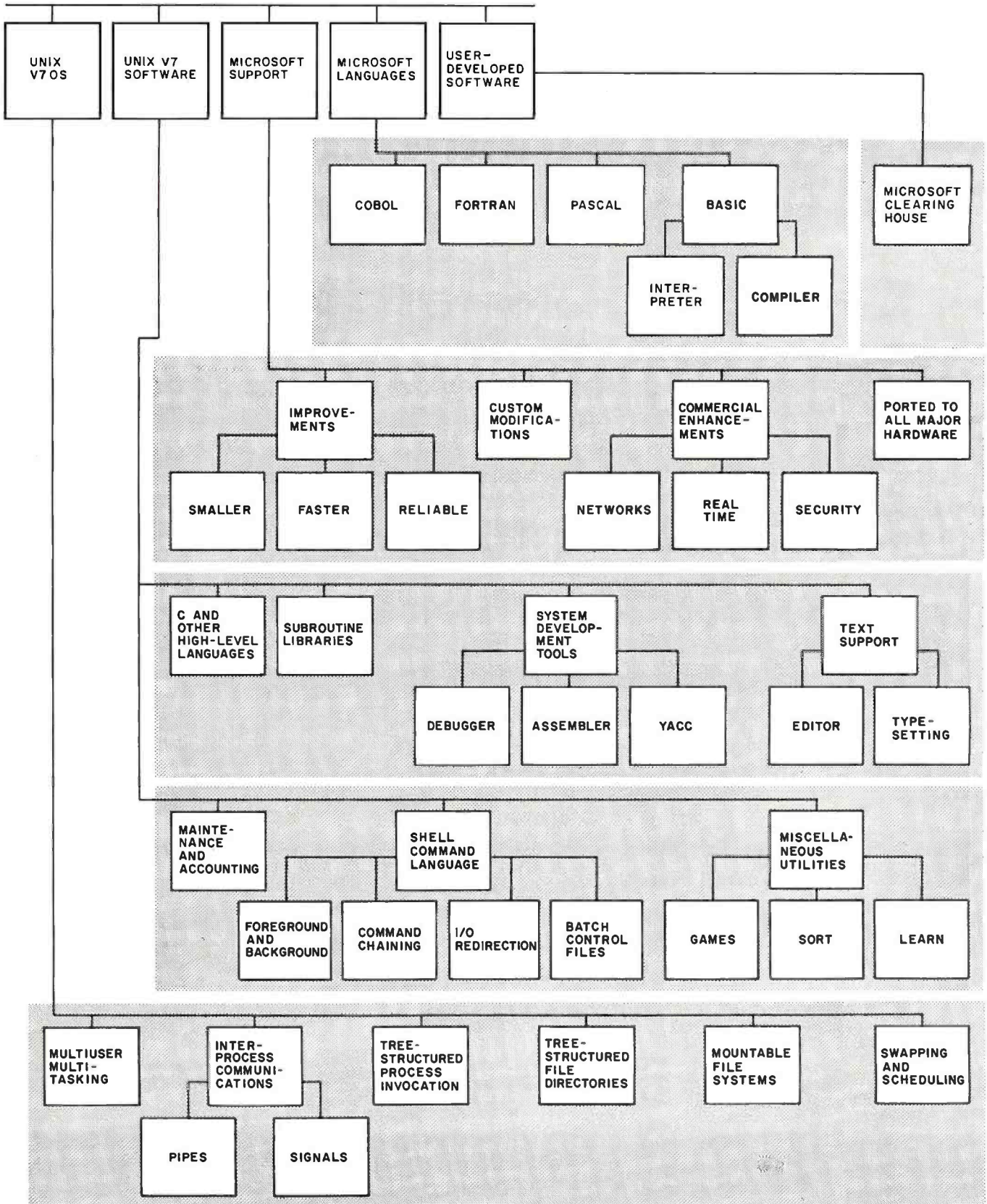


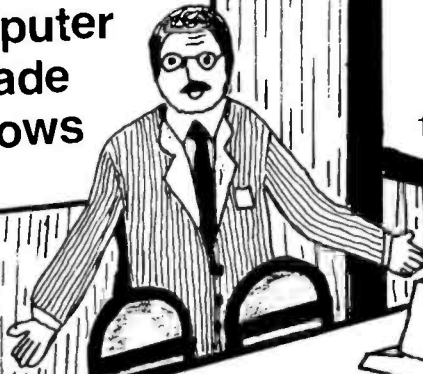
Figure 1: Microsoft's XENIX operating system. The five "layers" of the XENIX software structure are shown. XENIX, a superset of Bell Laboratories' UNIX operating system developed in the early 1970s, has a hierarchical structure. Each of the five layers depends on the layers beneath it for its operation. The bottom two layers represent the latest version of UNIX (version 7). The remaining three layers are the refinements that combine to make the XENIX system.

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creation of a UNIX users' organization, later called USENIX.

The first public release of the UNIX operating system, labeled version 5, was an unpolished snapshot of a research project that was still evolving. It was replaced in 1975 with version 6, a system that is still operating today at many sites. UNIX continued to evolve, benefitting from the feedback it received from scores of internal and external test sites.

In January 1979, Western Electric released version 7. By this time, hundreds of man-years' effort has been expended on UNIX's design and software utilities, with most of the system coded in C. Research had proven that UNIX was compatible with the concepts of memory-limited computers, machine transportability, networks, and multiple-processor designs.

Unfortunately, there was no single standard design for UNIX. Because the operating system was simple and easy to change, almost every site altered it to meet their specific needs. Harvard, the University of California at Berkeley, and the RAND Corporation each offered a set of modifications. A number of incompatible versions of UNIX existed within Western Electric.

In addition, there has been a legal impediment to the UNIX system's distribution. The system is available essentially free-of-charge for educational institutions. Legally, however, Western Electric cannot be in the software business, so the commercial world is offered the operating system under noncompetitive terms: source code as is and no warranty, support, or maintenance—a steep fee for software that was never intended to serve commercial applications outside of Western Electric.

It had become clear that the support of a commercial software company was essential if UNIX was to become a software standard. In August of 1980, Microsoft announced that it would offer and support XENIX, a commercial version of the operating system, on 16-bit microprocessors. Working closely with Western Electric and a newly formed commercial users' organization, Microsoft intends to establish a stan-

dard industry version of UNIX that can provide a highly productive environment worthy of meeting the challenges of software development in the 1980s.

UNIX Design Goals

Two aspects of UNIX's origin have contributed to its design: (1) it was created in a few man-years by two people, and (2) the implementers were also major users of the system. The result is a polished, consistent, coherent design. UNIX achieves great power and flexibility, including compatible interfacing between all its features, without resorting to a large, complex program. An experienced system programmer can understand the entire operating system in weeks, rather than months.

The UNIX system's design goals unite various features supported by the UNIX system into a consistent and simple whole. The first design goal is to support a very basic level of functionality within the operating system itself, relying on normal user programs to provide sophistication. Such features as line printer queuing, login/logout, monitor commands, and file access methods are implemented as normal user programs instead of operating-system functions. This approach, which reduces the overall complexity of the system, has several advantages. Functions are more modular, and therefore easier to debug, features can be altered and upgraded without stopping the operating system, and alterations made to one feature are less likely to affect the rest of the system. Finally, individual users may create personal versions of certain features.

The second design goal is generality—that is, having a single method serve a variety of related purposes. For example, the same system calls are used to read and write disk files, devices, and interprocess message buffers. Likewise, the same naming, aliasing, and access protection mechanisms apply to data files, directories, and devices. As a final example, the same mechanism is used to trap software interrupts, user abort requests, and processor traps. The benefits of generality extend well

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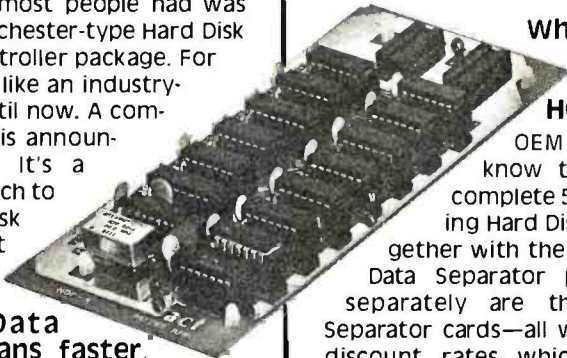
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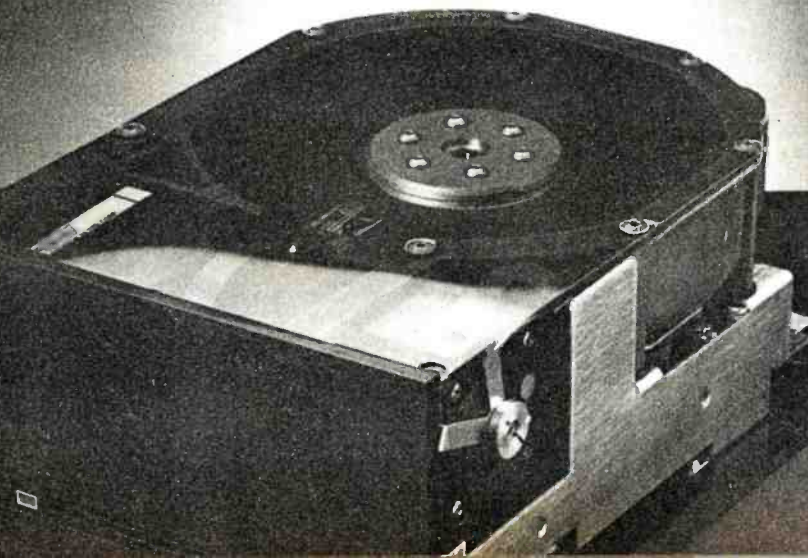
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beyond the simplicity of design; UNIX programming style is notably flexible, extensible, easily learned, and easily debugged.

The third goal is to accomplish large tasks by combining several small tasks whenever possible. UNIX's filters are an excellent example. A filter is a program that processes a single stream of input to generate one output stream. The UNIX system has a large variety of filters, including those that perform multicolumn formatting, string replacement, text processing, character translation, sorting, and graphics interfacing. Programs that generate output, such as the assembler, do not include facilities for listings; this task is accomplished by feeding programs directly to the various filters. This keeps the large programs simple to use, lets a user learn about each filter separately, and allows for special combinations of formatting without multiplying the options that each program would then have to support. It also leads to a uniform appearance of formatted

output and the commands needed to produce it, and yields all the benefits of modular solutions to complex problems.

The vast number of utilities provided with the system and the ease of linking them together via pipes provide a surprising amount of functionality. For example, to find out how many people are currently using the system, you need only feed the output of the system "who" command to the utility that prints the number of lines in its input. Thus, the command line:

```
who | wc -l
```

causes the output of the who command, which might look like:

```
arw      console   Jan 30 14:20
bobg     tty00       Jan 30 01:00
henry    tty01       Jan 30 12:50
gordon   tty03       Jan 29 10:08
```

to be fed to the program "wc," for "word count." The -l option tells wc, which normally prints the

number of characters, words, and lines in a file, that we only want to see the number of lines. Thus, this composite command prints a number which is the number of users on the system:

```
> who | wc -l
4
>
```

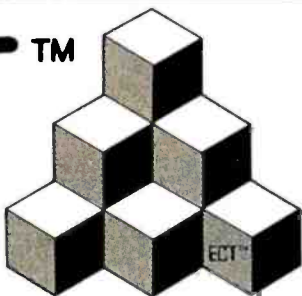
As a final step, we can create a file called "users," which contains the line:

```
who | wc -l
```

Typing "users" causes the command interpreter (or shell) to execute that line, and type the number of current users. We have now created a new system command.

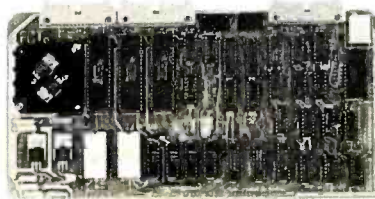
A more dramatic example is shown in the following sequence: take a program that puts each text word in a file (or files) onto a separate line. Connect the output to a program that sorts lines into alphabetical order.

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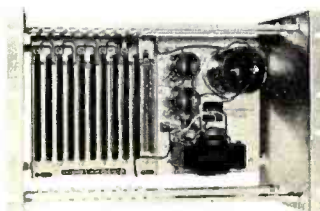
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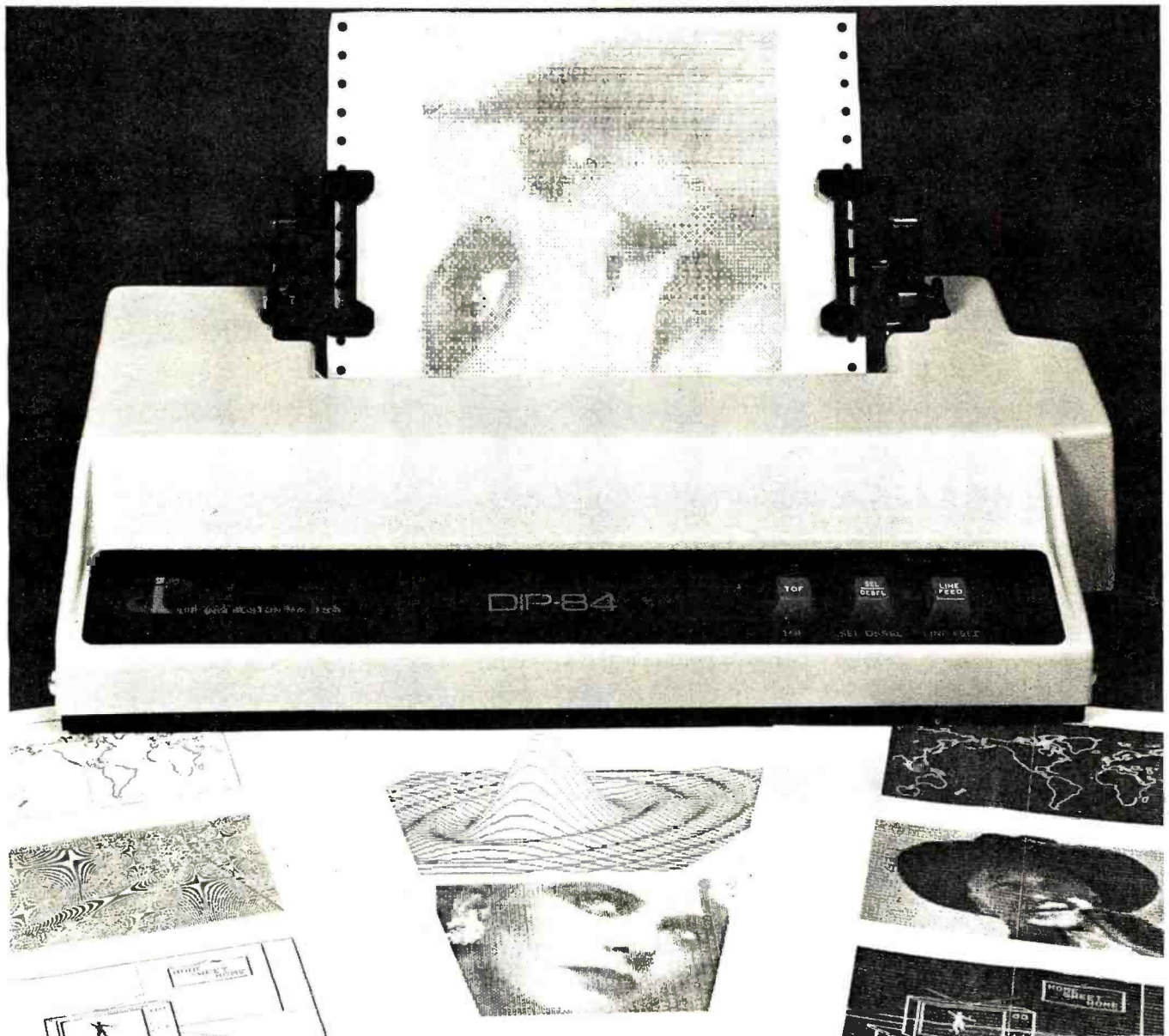
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The output is a sorted list of all words in the text file(s). This list is fed to the program "uniq", which removes adjacent duplicate lines. The result is a data stream that contains one line for each different word in the original file(s). This stream is in turn connected to a program that reports differences between two files (one file

being a list of 30,000 words from the dictionary). Thus, typing the line:

```
prep file | sort | uniq | comm wdlst
```

will result in a list of words present in "file" but not present in "wdlst". Without writing a line of code, you have created a simple spelling program! Now, by creating a file called

"spell", which contains the line:

```
prep $* | sort | uniq | comm /usr/dict/words
```

you have created the command "spell". Note that the "\$*" is replaced by the command line interpreter with the arguments typed to the spell command. The UNIX system's command

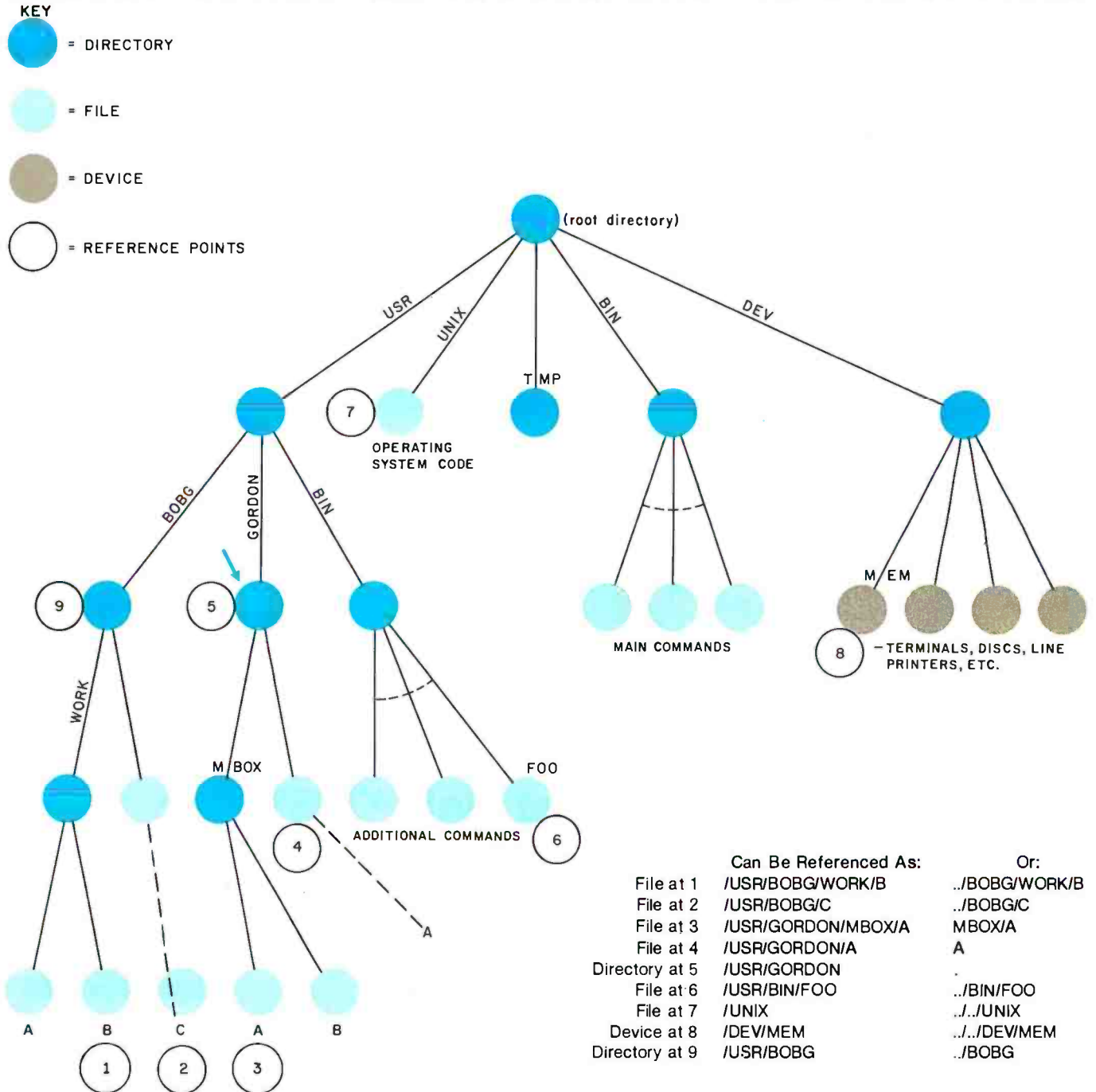


Figure 2: Hierarchical structure of the names and conventions for getting to any reference point in a typical XENIX file structure. In this example, it is assumed that the user is at reference point 5 (blue arrow). A list of instructions for getting to the various reference points appears beneath the diagram. (The file and directory labels shown here are actual labels used in the author's system.) To get to file 1, the user types "/USR/BOBG/WORK/B". XENIX then progresses down the tree from the root directory (at top) to the branches USR, BOBG, WORK, and B, arriving at point 1. Alternatively, the user can use the command "../BOBG/WORK/B", where ".." refers to the parent node of the node currently in use. In XENIX, "." refers to the node itself.

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interpreter, the shell, is a fully interactive language in its own right.

UNIX Operating System Design

The UNIX design introduces few new concepts because it borrows heavily from the better aspects of previously existing systems. UNIX contains numerous features found in the MULTICS and AOS operating systems, and the language C is modeled after BCPL. However, the coherence and simplicity with which the chosen features interact result in an unusually elegant design that has great merit of its own.

The UNIX operating system supports a multiuser, multitasking environment. Each user has full access to the resources of the computer on a timesharing basis. UNIX implements scheduling and swapping algorithms that allow the processor and memory to service more tasks, seemingly simultaneously, than would otherwise be possible. UNIX also includes various protection schemes that protect each user from the others. This functionality contrasts markedly with the current microcomputer systems that simplify hardware operation by providing device drivers but make little attempt to extend the computer's utility.

The UNIX file system is a recursive structure originating from a *root directory*. The root directory contains the names of files and subdirectories; the subdirectories contain names of other files and additional subdirectories, etc. When a user logs into the system, he is assigned a specific subdirectory as his current working directory. Full path names for files consist of a possibly null sequence of subdirectories separated by a slash, beginning with either the root or the current working directory, and followed by the file name. By convention, the file in each subdirectory called "." refers to the parent directory (see figure 2). Thus the user has a concept of local and global files neatly organized into directory groupings.

File names refer to data files, the directories themselves, character devices such as user terminals, block devices such as magnetic tape, file

systems mounted onto other disk devices, and interprocess communications devices known as *multiplexed pipes*. Multiple names (called aliases) can be assigned to any of these objects. A set of information, including owner and access permissions, is stored with each object; the directory entries only specify names for the objects.

Programs communicate with their environment with read and write calls directed to a set of open files. Each program starts with three open files: *standard input*, *standard output*, and *error output*. Normally, these files are connected to the user's terminal, but a powerful command-language program, the shell, allows easy and invisible reassignment of these channels. A program can also open any other object (file, device, etc) named in the file system to which it has appropriate access permission. Using a special call, a program can create

pipes, data channels that allow for communication between the program and any other programs connected to an end of the pipe.

All I/O (input/output) operations are performed as byte streams, with all channels appearing to contain a sequence of bytes until a globally defined end-of-file condition is indicated. Random access is also supported, using a call to reposition within the stream. Neither record sizes nor file types are imposed by the operating system. The system handles all interrupts and buffering, and each I/O call is suspended until the requested I/O operation can be completed. All devices, files, and pipes are treated identically (with minor exceptions), which greatly simplifies I/O routines.

A program may initiate another program by issuing a system call to duplicate itself. The two programs then operate independently, with

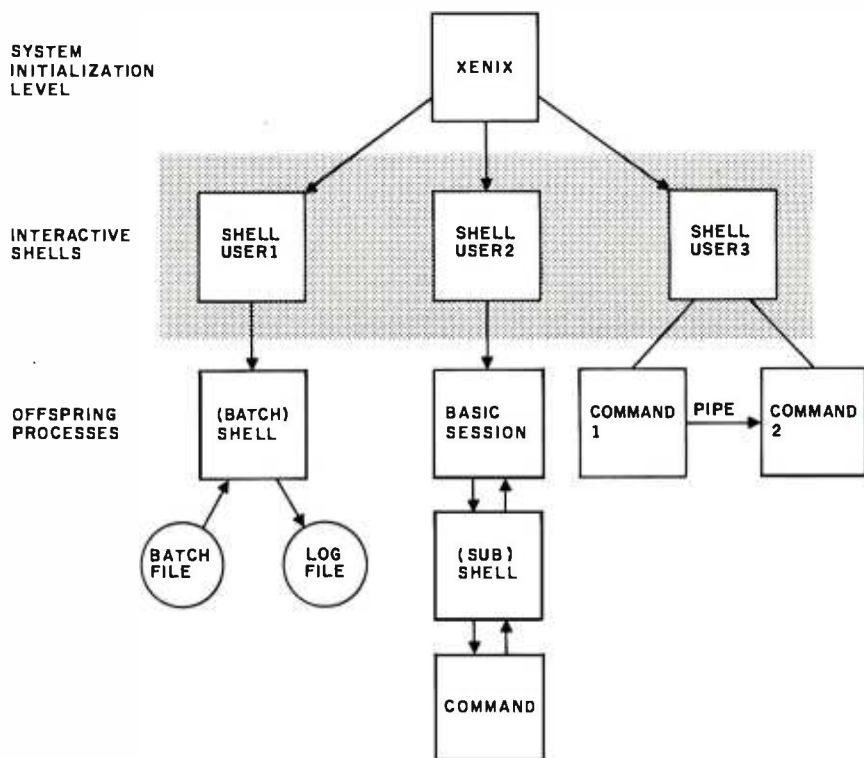
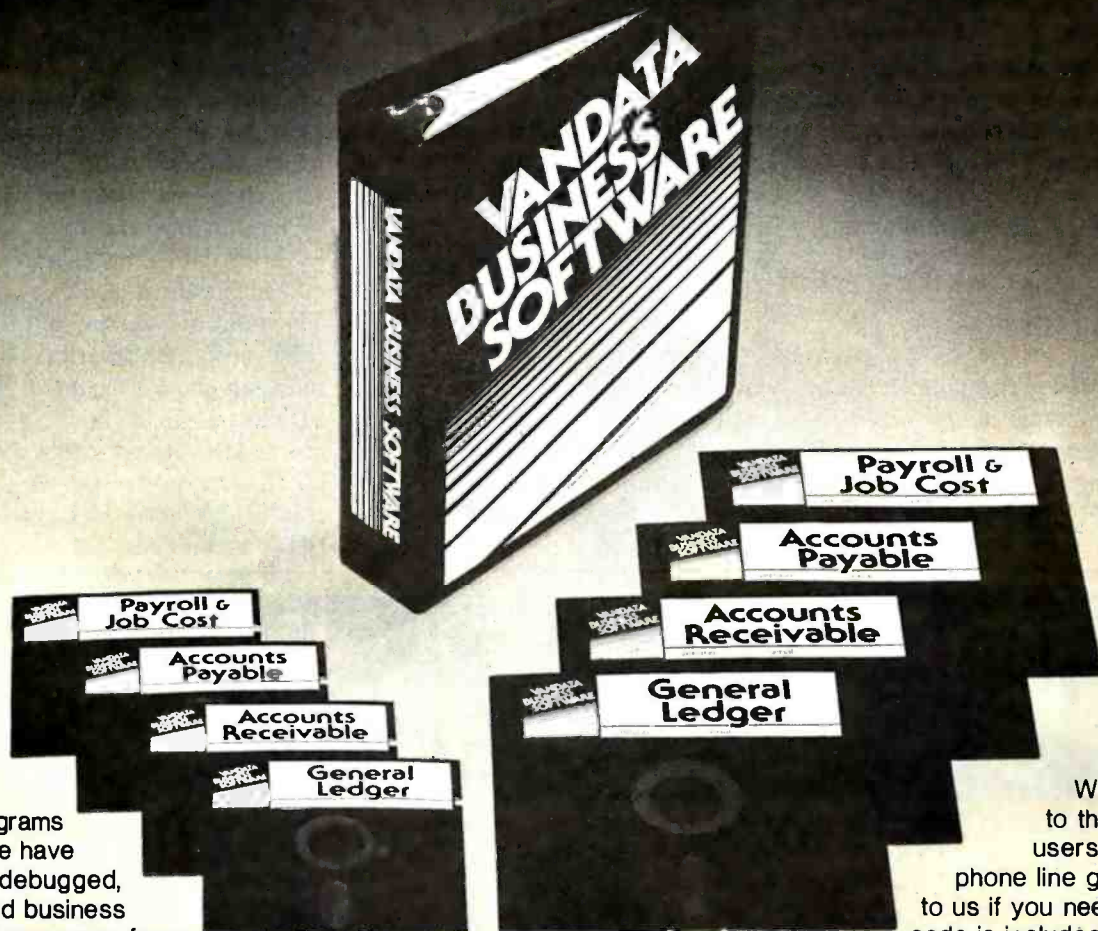


Figure 3: Tree-structured process hierarchies in the XENIX system. Three users are currently on line. The term "shell" refers to that portion of the XENIX operating system program that "surrounds" the operating system and allows it to communicate with the outside world. User 1 is running a batch shell that is executing commands from a file. User 2 has suspended a BASIC session and entered a subshell to issue a command at the system-monitor level, perhaps to send a message to another user. User 2 can then return to BASIC and resume the session. User 3 has executed a command whose output is piped through a second command.

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UNIX timesharing between them (see figure 3). Typically, the parent process waits for the completion of its child, and the child process executes another program in the file system by issuing a system call. However, both programs may continue execution in parallel. To synchronize their operation, they can communicate via the file system, pipes, or signals. Signals are software asynchronous interrupts that are issued by one program to another to cause the second program to interrupt its execution, process the signal, and then resume normal execution. Signals are also generated by user interrupt requests and software failures, such as divide-by-zero.

Thus, when a user compiles and links a program test.c by typing:

```
> cc test.c
```

the shell runs the C compiler (cc) as a child process. After it has spawned the child process, the shell puts itself to sleep. When the child process (the C compiler) finishes, the shell awakens and issues another prompt.

However, by simply adding an ampersand character to the command line:

```
> cc test.c &
```

you can instruct the shell not to sleep, but rather to return immediately for another command. You can then edit your documentation or some further program, while the first one is compiling. Note that typing:

```
> filename
```

causes the shell to run a copy of itself as a child. This child shell then executes, one by one, the commands in "filename." By simply adding the "&" character to the following line:

```
> filename &
```

you now have the capabilities of a full batch system, for free, as a result of the UNIX system's flexibility.

This section has presented a brief overview of the UNIX system features. A more complete descrip-

tion is available in documents from Microsoft, Western Electric, and a number of universities. I will conclude this section with a discussion of an excellent example of UNIX's multitasking abilities.

Multitasking

The multitasking and interprocess communication features of the UNIX system provide power that is unavailable in existing 8-bit computer systems. RITA, a large interpreter language for UNIX that I helped create for the RAND Corporation, provides an extensive example of the utility of these features. The RITA interpreter consists of over 100 K bytes of instructions and more than 64 K bytes of data—much larger than the current limit on UNIX program size. The solution was to split RITA into three separate programs that communicate through the use of five pipes, as illustrated in figure 4. Furthermore, separate programs are created by the interpreter to edit programs, read RITA news files, and perform UNIX commands, such as obtaining



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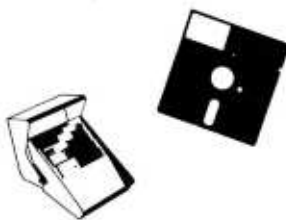
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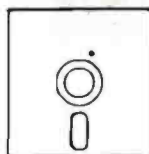
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access to networks. Several files are written for analysis by still other programs. All this multitasking takes place invisibly: the user still thinks he or she is running a single program.

A further benefit of multitasking and device-independent I/O is an unexpected feature of RITA's three-program arrangement. Normally, the first program, UFE (user front end) allows you to type and edit program statements, which are then converted to internal form by the second program, the parser, which in turn stores them in the third program, the monitor, for evaluation. The UFE also allows the statements to be

entered from a disk file; however, due to the complex parser program, loading a large file is too time consuming for many applications. A slight alteration to the UFE, the program which creates the other two programs and the five pipes, provides the solution. The new UFE (now called RC for RITA compiler), which requires no changes to the parser or monitor, funnels the output of the parser, normally fed to a pipe, into a disk file. Thus, RC produces "compiled" files whose contents can be fed directly into the monitor, bypassing the parser, when later loaded by RITA's UFE.

An Assessment of UNIX

UNIX offers unparalleled power for such a straightforward system. For the programmer, the system is easy to learn and offers immediate functionality, even for beginners. For more experienced users, the wealth of software tools leads to a more productive environment than less complete systems.

In addition, the UNIX operating system comes with hundreds of utilities and software tools that make it a complete software development environment. There is software for accounting, text editing, formatting and typesetting, high-level languages,

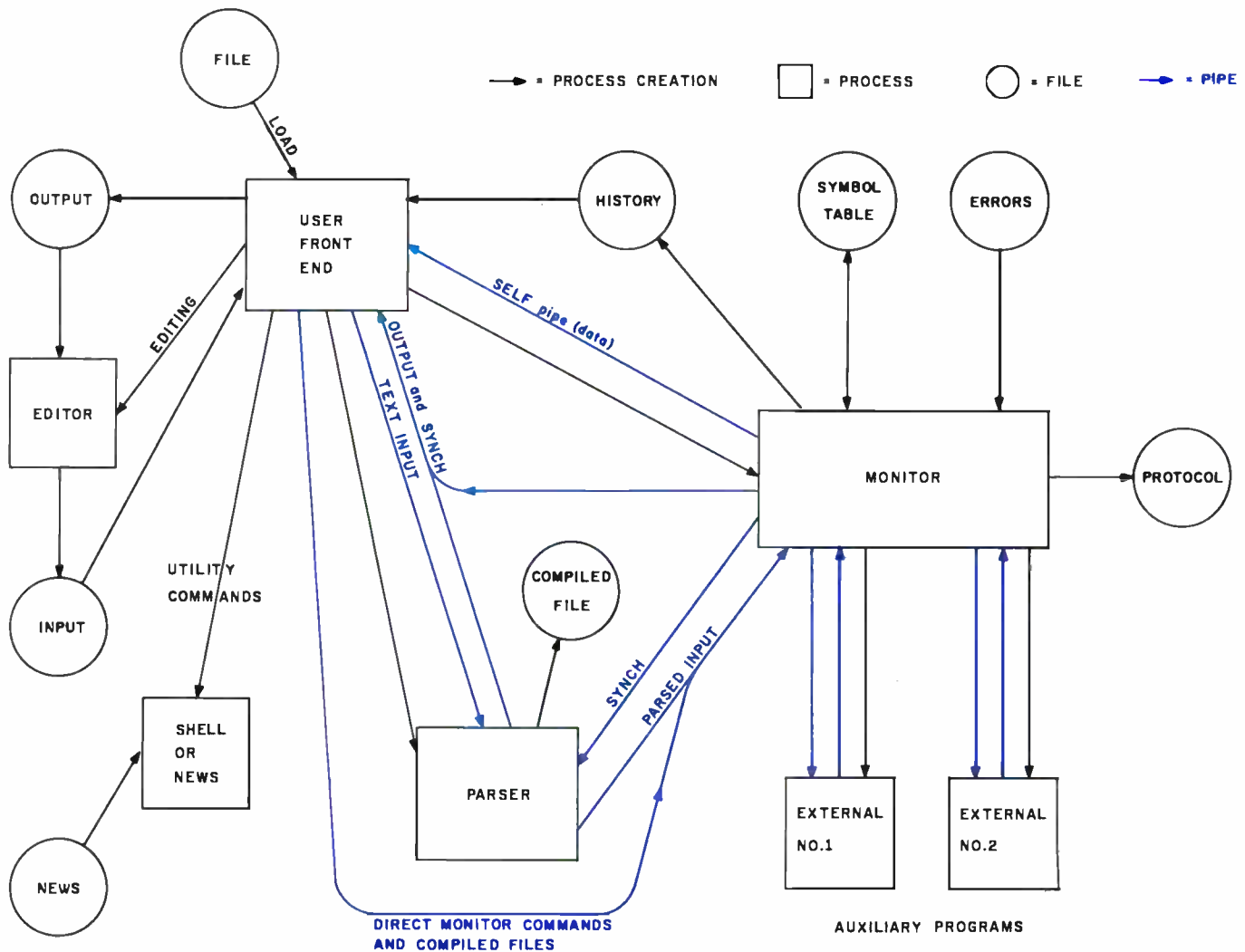


Figure 4: RITA, a program designed in part by the author to illustrate the multitasking and interprocess communication features of the UNIX system. The RITA interpreter consists of over 100 K bytes of instructions and more than 64 K bytes of data; much larger than the current limits on UNIX program size. The solution to the problem is to split RITA into three separate programs that communicate through the use of five "pipes." A different UFE (user front end) program, called the RITA compiler, can refunnel the output of the parser, normally fed to the monitor, into a disk file. Thus, the RITA compiler produces "compiled" files whose contents can be fed directly into the monitor, bypassing the parser, when later loaded by RITA's user front end. This approach allows the user to load large files that might otherwise require too much time.

Percom's DOUBLER II™ tolerates wide variations in media, drives

GARLAND, TEXAS — May 22, 1981 — Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER™ adapter, a double-density plug-in module for TRS-80* Model I computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II™, so named, permits even greater tolerance in variations among media and drives than the previous design.

Like the original DOUBLER, the DOUBLER II plugs into the drive controller IC socket of a TRS-80 Model I Expansion Interface and permits a user to run either single- or double-density diskettes on a Model I.

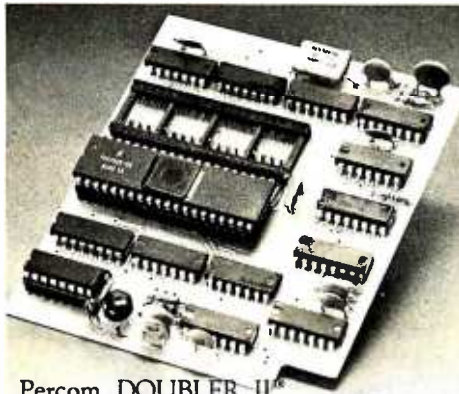
With a DOUBLER II installed, over four times more formatted data — as much as 364 Kbytes — can be stored on one side of a five-inch diskette than can be stored using a standard Tandy Model I drive system.

Moreover, a DOUBLER II equips a Model I with the hardware required to run Model III diskettes.

(Ed. Note: See "OS-80[®]: Bridging the TRS-80* software compatibility gap" elsewhere on this page.)

The critical clock-data separation circuitry of the DOUBLER II is a proprietary design called a ROM-programmed digital phase-lock loop data separator.

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides immunity to performance degradation caused by circuit component aging.



Percom DOUBLER II™

Mauch said "A DOUBLER II will operate just as reliably two years after it is installed as it will two days after installation."

The digital phase-lock loop also eliminates the need for trimmer adjustments typical of analog phase-lock loop circuits.

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The DOUBLER II sells for \$219.95, including the DBLDOS diskette.

Owners of original DOUBLERs may purchase a DOUBLER II upgrade kit, without the disk controller IC, for \$30.00. Proof of purchase of an original DOUBLER is required, and each DOUBLER owner may purchase only one DOUBLER II at the \$30.00 price.

The Percom DOUBLER II is available from authorized Percom retailers, or may be ordered direct from the factory. The factory toll-free order number is 1-800-527-1592.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 288 on inquiry card.

All that glitters is not gold OS-80[®]: Bridging the TRS-80* software compatibility gap

Compatibility between TRS-80* Model I diskettes and the new Model III is about as genuine as a gold-plated lead Krugerrand.

True, Model I TRSDOS* diskettes can be read on a Model III. But first they must be converted and re-recorded for Model III operation.

And you cannot write to a Model I TRSDOS* diskette. Not with a Model III. You cannot add a file. Delete a file. Or in any way modify a Model I TRSDOS diskette with a Model III computer.

Furthermore, your converted TRSDOS diskettes cannot be converted back for Model I operation.

TRSDOS is a one-way street. And there's no retreating. A point to consider before switching the company's payroll to your new Model III.

Real software compatibility should allow the direct, immediate interchangeability of Model I and Model III diskettes. No read-only limitations, no conversion/re-recording steps and no chance to be left high and dry with Model III diskettes that can't be run on a Model I.

What's the answer? The answer is Percom's OS-80[®] family of TRS-80 disk operating systems.

OS-80 programs allow direct, immediate interchangeability of Model I and Model III diskettes.

You can run Model I single-density diskettes on a Model III; install Percom's plug-in DOUBLER™ adapter in your Model I, and you can run double-density Model III diskettes on a Model I.

There's no conversion, no re-recording. Slip an OS-80 diskette out of your Model I and insert it directly in a Model III.

And vice-versa. Just have the correct OS-80 disk operating system — OS-80, OS-80D or OS-80/III — in each computer.

Moreover, with OS-80 systems, you can add, delete, and update files. You can read and write diskettes regardless of the system of origin.

OS-80 is the original Percom TRS-80 DOS for BASIC programmers.

Even OS-80 utilities are written in BASIC. OS-80 is the Percom system about which a user wrote, in Creative Computing magazine, "... the best \$30.00 you will ever spend."[†]

Requiring only seven Kbytes of memory, OS-80 disk operating systems reside completely in RAM. There's no need to dedicate a drive exclusively for a system diskette.

And, unlike TRSDOS, you can work at the track sector level, defining and controlling data formats — in BASIC — to create simple or complex data structures that execute more quickly than TRSDOS files.

The Percom OS-80 DOS supports single-density operation of the Model I computer — price is \$29.95; the OS-80D supports double-density operation of Model I computers equipped with a DOUBLER or DOUBLER II; and, OS-80/III — for the Model III of course — supports both single- and double-density operation. OS-80D and OS-80/III each sell for \$49.95.

Circuit misapplication causes diskette read, format problems. High resolution key to reliable data separation

GARLAND, TEXAS — The Percom SEPARATOR™ does very well for the Radio Shack TRS-80* Model I computer what the Tandy disk controller does poorly at best: reliably separates clock and data signals during disk-read operations.

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The problem is most severe on high-number (high-density) inner file tracks.

As reported earlier, the clock-data separation problem was traced by Percom to misapplication of the internal separator of the 1771 drive controller IC used in the Model I.

The Percom Separator substitutes a high-resolution digital data separator circuit, one which operates at 16 megahertz, for the low-resolution one-megahertz circuit of the Tandy design.

Separator circuits that operate at lower frequencies — for example, two- or four-

megahertz — were found by Percom to provide only marginally improved performance over the original Tandy circuit.

The Percom solution is a simple adapter that plugs into the drive controller of the Expansion Interface (EI).

Not a kit — some vendors supply an untested separator kit of resistors, ICs and other paraphernalia that may be installed by modifying the computer — the Percom SEPARATOR is a fully assembled, fully tested plug-in module.

Installation involves merely plugging the SEPARATOR into the Model I EI disk controller chip socket, and plugging the controller chip into a socket on the SEPARATOR.

The SEPARATOR, which sells for only \$29.95, may be purchased from authorized Percom retailers or ordered directly from the factory. The factory toll-free order number is 1-800-527-1592.

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assembly support utilities, sorters and index generators, communication facilities, tools that create parsers and lexical analyzers, graphics, games, mathematical function libraries, maintenance and performance utilities, and a host of file manipulators. Few needs cannot be met through a combination of these existing utilities.

The flexibility of UNIX allows easy alteration of its user interface. Various installations have demonstrated how easy it is to completely alter the appearance of UNIX in order to serve a different class of users. That UNIX cannot be everything to everyone is overshadowed by the fact that, as it is truly general-purpose, it can perform in almost any environment.

UNIX, as supplied by Western Electric, is not without its weaknesses. The general-purpose timesharing design limits UNIX's efficiency in real-time applications, such as process control. Its standard interface is highly terse, and though this is often considered desirable by programmers, the untamed UNIX will frighten almost everyone else. The origins of many of the command names are obscure; examples include a tape command "r" to write to a tape, command "cat" which types files, and "awk", a program for finding patterns in files. However, command names can be easily changed by the user.

UNIX has not been adapted for commercial use, where the issues of reliability, stability during hardware errors, full per-user accounting, reconfigurability for a large variety of environments, and security take on special importance. For example, less expensive disk packs for larger disk drives usually contain bad spots, and UNIX does not automatically adjust for them. In the environment for which the UNIX system was developed, it was cheaper to buy perfect packs than to write a "bad spot avoidance" routine. These issues must be addressed before UNIX can be considered a sturdy, robust, and commercial piece of software.

A crucial problem, and one not restricted to UNIX, is the lack of true

applications software. Currently, there are few good accounts payable, invoicing, mailing list, income tax, or data-base management packages. UNIX provides an excellent software production environment because of its wealth of software tools utilities, but the system does not contain a similar variety of application-oriented software.

The XENIX System

Microsoft's XENIX operating system represents an attempt to preserve the strengths of the UNIX design and also meet the needs of the commercial microprocessor industry. To achieve this goal, Microsoft used the system as it was distributed by Western Electric and then added modifications, customizations, improvements, enhancements, support, and additional software.

Modifications included those necessary to transport the UNIX system from the larger PDP-11 mini-computer to the 16-bit microprocessors. Currently scheduled machines include the DEC LSI-11/23, Zilog's Z8001 and Z8002, Intel's 8086 and 286, and Motorola's MC68000. Numerous other processors are also being considered, and Microsoft will then customize the XENIX systems to the specific hardware environments of the various computer systems built around these processors. The company is also working closely with a number of hardware manufacturers to design products that will be capable of efficiently executing the XENIX software.

Improvements will include elimination of known bugs and recoding of certain routines to produce a smaller and faster operating system. XENIX will also incorporate hardware error recovery strategies, automatic file repair after crashes, power-fail and parity-error detection, and similar features, depending on the particular hardware requirements of each XENIX system.

The planned enhancements will add a number of new features to XENIX. These features include record locking, shared data segments, synchronous writing, and improved interprocess communication—all of

which are designed to make XENIX commercially viable and more compatible with the newer hardware technologies that involve distributed data processing, networking, and multiple-CPU approaches.

XENIX is a dynamic, evolving system. In its first release, its code was very close to the original UNIX version 7 source. The improvements and enhancements that I have mentioned are part of an evolving process, and the exact selection and specification of features will be developed throughout the course of 1981. Updates to XENIX will result in systems upwardly compatible from its first release.

The adaptation of Microsoft's full line of system software products to XENIX will further strengthen XENIX's role as a software standard. These products, including the BASIC interpreter and compiler, COBOL, FORTRAN, and Pascal, have already established themselves as standards within the 8-bit market; they are also compatible with corresponding ANSI (American National Standards Institute) standards. Standard high-level languages will allow the rapid introduction of existing application software into the XENIX environment.

The XENIX system will offer an ever-expanding variety of software, including data-base management, financial planning, communication, and networking packages. Microsoft is establishing a clearinghouse, wherein quality software running under XENIX may receive widespread distribution, thereby reducing duplication of effort. The combination of the UNIX operating system's strengths and Microsoft's awareness of the needs of the commercial marketplace promises to make XENIX a very powerful defense against the looming software crisis. By establishing a universal operating environment, complete with software tools to increase productivity, flexible design to widen applicability, and multiple microprocessor support to improve availability, Microsoft hopes that XENIX will become the preferred choice for software production and exchange. ■

MAIN FRAME POWER— MICRO PRICE



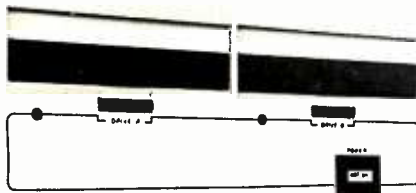
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OSM's MUSE operating system—the Multi User System Executive—is **many times faster than other leading operating systems.** Each user owns a resident copy of MUSE so you don't wait for the bus or interrupt the master processor to do console I/O and applications code. MUSE finds files fast with a random directory access similar to random file access. And MUSE protects shared files from simultaneous update to the same record by different users. We designed MUSE from the start for multi-user data base environments—yet MUSE is **CP/M* compatible!**

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- independent user processor reset directly from each keyboard



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 - Peripherals.
- C. Computer Software
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ABOUT THE INSTRUCTOR

The instructor for the course is Barbara Schwartz. The course lecture and workbook is all original material created by her. She is a consultant to major corporations and small businesses and is a writer on computer and data processing topics. She has taught courses for companies and schools in simple clear English.

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Understanding the Cost of Business Software	12 & 13
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CP/M Update	14
Interfacing to the Real World	13 & 15
The Multi-Lingual Microcomputer	13
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The Next Five Years in Small Computers	14 & 15
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The Ins and Outs of CP/M

James Larson
3422 Union St
San Diego CA 92103

CP/M (Control Program for Microprocessors) is the most commonly used 8080/8085/Z80 operating system. CP/M is easy to use and the Digital Research documentation is reasonably thorough and clear, especially by microprocessor-software standards. However, the documentation is lacking in one area: the explanation of I/O (input/output) and disk interfacing. This article will clarify and expand upon the documentation. A summary of the I/O and disk-interface routines, calling sequences, use of return codes, and typical subroutines using these will be presented. The use of file-control blocks (FCBs) and I/O buffers will also be explained. Finally, some details of the CP/M I/O functions and their workings will be presented.

Calling CP/M Routines

The procedure for calling CP/M routines is straightforward. I/O procedures are defined as a series of functions. Each function is assigned a unique *function number*. The function number is placed in the microprocessor's C register; the data required (*entry parameter* in CP/M parlance) is placed in the E register if only 1 byte is to be sent, or in the DE register pair if a word (2 bytes) is required. Some functions have no entry

parameters. Results (called *returned values*) are either returned as a byte in the A register or as a filled buffer (whose address is usually sent as an entry parameter). Table 1 summarizes the basic I/O functions and calling sequences. Once the registers are properly loaded, a call to the CP/M entry point at hexadecimal memory location 0005 is made. It is important to know that CP/M does not preserve the contents of these registers, so any routine calling CP/M routines must protect any registers to be preserved. A typical subroutine to call a CP/M-utility routine is shown in listing 1. Refer to the examples for specific applications of this sequence. The function numbers and their purpose, entry parameters, and returned-value codes are summarized in table 1 and table 2.

I/O Routines

Listing 2 presents several useful subroutines that make calls to CP/M I/O routines. Calls to the punch device and reader device assume that these drivers exist in your version of CP/M, though they may or may not actually be driving a physical paper-tape reader/punch. As explained in the CP/M *Features and Facilities Guide*, logical devices may or may not correspond to actual physical

devices. Writing and installing these drivers for CP/M is beyond the scope of this article.

Listing 3 shows the use of buffers for CP/M I/O. The address of the buffer is placed in the DE register pair and the call to the CP/M entry point is made. The contents of the print buffer are printed on the console until a dollar sign is encountered. The print buffer is not destroyed in this process. A typical print buffer is configured as:

```
c1 c2 c3 c4 .... ck $
```


where *k* is the number of valid characters and \$ signifies the end of the buffer. The read buffer is configured as:


```
m k c1 c2 c3 c4 .... ck
```


where *m* is the maximum number of characters allowed in the buffer, and *k* is the number of characters actually in the buffer. CP/M places characters in the buffer until a carriage return is encountered or the maximum buffer length is reached. The maximum length, *m*, may be from 1 to 256, and is defined by the user program. The value of *k*, the number of valid characters, is initially set to 0. It is set by CP/M to reflect the number of


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BYTE-6

characters read into the buffer from the console. The CP/M line-editing features (control R, control C, etc) may be used with this routine. Other control characters will be echoed with a leading ^ (called a circumflex), and will be inserted into the buffer. Any parity bits will be stripped by CP/M (this also applies to the single-character read functions in listing 2).

The final aspect of CP/M I/O that

requires clarifying is the I/O status byte. This is a single byte at hexadecimal memory location 0003. It was apparently included in CP/M for compatibility with Intel software and must be specifically implemented by the user in BIOS (Basic I/O System). The I/O status byte, poorly described in the *Interface Guide*, is described much better in the *System Alteration Guide*, Section 6. By varying the

value of this location, the user may reassign logical I/O devices without rewriting the system software.

CP/M Disk-Interface Routines

The use of the disk-interface routines provided by CP/M is more involved. But it is not too difficult once the basic concepts are grasped.

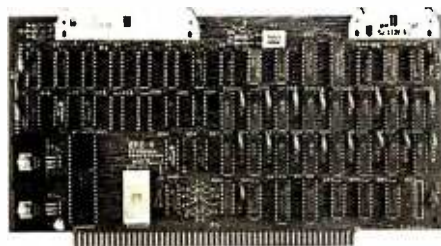
Text continued on page 274

Function Number	Function Description	Entry Parameters (placed in DE)	Returned Value (Returned in A or AB (A = LSB))	Typical Call **
1	Read a character from the console.	None	ASCII character	MVI C,1 ;READ FUNCTION CALL NTRY ;CPM ENTRY POINT
2	Write a character to the console.	ASCII character	None	MVI E,CHAR ;CHARACTER IN E MVI C,WRITE ;WRITE FUNCTION = 2 CALL NTRY
3	Read a character from the reader device.	None	ASCII character	MVI C,RDR ;READER FUNCTION = 3 CALL NTRY
4	Write a character to the punch device.	ASCII character	None	MVI E,CHAR ;CHARACTER IN E MVI C,PNCH ;PUNCH FUNCTION = 4 CALL NTRY
5	Write a character to the list device (usually a printer).	ASCII character	None	MVI E,CHAR ;WRITE TO PRINTER = 5 MVI C,PRNT CALL NTRY
7	Get I/O status.*	None	I/O status byte	
8	Set I/O status.*	I/O status byte	None	
9	Output print buffer to console.	Address of a print buffer	None	LXI D,PBUF ;ADDRESS OF BUFFER MVI C,BUFO ;OUTPUT BUFFER = 9 CALL NTRY
10	Input a character string from the console.	Address of a read buffer	The read buffer is filled to its maximum length or until a <CR> is typed.	LXI D,RBUF ;ADDRESS OF BUFFER MVI C,BUFI ;INPUT BUFFER = 10 CALL NTRY
11	Interrogate console for a character ready.	None	01 if a character is ready	MVI C,ASK ;INTERROGATE = 11 CALL NTRY

*If implemented
 **See listings 1, 2, and 3 for subroutines and program usage.
 NTRY is the CP/M entry point (0005).

Table 1: Summary of the basic I/O functions available on a standard CP/M system.

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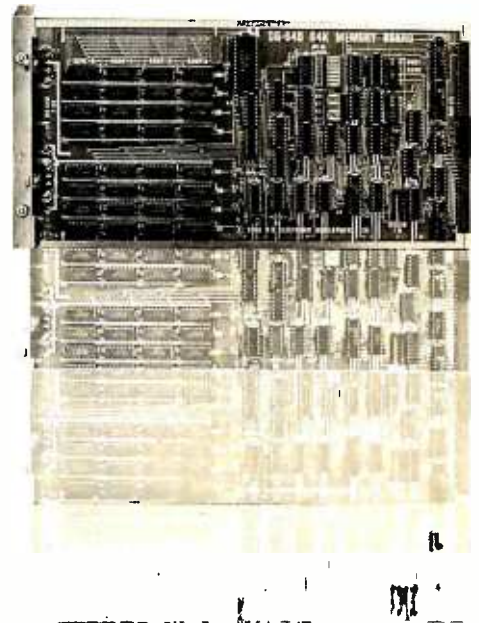
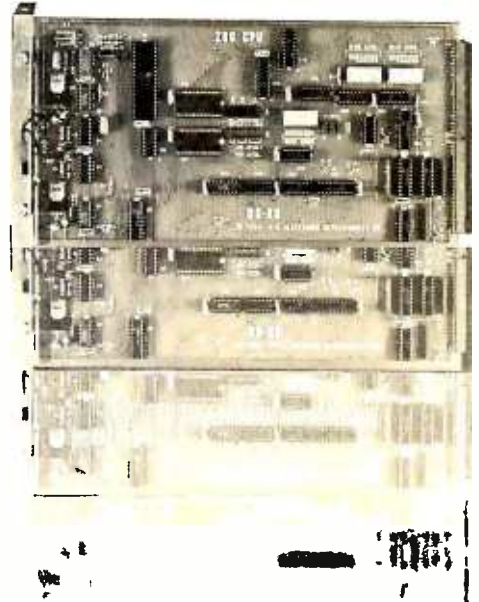
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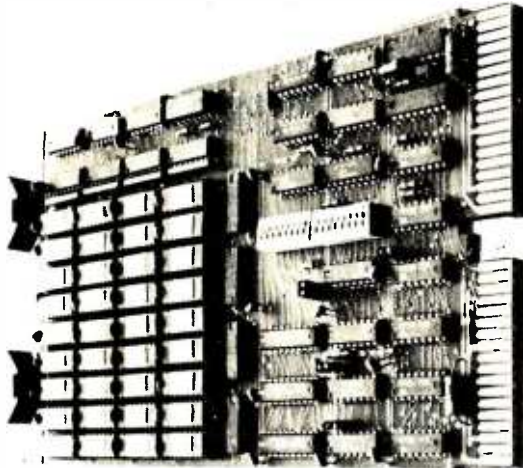
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Function Number	Function Description	Entry Parameters and Comments (placed in DE)	Returned Value and Comments. (Returned in A or AB (A = LSB))	Typical Call*	
12	Lift head.	None	None—head is lifted from currently logged disk.	MVI CALL	C,12 NTRY ;LIFT FUNCTION ;CP/M ENTRY POINT
13	Initialize CP/M disk access.	None	None—disk drive A is "logged in" for access. The DMA address is set to 0080H.	MVI CALL	C,13 NTRY ;INITIALIZE
14	Select and log in disk.	Value corresponding to the desired disk: A = 0, B = 1, etc	None—specified disk is selected for subsequent file operations.	MVI MVI CALL	E,DISKNO ;DISK # IN E C,SELDSK ;SELECT = 14 NTRY
15	Open file.	Address of FCB for the file to be opened	Byte address of the FCB in the disk directory, or 255H if file is not found—the disk map (DM) bytes in the FCB are filled by CP/M.	LXI MVI CALL	D,FCB ;ADDRESS IN DE C,OPEN ;OPEN = 15 NTRY
16	Close file.	Address of FCB for the file to be closed	Byte address of the FCB in the disk directory, or 255 if not found—the disk map of the FCB is written to the directory, replacing any existing data for that file.	LXI MVI CALL	D,FCB C,CLOSE ;CLOSE = 16 NTRY
17	Search for file.	Address of FCB containing name and type of file to search for. "?" matches any character.	Byte address of first FCB in directory that matches the name and type in the input FCB. If no match, 255H is returned.	LXI MVI CALL	D,FCB C,SEARCH ;SEARCH = 17 NTRY
18	Search for next occurrence.	Address of FCB as in 17, but called after 17 before any other disk access	Byte address of next match. 255H if no additional match.	LXI MVI CALL	D,FCB C,SEARN ;SEARN = 18 NTRY
19	Delete file.	Address of FCB of file to be deleted	None—FCB in directory is marked as deleted. (E5H is placed in ET field.)	LXI MVI CALL	D,FCB C,DEL ;DEL = 19 NTRY
20	Read record.	Address of FCB containing a disk map. Normally as a result of opening the file (15) and setting NR to the record to be read.	0 = successful read 1 = read past logical end of file (^Z) 2 = reading unwritten data Data read is placed in memory at the DMA address (function 26).	LXI MVI CALL JNZ	D,FCB C,READ ;READ = 20 NTRY ERROR ;HANDLE READ ERROR
21	Write record.	Same as read, but NR is set to the record to be written	0 = successful write 1 = error in extending file 2 = end of disk data 255H = no more directory space—Data written is taken from memory starting at the DMA address.	LXI MVI CALL JNZ	D,FCB C,WRITE ;WRITE = 21 NTRY ERROR ;HANDLE WRITE ERROR
22	Create file.	Address of FCB of new file, all data set to 0 except name and type	Byte address of directory entry of new file or 255H if directory is full.	LXI MVI CALL JM	D,FCB C,CREATE ;CREATE = 22 NTRY NOROOM ;HANDLE FULL ; DIRECTORY
23	Rename file.	Address of FCB with old file name and type in first 16 bytes and the new file name in the next 16 bytes	Directory address of old file, or 255H if not found. The file name and type are changed to that specified.	LXI MVI CALL	D,FCB C,RENAM ;RENAM = 23 NTRY
24	Interrogate disk log-in.	None	Byte with 1 bit set for each disk logged in. LSB = disk A, etc.	JM	NOFILE ;HANDLE NOT FOUND
25	Interrogate drive number.	None	Number of disk to be used for next access.		
26	Set DMA address.	Address of 128-byte buffer	None—subsequent reads and writes take data to/ from memory beginning at this address.	LXI MVI CALL	D,BUFF ;BUFFER ADDRESS C,26 ;DMA SET FUNCTION NTRY
27	Interrogate allocation.	None	Address of the current disk-allocation data. (Used by STAT—not well documented.)		

*See listing 3 for subroutines and program usage.

Table 2: Summary of disk-access operations and disk-utility functions available on a standard CP/M operating system.

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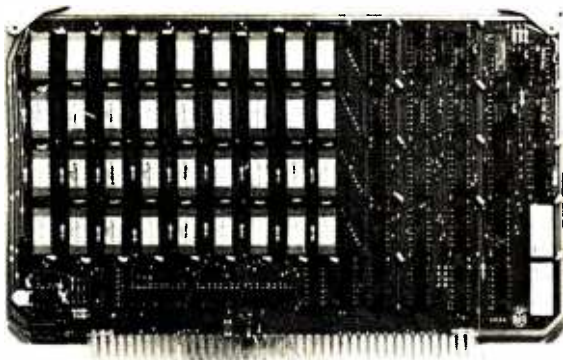
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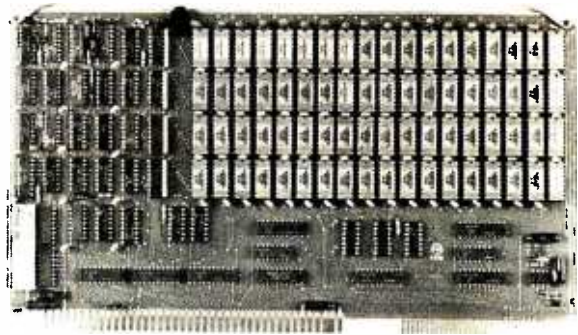
4 MEGABYTE ADDRESS FIELD — Most memories available for the DEC PDP 11/23 are only addressable to 256K bytes (18 address lines). The CI-1123 is addressable to 4 mega bytes (22 address lines) so there is no need to worry about obsolescence.

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Text continued from page 270:

Proper use of these routines provides powerful capabilities for file manipulation, creation, and alteration. Tasks such as reading an application program into the proper region of memory, sending instructions with a file name, or detecting which disk drive a given file resides on (if any) are readily handled by CP/M. Let us see how these tasks may be accomplished.

Before a file can be manipulated by CP/M, its name must be made known to the system. This is done via the file-control block (FCB). A file-

control block contains six types of information defined with 33 contiguous bytes in memory (0 to 32):

- Entry type (ET, byte 0)—assumed 0 by CP/M. CP/M places hexadecimal E5 here to signify a deleted file.
- File name (FN, bytes 1 to 8)—ASCII characters padded with ASCII blanks.
- File type (FT, bytes 9 to 11)—ASCII characters padded with ASCII blanks.
- File extent (EX, byte 12)—in 128-record segments. If file is longer

than 128 records, this byte must be incremented to access the additional records. Normally, this will be initialized to 0.

- Initialize to 0 (bytes 13 to 14)—these bits may be used by some systems (such as Micropolis), but should not be tampered with.
- Record count (RC, byte 15)—current file size in 128-byte records. Initialized to 0—correct value will be supplied by executing the OPEN statement.
- Disk allocation map (DM, bytes 16 to 31)—this map is used by CP/M to access the desired file. It is written into memory by the OPEN command, updated during access, and written back to the directory by the CLOSE command. It is not necessary to initialize this area if OPEN is used.
- Next record (NR, byte 32)—this is the number of the next record to access in the currently open extent. Normally, this will be initialized to 0 unless random access is desired or a file is to have something appended to it.

Listing 1: Structure of a typical function-calling routine. The CP/M operating system does not preserve the registers.

IOSBR:	PUSH REGISTERS	;	PRESERVE REGISTERS. DO NOT PUSH REGISTERS IN WHICH VALUES WILL BE RETURNED.
	MVI C,FUNCTION#	;	FUNCTION # MUST BE IN REGISTER C BEFORE CALLING NTRY.
	MOV E,A	;	IF A CHARACTER IS TO BE OUTPUT, IT IS OFTEN CONVENIENT TO SEND IT IN THE A REGISTER (ACCUMULATOR). IT MUST BE MOVED TO E BEFORE CALLING NTRY.
	CALL NTRY	;	CP/M ENTRY POINT, NTRY, MUST BE PREVIOUSLY DEFINED AS 0005H.
	POP REGISTERS	;	RESTORE REGISTERS—BE SURE TO USE AS MANY POPS AS YOU DID PUSHES.
	RET	;	RETURN TO CALLING ROUTINE

File-control blocks are written to the directory by each CLOSE command; they are read by each OPEN command. They maintain the disk-file allocation map, size (in 128-byte records), and extent (in 128-record segments). A separate FCB is maintained in the directory for each extent of the same file (each extent contains 128 128-byte records). That is, a file of 158 records will have an entry with extent=0 and record count=128 and another entry with extent=1 and record count=30, both having the same file name and file type.

The system maintains a default FCB at hexadecimal location 005C and a default buffer at hexadecimal location 0080. These are used by CP/M to pass information to a user program. This is best explained by considering what happens when the program given in listing 4 is run. After it has been assembled and loaded, it is run by typing its name, as is any compiled program running under CP/M. However, in addition to its name, the name of the file to be processed and the desired options must be entered. For this example program, the file to be processed must have a file type .DEM. This file is read into memory beginning at the first free memory location after the end of the program. The options

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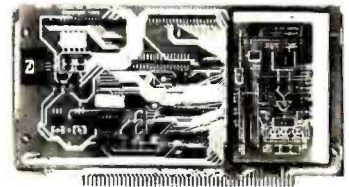
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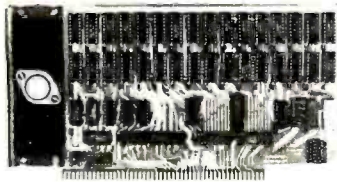
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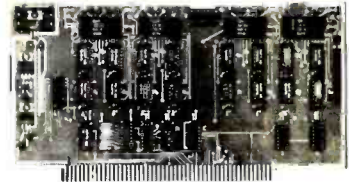
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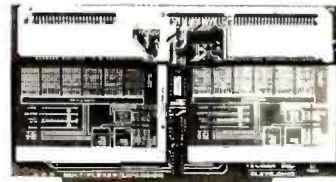
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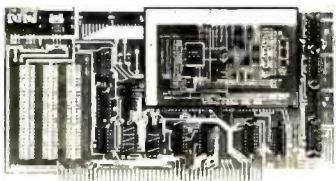
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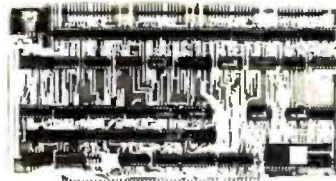
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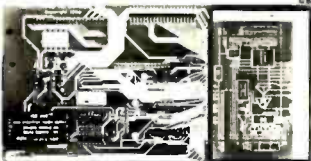


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Listing 2: Examples of some simple I/O routines that utilize the CP/M I/O functions.

SUBROUTINE RCHAR—READS A SINGLE CHARACTER FROM THE CONSOLE. PLACES THE CHARACTER READ INTO THE ACCUMULATOR (A REGISTER).

```

RFUNC EQU 1 ;READ CONSOLE FUNCTION NUMBER
;REFER TO TABLE I OF INTERFACE
;GUIDE.
NTRY EQU 0005H ;CP/M NTRY POINT
RCHAR: PUSH H ;PRESERVE REGISTERS
        PUSH D
        PUSH B
        MVI C,RFUNC ;PLACE CODE FOR READ FUNCTION
;IN C REGISTER
        CALL NTRY ;READ A CHARACTER
        MOV A,E ;MOVE CHARACTER JUST READ INTO
;A REGISTER.
        POP B ;RESTORE REGISTERS
        POP D
        POP H
        RET
    
```

SUBROUTINE WCHAR—WRITES A SINGLE CHARACTER TO THE CONSOLE. ASSUMES THAT THE CHARACTER TO BE WRITTEN IS IN THE A REGISTER.

```

WFUNC EQU 2 ;CP/M FUNCTION NUMBER
WCHAR: PUSH H ;PRESERVE ALL REGISTERS
        PUSH D
        PUSH B
        PUSH PSW
        MOV E,A ;PLACE CHARACTER IN THE E
;REGISTER BEFORE CALLING NTRY
        MVI C,WFUNC ;PLACE FUNCTION NUMBER IN C
        CALL NTRY ;WRITE HIM
        POP PSW ;RESTORE REGISTERS
        POP B
        POP D
        POP H
        RET
    
```

SUBROUTINE CLEAR—CLEARS THE SCREEN OF A SOROC IQ-120 TERMINAL. USES SUBROUTINE WCHAR TO SEND THE CHARACTERS TO THE TERMINAL.

```

HOME EQU 42 ;HOMES CURSOR AND CLEARS SCREEN
CLEAR: PUSH PSW ;PROTECT STATUS FROM CALLING ROUTINE
        MVI A,27 ;SEND ESCAPE CODE
        CALL WCHAR ;WRITE HIM
        MVI A,HOME ;CLEAR SCREEN AND HOME CURSOR
        CALL WCHAR ;WRITE AGAIN
        POP PSW ;RESTORE STATUS
        RET
    
```

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Listing 3: Program to prompt for input, clear the screen, and echo the characters entered using the techniques discussed in this article. Except for the clear-screen codes, this routine works on any CP/M system.

```

;*****
;
;   CP/M I/O UTILITIES PROGRAM
;   WRITTEN BY JAMES F. LARSON
;
;*****
;
0100          ORG      0100H
0100 03730?  JMP      BEGIN  ;SKIP TO START OF MAIN ROUTINE
;*****
;
;   EQUATES AND DATA STORAGE AREA
;
;*****
;
0005 =      NTRY   EQU      0005H  ;CPM ENTRY POINT
0009 =      PSTR   EQU      9      ;PRINT BUFFER FUNCTION
000A =      GSTR   EQU      10     ;READ BUFFER FUNCTION
0002 =      WFUNC  EQU      2      ;WRITE CONSOLE FUNCTION
002A =      HOME   EQU      42     ;HOME CURSOR AND CLEAR
000D =      CR     EQU      13     ;CARRIAGE RETURN
000A =      LF     EQU      10     ;LINE FEED
0020 =      LEN    EQU      32     ;DESIRED OUTPUT LINE LENGTH
0103      OLDSTK: DS      2        ;OLD STACK POINTER
0105      STR:    DS      257      ;INPUT STRING BUFFER
0206 454E544552PROMPT: DW      'EN', 'TE', 'R$'
020C 594F552057LEADER: DW      'YO', 'U ', 'WR', 'OT', 'E$'
;*****
;
;   SUBROUTINE PRINT -- PRINTS A STRING ENDING IN $
;   PLACE STRING BUFFER STARTING ADDRESS IN DE REGISTER
;   PRESERVES REGISTER CONTENTS
;
;*****
;
0216 E5      PRINT:  PUSH    H          ;PRESERVE REGISTERS
0217 D5      PUSH    D
0218 C5      PUSH    B
0219 F5      PUSH    PSW
021A 0E09    MVI     C,PSTR  ;PRINT FUNCTION IN C REG
021C CD0500  CALL    NTRY  ;DO IT
021F F1      POP     PSW  ;RESTORE REGISTERS
0220 C1      POP     B
0221 D1      POP     D
0222 E1      POP     H
0223 C9      RET
;*****
;
;   SUBROUTINE GETBUF -- GETS A BUFFER FULL FROM CONSOLE
;   PLACE INPUT BUFFER ADDRESS IN HL REGISTER - BUFFER
;   SHALL HAVE THE FIRST BYTE SET TO THE MAXIMUM BUFFER
;   LENGTH, THE NUMBER OF CHARACTERS PUT INTO BUFFER WILL
;   BE RETURNED AS THE SECOND BYTE OF THE BUFFER.
;
;*****
;
0224 E5      GETBUF: PUSH    H          ;PRESERVE REGISTERS
0225 D5      PUSH    D
0226 C5      PUSH    B
0227 F5      PUSH    PSW
0228 EB      XCHG   ;PLACE ADDRESS IN DE FOR CALL TO CPM
0229 0E0A    MVI     C,GSTR  ;READ BUFFER FUNCTION
022B CD0500  CALL    NTRY  ;GET UM
022E F1      POP     PSW  ;RESTORE
022F C1      POP     B
0230 D1      POP     D
0231 E1      POP     H

```

Listing 3 continued on page 280

INTRODUCING... □□□

COMES WITH: (ADDITIONAL)

- ▲ WORD STAR® WORD PROCESSOR
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- ◆ Dual 8" QUME Double Sided Drives (2MB) add \$625.00



WORD STAR is a TM of Micropro Inc. - CP/M2.2 is a TM of Digital Research Inc.

```

0232 C9          RET
;*****
;
;   SUBROUTINES WCHAR AND CLEAR FROM EXAMPLE 1 INSERTED HERE
;
;*****
;*****
;
;   SUBROUTINE WCHAR -- WRITES A SINGLE CHARACTER
;   CHARACTER IN A REGISTER - PRESERVES ALL REGISTERS
;*****
;
0233 E5  WCHAR:  PUSH   H           ;PRESERVE REGISTERS
0234 D5          PUSH   I
0235 C5          PUSH   B
0236 F5          PUSH   FSW
0237 5F          MOV    E,A           ;PUT CHAR IN E REGISTER
0238 0E02        MVI    C,WFUNC      ;WRITE CHARACTER FUNCTION
023A C10500      CALL   NTRY           ;PRINT HIM
023D F1          POP    FSW
023E C1          POP    B
023F I1          POP    I
0240 E1          POP    H
0241 C9          RET
;*****
;
;   SUBROUTINE CLEAR -- CLEARS SCREEN AND HOMES CURSOR ON
;   A SOROC IQ-120 TERMINAL - PRESERVES REGISTERS
;*****
;
0242 F5  CLEAR:  PUSH   FSW           ;PROTECT STATUS
0243 3E1B        MVI    A,27         ;SEND ESCAPE CODE
0245 C13302     CALL   WCHAR
0248 3E2A        MVI    A,HOME      ;CLEAR SCREEN AND HOME CURSOR
024A C13302     CALL   WCHAR
024D F1          POP    FSW
024E C9          RET
;*****
;
;   SUBROUTINE CRLF -- SENDS CRLF TO CONSOLE - PRESERVES REGISTERS
;*****
;
024F F5  CRLF:   PUSH   FSW
0250 3E0D        MVI    A,CR
0252 C13302     CALL   WCHAR
0255 3E0A        MVI    A,LF
0257 C13302     CALL   WCHAR
025A F1          POP    FSW
025B C9          RET
;*****
;
;   SUBROUTINE SAVSTK -- SAVES THE OLD STACK POINTER AND SETS
;   A NEW STACK AT CBASE (BASE OF CONSOLE COMMAND PROCESSOR).
;   CBASE IS 800H BELOW FBASE (BASE OF THE DISK OPERATING SYSTEM)
;   FBASE MAY BE READ AT NTRY+1.
;*****
;
025C C1  SAVSTK:  POP    B           ;GET RETURN ADDRESS
025D 210000      LXI    H,00         ;CLEAR HL
0260 39          DAD    SP          ;GET STACK POINTER
0261 220301      SHLI   OLI2STK      ;SAVE HIM
0264 2A0600      LHLD  NTRY+1      ;GET FBASE
0267 7C          MOV    A,H
0268 D160B      SUI    0BH         ;SUBTRACT CBASE OFFSET

```

QUALITY DISK SOFTWARE

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CHECK REGISTER AND BUDGET: This comprehensive CHECKING ACCOUNT MANAGEMENT SYSTEM not only keeps complete records, it also gives you the analysis and control tools you need to actively manage your account. The system provides routines for BUDGETING INCOME AND EXPENSE, AUTOMATIC CHECK SEARCH, and BANK STATEMENT RECONCILING. CRT or printer reports are produced for ACTUAL EXPENSE vs BUDGET, CHECK SEARCH DISPLAY RECONCILIATION REPORT and CHECK REGISTER DISPLAY by month. Check entry is prompted by user-defined menus of standard purposes and recipient codes, speeding data entry and reducing disk storage and retrieval time. Six fields of data are stored for each check: amount, check no., date, purpose, recipient and TAX DEDUCTIBLE REMINDER. CHECK SEARCH routines allow searching on any of these data fields. Up to 100 checks/mo. storage \$39.95

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UNIVERSAL COMPUTING MACHINE: \$49.95 (A)

A user programmable computing system structured around a 50 row x 50 column table. User defines row and column names and equations forming a unique computing machine. Table elements can be multiplied, divided, subtracted or added to any other element. Hundreds of unique computing machines can be defined, used, stored, and recalled, for later use. Excellent for sales forecasts, budgets, inventory lists, income statements, production planning, project cost estimates-in short for any planning, analysis or reporting problem that can be solved with a table.

COLOR CALENDAR: \$29.95 (A)

Got a busy calendar? Organize it with Color Calendar. Whether it's birthdays, appointments, business meetings or a regular office schedule, this program is the perfect way to schedule your activities. The calendar display is a beautiful HI-RES color graphics calendar of the selected month with each scheduled day highlighted in color. Using the daily schedule, you can review any day of the month and schedule an event or activity in any one of 20 time slots from 8:00 A.M. to 5:30 P.M.

BUSINESS SOFTWARE: Entire Series \$159.95 (A) (T)

MICROACCOUNTANT: The ideal accounting system for small businesses. Based on classic T-accounts and double-entry booking, this efficient program provides a journal for recording posting and reviewing up to 1,000 transactions per month to any one of 300 accounts. The program produces CRT and printer reports covering:

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Includes a short primer on Financial Accounting. (48K) \$49.95

UNIVERSAL BUSINESS MACHINE: This program is designed to SIMPLIFY and SAVE TIME for the serious businessman who must periodically Analyze, Plan and Estimate. The program was created using our Universal Computing Machine and it is programmed to provide the following planning and forecasting tools.

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PROFORMA PROFIT & LOSS	SOURCE AND USE OF FUNDS
PROFORMA BALANCE SHEET	JOB COST ESTIMATOR
REAL ESTATE INVESTMENT	INVENTORY ANALYSIS

Price, including a copy of the Universal Computing Machine \$89.95

BUSINESS CHECK REGISTER AND BUDGET: Our Check Register and Budget programs expanded to include up to 50 budgetable items and up to 400 checks per month. Includes bank statement reconciling and automatic check search (48K) \$49.95

ELECTRONICS SERIES VOL I & II: Entire Series \$259.95

LOGIC SIMULATOR: SAVE TIME AND MONEY. Simulate your digital logic circuits before you build them. CMOS, TTL, or whatever, if it's digital logic, this program can handle it. The program is an interactive, menu driven, full-fledged logic simulator capable of simulating the bit-timer response of a logic network to user-specified input patterns. It will handle up to 1000 gates, including NANDS, NORs, INVERTERS, FLIP-FLOPS, SHIFT REGISTERS, COUNTERS and user-defined MACROS. up to 40 user-defined random, or binary input patterns. Accepts network descriptions from keyboard or from LOGIC DESIGNER for simulation \$159.95 (A) (T)

LOGIC DESIGNER: Interactive HI-RES graphics program for designing digital logic systems. Draw directly on the screen up to 10 different gate types, including NAND, NOR, INVERTER, EX-OR, T-FLOP, JK-FLOP, D-FLOP, RS-FLOP, 4 BIT COUNTER and N-BIT SHIFT REGISTER. User interconnects gates using line graphics commands. Network descriptions for LOGIC SIMULATOR generated simultaneously with the CRT diagram being drawn \$159.95 (A)

MANUAL AND DEMO DISK: Instruction Manual and demo disk illustrating capabilities of both program (s) \$29.95 (A) (T)

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CIRCUIT SIMULATOR: Tired of trial & error circuit design? Simulate & debug your designs before you build them! With CIRCUIT SIMULATOR you build a model of your circuit using RESISTORS, CAPACITORS, INDUCTORS, TRANSISTORS, DIODES, VOLTAGE and CURRENT SOURCES and simulate the waveform response to inputs such as PULSES, SINUSOIDS, SAWTOOTHs, etc. ... all fully programmable. The output is displayed as an OSCILLOSCOPE-STYLE PLOT of the selected waveforms (Apple only) or as a printed table of voltage vs time. Handles up to 200 notes and up to 20 sources. Requires 48 RAM \$159.95 (A) (T)

CIRCUIT DESIGNER: Interactive HI-RES graphics program for designing electronic circuits. Draw directly on the screen up to 10 different component types, including those referenced above. Components interconnect list for CIRCUIT SIMULATOR generated automatically. Requires \$159.95

MATHEMATICS SERIES: Entire Series \$49.95

STATISTICAL ANALYSIS I: This menu driven program performs LINEAR REGRESSION analysis, determines the mean, standard deviation and plots the frequency distribution of user-supplied data sets. Printer, Disk, I/O routines \$19.95

NUMERICAL ANALYSIS: HI-RES 2-Dimensional plot of any function. Automatic scaling. At your option, the program will plot the function, plot the INTEGRAL, plot the DERIVATIVE, determine the ROOTS, MAXIMA, MINIMA, INTEGRAL VALUE \$19.95

MATRIX: A general purpose, menu driven program for determining the INVERSE and DETERMINANT of any matrix, as well as the SOLUTION to any set of SIMULTANEOUS LINEAR EQUATIONS. \$19.95

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ACTION ADVENTURE GAMES: Entire Series \$29.95 (A)

RED BARON: Can you outfly the RED BARON? This fast action game simulates a machine-gun DOGFIGHT between your WORLD WAR I BI-PLANE and the baron's. You can LOOP, DIVE, BANK or CLIMB-and so can the BARON. In HI-RES graphics plus sound. \$14.95

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SUB ATTACK: It's April 1943. The enemy convoy is headed for the CONTROL SEA. Your sub, the MORAY, has just sighted the CARRIERS and BATTLESHIPS' Easy pickings. But watch out for the DESTROYERS - they're fast and deadly. In HI-RES graphics plus sound \$14.95

FREE CATALOG: All programs are supplied on disk and run on Apple II w/Disk & Applesoft ROM Card & TRS-80 Level II and require 32K RAM unless otherwise noted. Detailed instructions included. Orders shipped within 5 days. Card users include card number. Add \$1.50 postage and handling with each order. California residents add 6 1/2% sales tax. Foreign orders add \$5.00 postage and handling.



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```

026A 67          MOV     H,A
026B F9          SPHL          ;SET NEW STACK POINTER
026C C5          PUSH    B          ;SET RETURN ADDRESS
026D C9          RET

;*****#*****
;
; SUBROUTINE GETSTK -- GETS OLD STACK POINTER AND RETURNS TO CPM
;
;*****#*****
026E 2A0301     GETSTK: LMLD   OLDSTK ;GET OLD STACK POINTER
0271 F9          SPHL          ;PLUG IT IN
0272 C9          RET          ;THIS WILL RETURN TO CPM

;*****#*****
;
; MAIN PROGRAM -- PROMPTS FOR INPUT, CLEARS SCREEN AND ECHOS
; THE INPUT STRING IN 32 CHARACTER LINES
;
;*****#*****
;
0273 CD5C02     BEGIN: CALL    SAVSTK ;SAVE OLD STACK POINTER
0274 110402     LXI    D,PROMPT
0279 CD1602     CALL   PRINT ;PRINT PROMPT
027C CD4F02     CALL   CRLF
027F 3EFF     MVI    A,255
0281 320501     STA    STR          ;SET MAX BUFFER LENGTH
0284 3E00     MVI    A,00
0286 320601     STA    STR+1 ;ZERO CHARACTER COUNTER
0289 210501     LXI    H,STR
028C CD2402     CALL   GETBUF ;GET A BUFFER FULL
028F CD4202     CALL   CLEAR ;CLEAR SCREEN
0292 110C02     LXI    D,LEADER
0295 CD1602     CALL   PRINT ;PRINT LEADER
0298 CD4F02     CALL   CRLF
029B 23          INX    H          ;ADDRESS STR+1
029C 46          MOV    B,M          ;NUMBER OF CHARACTERS READ IN
029D 3E20     FLIN: MVI    A,LEN          ;LINE LENGTH
029F BB          CMF    B
02A0 D2B402     JNC    ELIN ;PRINT LAST LINE
02A3 4F          MOV    C,A          ;PLACE LEN IN COUNTER
02A4 23          LINE: INX    H          ;NEXT CHARACTER
02A5 7E          MOV    A,M          ;GET HIM
02A6 CD3302     CALL   WCHAR ;WRITE HIM
02A9 05          DCR    B
02AA 0B          DCR    C
02AB C2A402     JNZ    LINE ;KEEP PRINTING TILL DONE
02AE CD4F02     CALL   CRLF
02B1 C39D02     JMP    PLIN ;NEXT LINE
02B4 23          ELIN: INX    H
02B5 7E          MOV    A,M          ;GET CHARACTER
02B6 CD3302     CALL   WCHAR
02B9 05          DCR    B
02BA C2B402     JNZ    ELIN ;PRINT TILL DONE
02BD CD4F02     CALL   CRLF
02C0 CD6E02     CALL   GETSTK ;RETURN TO CPM
02C3          END          ;00H

```

Text continued from page 274:

available are P, which prints the file on the system printer, and D, which creates a copy of the input file having type .RES. The input file may reside on drive A or B, but it is assumed to be on A unless otherwise specified. If option D is selected, the output file will be on the same drive as the input file.

Now, let us discuss the use of the default FCB and buffer. When the command DSKUTIL TEST.PD is entered in response to the CP/M prompt, the system places TEST in bytes 1 thru 4 of the FCB beginning at location 005C. PD is placed in bytes 9 and 10. The string (as typed) is also placed in the default buffer at location 0080 in the following manner:

byte 0 (that is, hexadecimal location 0080) contains the number of valid characters typed on the command line after the actual command and before a carriage return, in decimal. In this case, bTEST.PD (b represents a space—decimal ASCII 32) was typed—8 characters before a carriage return. Byte 0 of the buffer therefore

Text continued on page 300

SPEND \$62.40 TO READ THIS ADVERTISEMENT.*

A salesman generating 1.5 million dollars in sales annually for his company does so at the rate of \$12.48 per minute. That's expensive time—should it really be used in rummaging through filing cabinets, writing long reports or talking to dozens of people looking for one small, crucial piece of information?

Of course not, so you hire an accounting staff, customer support personnel, and marketing people to support the business and let your salespeople sell. But the overhead takes a large slice of that \$12.48.

A Delta system can do the work of a swarm of secretaries, a fleet of filers, a ton of telephones—simultaneously. It's a highly developed work processing system that can maintain files, generate reports, process orders and do all routine office work with speed and accuracy. It lets your people get on with the business of making money.

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able, allowing your Delta system to grow with your company's growth and change with your company's needs. And it's rugged; requiring a minimum of service or maintenance.

But the soul of any computer system is the software; therefore, having perfected the hardware technology, Delta is now dedicated to the development of application packages designed to warm the cockles of a corporate executive's heart. Our "Uni-form", for example, will keep purchase orders, account statements, sales and shipping orders indexed, cross-indexed and filed in any manner required.

And when your Delta system has helped your business grow, it's ready to grow right along with you—every Delta System is completely expandable and configurable.

You have spent five minutes reading this advertisement, at a cost of \$62.40 in potential sales. Have you calculated what a Delta system can save your company? (Hint: a Delta system can pay for itself in less than 24 hours of time saved.)

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Listing 4: Program using the discussed techniques to allow a user to either copy a specified file into another file or transmit its contents to the printer.

```

;*****
;
;       CPM DISK UTILITIES PROGRAM
;       WRITTEN BY JAMES K. LARSON
;
;*****
;
0100          ORG      0100H
0100 C38902          JMP      BEGIN      ;SKIP TO START OF MAIN PROGRAM
;*****
;
;       EQUATES AND DATA STORAGE AREA
;
;*****
;
0005 =        NTRY     EQU      0005H    ;CPM ENTRY POINT
0002 =        WFUNC   EQU      2        ;WRITE TO CONSOLE FUNCTION
0005 =        PFUNC   EQU      5        ;LINEPRINTER FUNCTION
0009 =        PSTR    EQU      9        ;PRINT BUFFER FUNCTION
000E =        LOGF    EQU      14       ;LOGIN AND SELECT DISK
000F =        OPENF   EQU      15       ;OPEN DISK FILE
0010 =        CLOSEF  EQU      16       ;CLOSE DISK FILE
0013 =        REMVF   EQU      19       ;DELETE A DISK FILE
0014 =        READF   EQU      20       ;READ A DISK RECORD
0015 =        WRITEF  EQU      21       ;WRITE A DISK RECORD
0016 =        MAKEF   EQU      22       ;CREATE A DISK FILE
001A =        SETF    EQU      26       ;SET DMA ADDRESS FOR NEXT READ/WRITE
0080 =        TRUFF   EQU      0080H    ;DEFAULT TEXT BUFFER
005C =        TFCB    EQU      005CH    ;DEFAULT FILE CONTROL BLOCK
0080 =        RECLEN  EQU      128      ;LENGTH OF ONE DISK RECORD
000D =        CR      EQU      13       ;CARRIAGE RETURN
000A =        LF      EQU      10       ;LINE FEED
002A =        HOME    EQU      42       ;HOME CURSOR AND CLEAR SCREEN
0103 4445      DEM:    DW      'DE'
0105 4000000000 DB      'M',0,0,0
010A 5245      RES:    DW      'RE'
010C 5300000000 DB      'S',0,0,0
0111 5052494E54DNMSG: DW      'PR','IN','TI','NG',' C','OM','PL','ET','E$'
0123 50524F4345DNPRC: DW      'PR','OC','ES','SI','NG',' C','OM','PL','ET','E$'
0137 434F4D4D41ERRMSG: DW      'CO','MM','AN','D ','OR',' F','IL','E ','ER','RO','R$'
014D 4F50454E20PFERR: DW      'OP','EN',' E','RR','OR','$ '
0159 5752495445WERR:  DW      'WR','IT','E ','ER','RO','R$'
0165          RCRDIS:  DS      1        ;STORAGE FOR NUMBER OF RECORDS READ
0166          OLDSTK:  DS      2        ;STORAGE FOR ORIGINAL STACK ADDRESS
0168 00          FLAG:  DB      00      ;INITIALIZE FLAG BITS STORAGE
0169          TFCB1:   DS      33       ;SECOND FILE CONTROL BLOCK
;*****
;
;       SUBROUTINE PRINT -- PRINTS A STRING ENDING IN $
;
;       PLACE STRING BUFFER STARTING ADDRESS IN DE REGISTER
;
;       PRESERVES REGISTER CONTENTS
;
;*****
;
018A E5        PRINT:  PUSH     H          ;PRESERVE REGISTERS
018B D5        PUSH     D
018C C5        PUSH     B
018D F5        PUSH     PSW
018E 0E09      MVI      C,PSTR    ;FUNCTION IN C REGISTER
0190 CD0500    CALL     NTRY     ;DO IT
0193 F1        POP      PSW        ;RESTORE REGISTERS
0194 C1        POP      B
0195 D1        POP      D
0196 E1        POP      H
017 C9        RET
;*****
;
;       SUBROUTINE WCHAR -- WRITES A SINGLE CHARACTER TO THE CONSOLE
;
;       CHARACTER IN THE A REGISTER - PRESERVES REGISTERS

```

Listing 4 continued on page 286

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. Hierarchical & Network DBMS.

CODASYL-like hierarchical 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 pre-defined 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

©Ashton-Tate 1980

Listing 4 continued:

```

;
;*****
;
0198 E5   WCHAR:  PUSH    H
0199 D5           PUSH    D
019A C5           PUSH    B
019B F5           PUSH    PSW
019C 5F           MOV     E,A      ;CHARACTER IN E REGISTER
019D 0E02         MVI    C,WFUNC
019F C00500       CALL   NTRY
01A2 F1           POP     PSW
01A3 C1           POP     B
01A4 D1           POP     D
01A5 E1           POP     H
01A6 C9           RET

;*****
;
;   SUBROUTINE PCHAR -- PRINTS A SINGLE CHARACTER ON THE PRINTER
;   CHARACTER IN THE A REGISTER -- PRESERVES REGISTERS
;
;*****
;
01A7 E5   PCHAR:  PUSH    H
01A8 D5           PUSH    D
01A9 C5           PUSH    B
01AA F5           PUSH    PSW
01AB 5F           MOV     E,A
01AC 0E05         MVI    C,PFUNC
01AE C00500       CALL   NTRY
01B1 F1           POP     PSW
01B2 C1           POP     B
01B3 D1           POP     D
01B4 E1           POP     H
01B5 C9           RET

;*****
;
;   SUBROUTINE CLEAR -- CLEARS SCREEN AND HOMES CURSOR ON
;   A SOROC IQ-120 TERMINAL -- PRESERVES REGISTERS
;
;*****
;
01B6 F5   CLEAR:  PUSH    PSW      ;PROTECT STATUS
01B7 3E1B         MVI    A,27      ;SEND ESCAPE CODE
01B9 C009801     CALL   WCHAR
01BC 3E2A         MVI    A,HOME
01BE C009801     CALL   WCHAR
01C1 F1           POP     PSW
01C2 C9           RET

;*****
;
;   SUBROUTINE CRLF -- SENDS CRLF TO CONSOLE
;
;*****
;
01C3 F5   CRLF:  PUSH    PSW
01C4 3E0D         MVI    A,CR
01C6 C009801     CALL   WCHAR
01C9 3E0A         MVI    A,LF
01CB C009801     CALL   WCHAR
01CE F1           POP     PSW
01CF C9           RET

;*****
;
;   SUBROUTINE SAVSTK -- SAVES THE OLD STACK POINTER AND SETS
;   A NEW STACK AT CBASE (BASE OF THE CONSOLE COMMAND PROCESSOR).
;   CBASE IS 800H BELOW FBASE (BASE OF THE DISK OPERATING SYSTEM).
;   FBASE MAY BE READ AT NTRY+1.
;
;*****

```

Listing 4 continued on page 288

NEW

ITS MAGIC[®]



The System/48 is the outstanding office automation computing system for the 80's . . . it's so productive we call it MAGIC[®]. Look at these features:

- Data management system
- Report generator
- Query processor
- Screen format generator
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- From one to eight interactive users per node
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Circle 359 on inquiry card.

MAGIC[®] also includes DataMagic II[®] — TEI's red-hot database manager. DataMagic II[®] has even more tricks up its sleeve — like automatic or manual record-lock protection and automatic transaction backout to protect the database and it runs application software written for CP/M 2.X.

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Arrange to attend one of our regularly scheduled System/48 workshops (RSVP).

OEM and Dealer Inquiries Invited



System/48[®]

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Listing 4 continued:

```

;
01D0 C1 SAVSTK: POP B ;GET RETURN ADDRESS
01D1 210000 LXI H,00 ;CLEAR HL
01D4 39 DAD SP ;GET STACK POINTER
01D5 226601 SHLD OLDSTK ;SAVE HIM
01D8 2A0600 LHLD NTRY+1 ;GET FBASE
01DB 7C MOV A,H
01DC D608 SUI 08H ;SUBTRACT CHASE OFFSET
01DE 67 MOV H,A
01DF F9 SPHL ;SET NEW STACK POINTER
01E0 C5 PUSH B ;SET RETURN ADDRESS
01E1 C9 RET

;*****
;
; SUBROUTINE GETSTK -- GETS OLD STACK POINTER AND RETURNS TO CFM
;
;*****
;
01E2 2A6601 GETSTK: LHLD OLDSTK ;GET OLD STACK POINTER
01E5 F9 SPHL ;PLUG HIM IN
01E6 C9 RET ;THIS WILL RETURN TO CFM

;*****
;
; SUBROUTINE PRT -- PRINTS THE NUMBER OF CHARACTERS IN THE B REG
; ON THE LINE PRINTER. ADDRESS OF FIRST CHARACTER TO PRINT
; IS IN HL.
;
;*****
;
01E7 7E PRT: MOV A,M ;GET CHAR
01E8 CDA701 CALL PCHAR ;PRINT HIM
01EB 23 INX H ;NEXT, PLEASE
01EC 05 DCR B ;DONE?
01ED C2E701 JNZ PRT ;NOPE, KEEP PRINTING
01F0 C9 RET ;DONE, GO HOME

;*****
;
; SUBROUTINE MOVCHR -- MOVES CHARACTERS BEGINNING AT LOCATION
; IN HL TO LOCATION BEGINNING IN DE FOR A COUNT IN REG C.
;
;*****
;
01F1 7E MOVCHR: MOV A,M
01F2 12 STAX D
01F3 23 INX H
01F4 13 INX D
01F5 0D DCR C
01F6 C2F101 JNZ MOVCHR ;GO TILL DONE
01F9 C9 RET

;*****
;
; SUBROUTINE LOGDISK -- LOGS IN A DISK AS ACTIVE FOR I/O. REG E
; CONTAINS 0 FOR DRIVE A AND 1 FOR DRIVE B.
;
;*****
;
01FA E5 LOGDISK: PUSH H
01FB D5 PUSH D ;PRESERVE
01FC C5 PUSH B
01FD F5 PUSH FSW
01FE 0E0E MVI C,LOGF
0200 CD0500 CALL NTRY
0203 F1 POP FSW
0204 C1 POP B ;RESTORE
0205 D1 POP D
0206 E1 POP H
0207 C9 RET

;*****
;

```

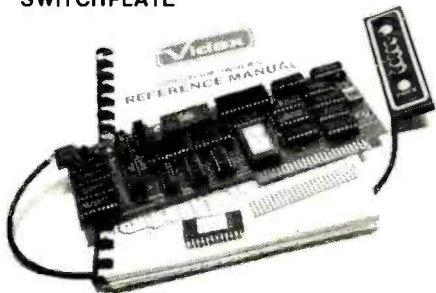
Listing 4 continued on page 290

The Text Solution for APPLE II®

Now APPLE II® Owners Can Solve Text Problems With VIDEOTERM 80 Column by 24 Line Video Display Utilizing 7 X 9 Dot Character Matrix

Perhaps the most annoying shortcoming of the Apple II® is its limitation of displaying only 40 columns by 24 lines of text, all in uppercase. At last, Apple II® owners have a reliable, trouble-free answer to their text display problem. VIDEOTERM generates a full 80 columns by 24 lines of text, in upper and lower case. Twice the number of characters as the standard Apple II® display. And by utilizing a 7 by 9 character matrix, lower case letters have true descenders. But this is only the start.

VIDEOTERM, MANUAL, SWITCHPLATE



VIDEOTERM

BASICs VIDEOTERM lists BASIC programs, both Integer and Applesoft, using the entire 80 columns. Without splitting keywords. Full editing capabilities are offered using the ESCape key sequences for cursor movement. With provision for stop/start text scrolling utilizing the standard Control-S entry. And simultaneous on-screen display of text being printed.

Pascal Installation of VIDEOTERM in slot 3 provides Pascal immediate control of the display since Pascal recognizes the board as a standard video display terminal and treats it as such. No changes are needed to Pascal's MISC.INFO or GOTOXY files, although customization directions are provided. All cursor control characters are identical to standard Pascal defaults.

Other Boards The new Microsoft Softcard™ is supported. So is the popular D. C. Hayes Micro-modem II™, utilizing customized PROM firmware available from VIDEX. The powerful EasyWriter™ Professional Word Processing System and other word processors are now compatible with VIDEOTERM. Or use the Mountain Hardware ROMWriter™ (or other PROM programmer) to generate your own custom character sets. Naturally, VIDEOTERM conforms to all Apple OEM guidelines, assurance that you will have no conflicts with current or future Apple II™ expansion boards.

Advanced Hardware Design VIDEOTERM's on-board asynchronous crystal clock ensures flicker-free character display. Only the size of the Pascal Language card, VIDEOTERM utilizes CMOS and low power consumption ICs, ensuring cool, reliable operation. All ICs are fully socketed for easy maintenance. Add to that 2K of on-board RAM, 50 or 60 Hz operation, and provision of power and input connectors for a light pen. Problems are designed out, not in.

Available Options The entire display may be altered to inverse video, displaying black characters on a white field. PROMs containing alternate character sets and graphic symbols are available from Videx. A switchplate option allows you to use the same video monitor for either the VIDEOTERM or the standard Apple II™ display, instantly changing displays by flipping a single toggle switch. The switchplate assembly inserts into one of the rear cut-outs in the Apple II™ case so that the toggle switch is readily accessible. And the Videx KEYBOARD ENHANCER can be installed, allowing upper and lower case character entry directly from your Apple II™ keyboard.

Firmware 1K of on-board ROM firmware controls all operation of the VIDEOTERM. No machine language patches are needed for normal VIDEOTERM use.

Firmware Version 2.0

Characters	7 x 9 matrix	Display	24 x 80 (full descenders)
Options	7 x 12 matrix option; Alternate user definable character set option; Inverse video option.		18 x 80 (7 x 12 matrix with full descenders)

Want to know more? Contact your local Apple dealer today for a demonstration. VIDEOTERM is available through your local dealer or direct from Videx in Corvallis, Oregon. Or send for the VIDEOTERM Owners Reference Manual and deduct the amount if you decide to purchase. Upgrade your Apple II™ to full terminal capabilities for half the cost of a terminal. VIDEOTERM. At last.

PRICE:

- VIDEOTERM includes manual. . . . \$345
- SWITCHPLATE. . . . \$ 19
- MANUAL refund with purchase. . . . \$ 19
- 7 x 12 CHARACTER SET. . . . \$ 39
- MICROMODEM FIRMWARE. . . . \$ 25



7X12 MATRIX
18X80 OPTIONAL



7X9 MATRIX
12X80 STANDARD

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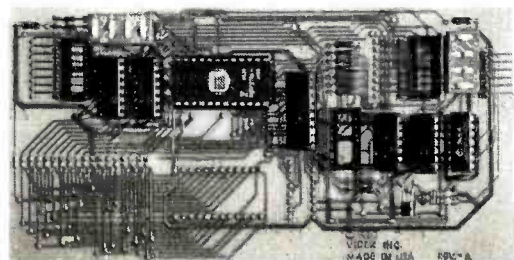
- PUT THE SHIFT AND SHIFT LOCK BACK WHERE IT BELONGS
- SEE REAL UPPER AND lower CASE ON THE SCREEN
- ACCESS ALL YOUR KEYBOARD ASCII CHARACTERS

Videx has the perfect companion for your word processor software: the **KEYBOARD AND DISPLAY ENHANCER**. Install the enhancer in your APPLE II and be typing in lower case just like a typewriter. If you want an upper case character, use the SHIFT key or the CTRL key for shift lock. Not only that, but you see upper and lower case on the screen as you type. Perfectly compatible with Apple Writer and other word processors like, for example, Super-Text.

If you want to program in BASIC, just put it back into the alpha lock mode, and you have the original keyboard back with a few im-

provements. Now you can enter those elusive 9 characters directly from the keyboard, or require the Control key to be pressed with the RESET to prevent accidental resets.

KEYBOARD AND DISPLAY ENHANCER is recommended for use with all revisions of the APPLE II. It includes 6 ICs, and EPROM and dip-switches mounted on a PC board, and a jumper table. Easy installation, meaning no soldering or cutting traces. Alternate default modes are dip-switch selectable. You can even remap the keyboard, selecting an alternate character set, for custom applications.



PRICE

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VIDEX
897 N.W. Grant Avenue
Corvallis, Oregon 97330
Phone (503) 758-0521



Listing 4 continued:

```

; SUBROUTINE OPEN -- OPENS FILE WHOSE FCB ADDRESS IS IN DE.
; RETURNS 255 IN REG A IF NO SUCH FILE.
;
;*****
0208 E5 OPEN: PUSH H ;PRESERVE
0209 D5 PUSH D
020A C5 PUSH B
020B 0E0F MVI C,OPENF
020D CD0500 CALL NTRY
0210 C1 POP B
0211 D1 POP D
0212 E1 POP H
0213 C9 RET
;*****
; SUBROUTINE CLOSE -- CLOSSES FILE WHOSE FCB ADDRESS IS IN DE.
; RETURNS 255 IN A IF NO SUCH FILE.
;
;*****
0214 E5 CLOSE: PUSH H
0215 D5 PUSH D
0216 C5 PUSH B
0217 0E10 MVI C,CLOSEF
0219 CD0500 CALL NTRY
021C C1 POP B
021D D1 POP D
021E E1 POP H
021F C9 RET
;*****
; SUBROUTINE DELETE -- DELETES THE FILE WHOSE FCB IS IN DE.
;
;*****
0220 E5 DELETE: PUSH H
0221 D5 PUSH D
0222 C5 PUSH B
0223 F5 PUSH PSW
0224 0E13 MVI C,REMOVF
0226 CD0500 CALL NTRY
0229 F1 POP PSW
022A C1 POP B
022B D1 POP D
022C E1 POP H
022D C9 RET
;*****
; SUBROUTINE CREATE -- CREATES THE FILE WHOSE FILENAME AND TYPE
; ARE IN THE FCB ADDRESSED BY DE. RETURNS 255 IN A IF NO
; DIRECTORY SPACE.
;
;*****
022E E5 CREATE: PUSH H
022F D5 PUSH D
0230 C5 PUSH B
0231 0E16 MVI C,MAKEF
0233 CD0500 CALL NTRY
0236 C1 POP B
0237 D1 POP D
0238 E1 POP H
0239 C9 RET
;*****;*****
; SUBROUTINE SETDMA -- SETS THE DMA ADDRESS FOR THE NEXT DISK I/O
; TO THAT IN HL. INCREMENTS HL BY 128 (READY FOR NEXT TIME).
;

```

Listing 4 continued on page 292



APPLE ACCESSORIES

LOBO Disk II/Controller	\$499.
LOBO Disk II	419.
SUPERTERM 80 Col. Card	329.
Z80 Soft Card	295.
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1-SA 800/801 Case, power	995.
2-SA 800/801 Case, power	1,495.
2-SA 850/851 Case, power	1,995.

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Diablo 1640 RO	2,795.
Diablo 1650 RO	3,095.
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Qume 3/55 RO	2,295.
Qume 5/45 RO	2,595.
Qume 5/55 RO	2,795.
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TI 820 RO	1,795.
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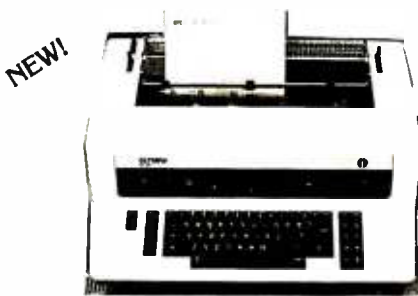
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Listing 4 continued:

```

;*****
;
SETDMA: PUSH    PSW
023A FS      PUSH    R
023B C5      PUSH    D
023C D5      PUSH    H
023D E5      PUSH    H
023E ER      XCHG    ;ADDRESS IN DE
023F 0E1A    MVI     C,SETF
0241 CD0500  CALL    NTRY
0244 E1      POP     H      ;MODIFY THIS GUY
0245 019000  LXI     R,128
0248 09      DAD     R      ;ADDRESS+128
0249 D1      POP     D
024A C1      POP     R      ;RESTORE
024B F1      POP     PSW
024C C9      RET

;*****
;
;   SUBROUTINE RDREC -- READS ONE RECORD FROM FILE WHOSE FCB IS IN
;   DE TO THE CURRENT DMA ADDRESS. RETURNS A 1 OR 2 IN REG A
;   IF EOF IS ENCOUNTERED. A ZERO IN REG A MEANS SUCCESSFUL READ.
;
;*****
;
024D E5      RDREC:  PUSH    H
024E D5      PUSH    D
024F C5      PUSH    R
0250 0E14    MVI     C,READF
0252 CD0500  CALL    NTRY
0255 C1      POP     R
0256 D1      POP     D
0257 E1      POP     H
0258 C9      RET

;*****
;
;   SUBROUTINE WRREC -- WRITES ONE RECORD TO FILE WHOSE FCB IS IN
;   DE FROM THE CURRENT DMA ADDRESS. RETURNS 0 IF A SUCCESSFUL
;   WRITE.
;
;*****
;
0259 E5      WRREC:  PUSH    H
025A D5      PUSH    D
025B C5      PUSH    R
025C 0E15    MVI     C,WRITEF
025E CD0500  CALL    NTRY
0261 C1      POP     R
0262 D1      POP     D
0263 E1      POP     H
0264 C9      RET

;*****
;
;   SUBROUTINE RDDSK -- READS FILE WHOSE FCB ADDRESS IS IN DE TO
;   MEMORY BEGINNING AT ADDRESS IN HL. ASSUMES FILE WILL FIT INTO
;   MEMORY. ENTIRE FILE IS READ IN.
;
;*****
;
0265 CD3A02  RDDSK:  CALL    SETDMA
0268 CD4D02  CALL    RDREC
026B A7      ANA     A      ;SET STATUS FLAGS - REG A WILL BE NON-ZERO
;           ; IF AN EOF WAS ENCOUNTERED
026C CA6502  JZ     RDDSK  ;READ TILL EOF
026F C9      RET

;*****
;
;   SUBROUTINE WRDSK -- WRITES TO DISK FROM MEMORY BEGINNING AT
;   ADDRESS IN HL. WRITES FILE WHOSE FCB IS IN DE. WRITES NUMBER
;   OF RECORDS IN REG B. ANY ERRORS RETURNED FROM WRREC ARE
;   REPORTED AND THE WRITE IS ABORTED.

```

Listing 4 continued on page 294

Wild Hare Software Systems Multiply the Capabilities of Data General's

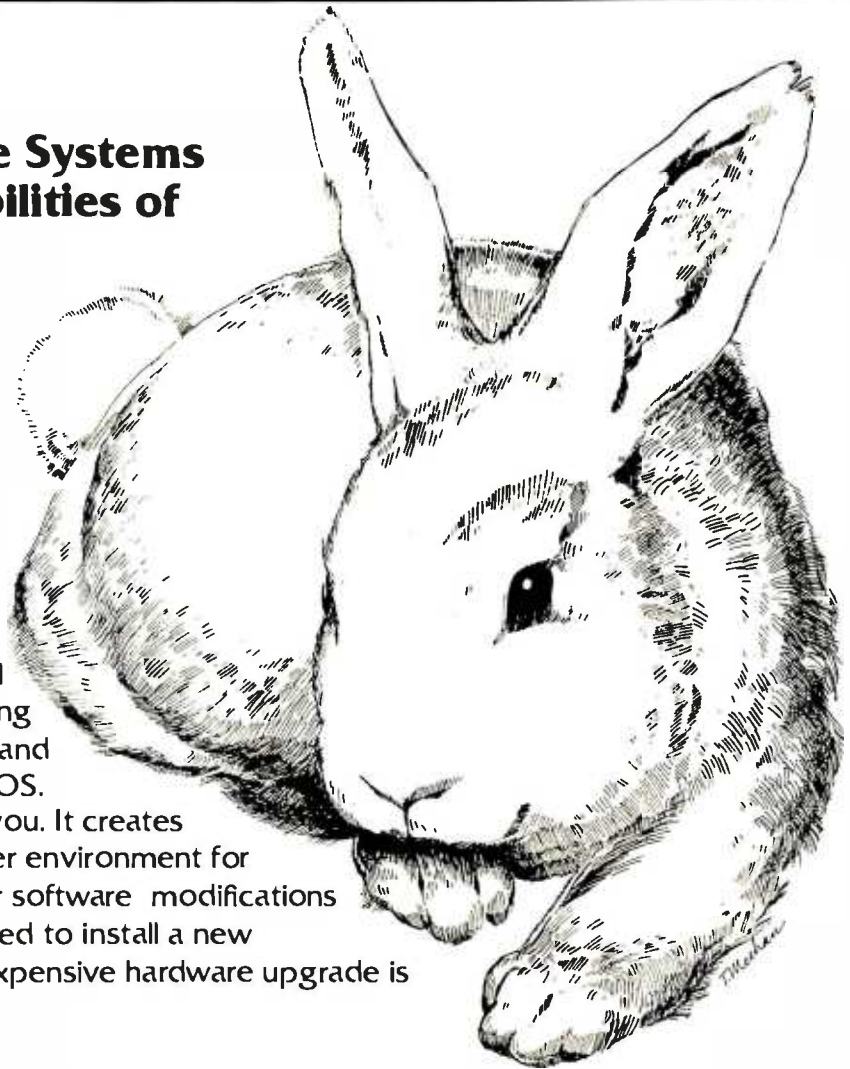
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Listing 4 continued:

```

;
;*****
;
0270 CD3A02 WRDSK: CALL SETDMA
0273 CD5902 CALL WRREC
0276 A7 ANA A ;SET STATUS FLAGS - REG A WILL BE NON-ZERO
; IF AN ERROR OCCURRED
0277 C27F02 JNZ WRER ;REPORT ERROR
027A 05 DCR B ;THUMP RECORD COUNTER
027B C27002 JNZ WRDSK ;WRITE EM ALL
027E C9 RET
027F 115901 WRER: LXI D,WERR ;PRINT ERROR MESSAGE
0282 CD8A01 CALL PRINT
0285 CDC301 CALL CRLF
0288 C9 RET
;*****
;
; MAIN PROGRAM -- READS A DISK DRIVE, FILE NAME, AND OPTIONS FROM
; THE DEFAULT BUFFER. OPTIONS ALLOW THE NAMED FILE TO BE
; PRINTED OR REWRITTEN TO A NEW FILE. ASSUMES FILE TYPE .DEM
; FOR INPUT FILE AND ASSIGNS TYPE .RES TO OUTPUT FILE.
;
;*****
;
0289 CDD001 BEGIN: CALL SAVSTK ;SAVE OLD STACK POINTER
028C CDB601 CALL CLEAR
028F 218000 LXI H,TRUFF ;COMMAND LINE IS HERE
0292 3E00 MVI A,0
0294 BE CMP M
0295 CAA303 JZ ERR ;ERROR IF NO VALID CHARACTERS
0298 46 MOV B,M ;GET NUMBER OF VALID CHARACTERS
0299 3E3A MVI A,';' ;DISK SPECIFIED?
029B 23 INX H
029C 23 INX H
029D 23 INX H ;COLON IS HERE IF A LABEL IS SPECIFIED
029E BE CMP M
029F CAAS02 JZ LISK ;LOG PROPER DISK
02A2 2B DCX H
02A3 2B DCX H
02A4 05 DCR B ;ASSUME FIRST CHARACTER BLANK
02A5 C3BF02 JMP TARG ;SKIP IF NOT NEEDED
02A8 05 LISK: DCR B ;THUMP COUNTER
02A9 05 DCR B
02AA 05 DCR B
02AB 3E42 MVI A,'B' ;DRIVE B?
02AD 2B DCX H ;BACK UP ONE
02AE BE CMP M
02AF CAB602 JZ DRB ;DRIVE B IT IS
02B2 23 INX H ;ASSUME DRIVE A
02B3 C3BF02 JMP TARG
02B6 3A6801 DRB: LDA FLAG ;FLAG DRIVE B
02B9 F604 ORI 00000100H
02BB 326801 STA FLAG
02BE 23 INX H
02BF 3E2E TARG: MVI A',' ;TARGET IS END OF FILE NAME
02C1 23 NCHAR: INX H ;NEXT CHAR
02C2 05 DCR B ;THUMP COUNTER
02C3 CAA303 JZ ERR ;ERROR IF NO COMMANDS
02C6 BE CMP M
02C7 C2C102 JNZ NCHAR ;KEEP LOOKING
02CA 23 INX H
02CB 3E50 INSTR: MVI A,'P' ;PRINT HIM?
02CD BE CMP M
02CE C2DC02 JNZ DTST
02D1 3A6801 LDA FLAG ;SET PRINT FLAG
02D4 F601 ORI 00000001B
02D6 326801 STA FLAG
02D9 C3EA02 JMP NXTINS
02DC 3E44 DTST: MVI A,'D' ;CREATE NEW DISK FILE?
02DE BE CMP M

```

Listing 4 continued on page 296

"WITH THE UCSD p-SYSTEM,TM WE CAN WRITE ONE APPLICATION THAT GOES FROM APPLE TO ZENITH."

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Listing 4 continued:

```

02DF C2EA02      JNZ      NXTINS  ;INVALID INSTRUCTIONS ARE SKIPPED
02E2 3A6801      LDA      FLAG    ;SET FILE FLAG
02E5 F602        ORI      0000010B
02E7 326801      STA      FLAG
02EA 23          NXTINS: INX    H
02EB 05          DCR      B
02EC C2CB02      JNZ      INSTR   ;KEEP READING INSTRUCTIONS
                    ;
                    ;LOG PROPER DRIVE
                    ;
02EF 1E00        MVI      E,00    ;SET DEFAULT DRIVE A
02F1 3A6801      LDA      FLAG
02F4 E604        ANI      00000100B ;WHICH DRIVE?
02F6 CAF802      JZ       LOG     ;LOG DRIVE A
02F9 1E01        MVI      E,01    ;LOG DRIVE B
02FB CDFA01      LOG:    CALL    LOGDSK
                    ;
                    ;SET FILE TYPE .DEM
                    ;
02FE 210301      LXI      H,DEM
0301 116500      LXI      D,TFCB+9
0304 0E07        MVI      C,7     ;MOVE 7 CHARACTERS -- .DEM AND ZEROS
0306 CDF101      CALL    MOVCHR
0309 AF          XRA      A     ;CLEAR A
030A 327C00      STA      TFCB+32 ;ZERO NEXT RECORD
                    ;
                    ;READ IN FILE
                    ;
030D 115C00      LXI      D,TFCB
0310 CD0802      CALL    OPEN
0313 3C          INR      A     ;ERROR TEST - A CONTAINS 255 IF ERROR
0314 C22303      JNZ      RDSK   ;OK- GO ON
0317 114D01      LXI      D,OFERR ;PRINT OPEN ERROR
031A CD8A01      CALL    PRINT
031D CDC301      CALL    CRLF
0320 C39703      JMP     DONE
0323 21AF03      RDSK:  LXI      H,FINIS ;LOCATION OF FIRST OPEN MEMORY LOCATION
                    ;DE ALREADY CONTAINS THE FCB ADDRESS
0326 CD6502      CALL    RDISK  ;READ HIM IN
0329 3A6800      LDA      TFCB+15 ;NUMBER OF RECORDS READ IN
032C 326501      STA      RCRDS
032F CD1402      CALL    CLOSE ;TFCB IS STILL IN DE
                    ;
                    ;PRINT ON LINE PRINTER IF FLAG SET
                    ;
0332 3A6801      LDA      FLAG
0335 E601        ANI      00000001B
0337 CA5803      JZ       FILE   ;TEST FOR FILE FLAG
033A 3A6501      LDA      RCRDS ;NUMBER OF RECORDS TO PRINT
033D 4F          MOV     C,A
033E 0D          DCR     C
033F 21AF03      LXI      H,FINIS ;FIRST CHARACTER
0342 118000      LXI      D,128  ;INCREMENT
0345 0680        PRTMOR: MVI     B,RELEN ;SET RECORD LENGTH
0347 CDE701      CALL    PRT    ;PRINT ONE RECORD
034A 19          DAD     D     ;INCREMENT CHAR COUNT
034B 0D          DCR     C
034C C24503      JNZ      PRTMOR ;PRINT MORE
034F 111101      LXI      D,INMSG ;PRINT COMPLETION MESSAGE
0352 CD8A01      CALL    PRINT
0355 CDC301      CALL    CRLF
                    ;
                    ;IF FILE FLAG SET, CREATE NEW FILE
                    ;
0358 3A6801      FILE:  LDA      FLAG
035B E602        ANI      00000010B
035D CA9703      JZ       DONE
                    ;
                    ;IF FILE .RES EXISTS, DELETE IT - THEN CREATE IT
                    ;

```

Listing 4 continued on page 298

PERIPHERALS FOR ATARI 400 & 800

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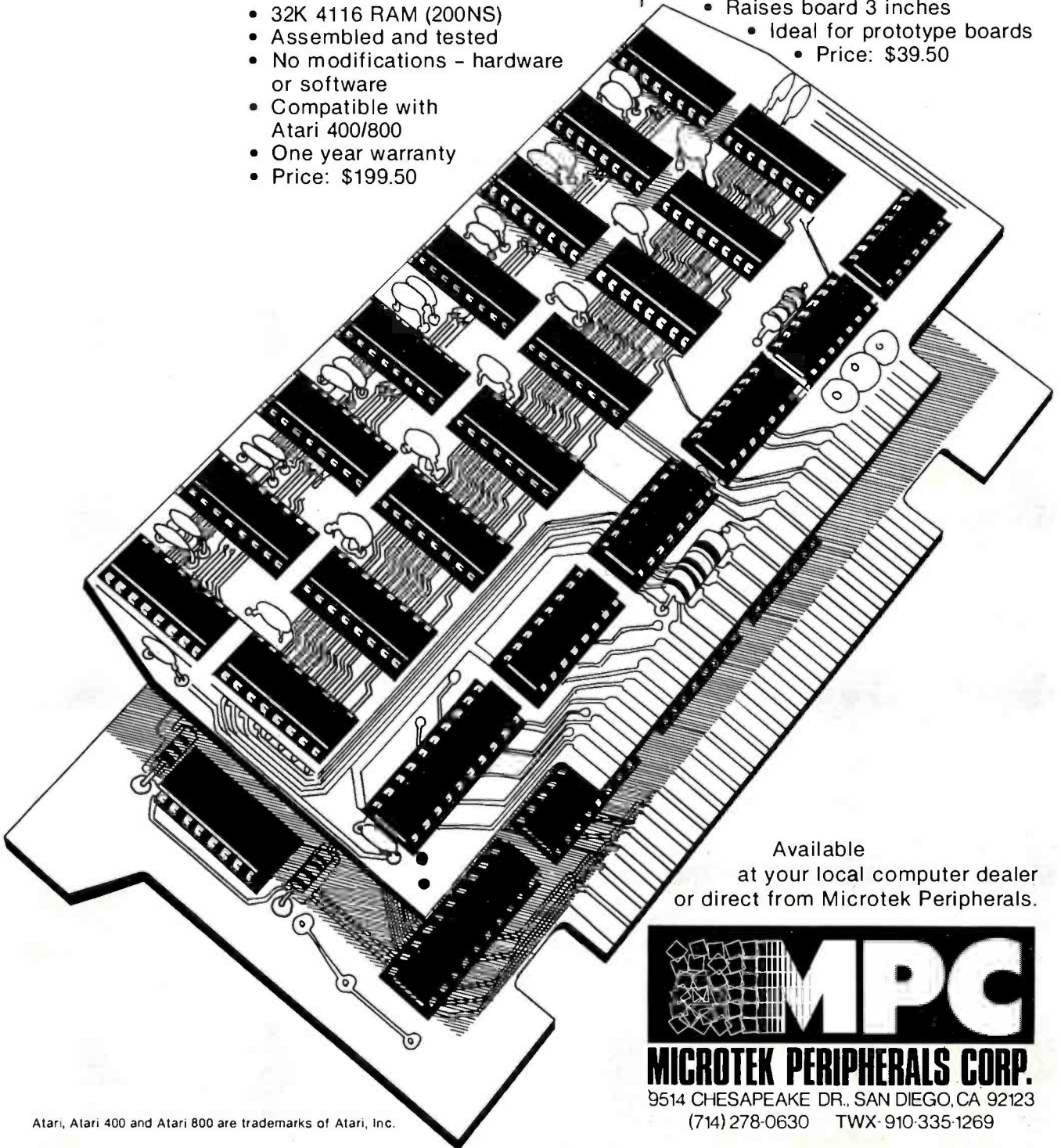
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Listing 4 continued:

```

0360 215C00      LXI      H,TFCB  ;MOVE FILE NAME
0363 116901      LXI      D,TFCB1
0366 0E09        MVI      C,9
0368 CDF101      CALL    MOVCHR
036B 210A01      LXI      H,RES  ;FILE TYPE .RES
036E 117201      LXI      D,TFCB1+9
0371 0E07        MVI      C,7  ;SET TYPE AND ZERO REST OF FCB
0373 CDF101      CALL    MOVCHR
0376 AF          XRA      A    ;CLEAR A
0377 328901      STA      TFCB1+32 ;ZERO NEXT RECORD
037A 116901      LXI      D,TFCB1 ;DESTINATION FILE
037D CD0802      CALL    OPEN
0380 3C          INR      A    ;DOES FILE EXIST?
0381 C28703      JNZ     MAKUM  ;NOPE, LETS CREATE
0384 CD2002      CALL    DELETE ;YUP, LETS DELETE
0387 CD2E02      MAKUM:  CALL    CREATE ;FCB IS STILL IN DE
                                ;FILE NOW EXISTS - WRITE TO HIM
038A 3A6501      LDA      RCRDS  ;NUMBER OF RECORDS TO WRITE
038D 47          MOV     B,A
038E 21AF03      LXI      H,FINIS ;LOCATION OF FIRST CHARACTER TO WRITE
0391 CD7002      CALL    WRDSK  ;WRITE HIM
0394 CD1402      CALL    CLOSE
0397 112301      DONE:  LXI      D,DNFRC ;PRINT COMPLETION MESSAGE
039A CD8A01      CALL    PRINT
039D CDC301      CALL    CRLF
03A0 CDE201      CALL    GETSTK ;RETURN TO CPM
03A3 213701      ERR:   LXI      H,ERRMSG
03A6 CD8A01      CALL    PRINT
03A9 CDC301      CALL    CRLF
03AC C39703      JMP     DONE
03AF          FINIS:  END      100H

```

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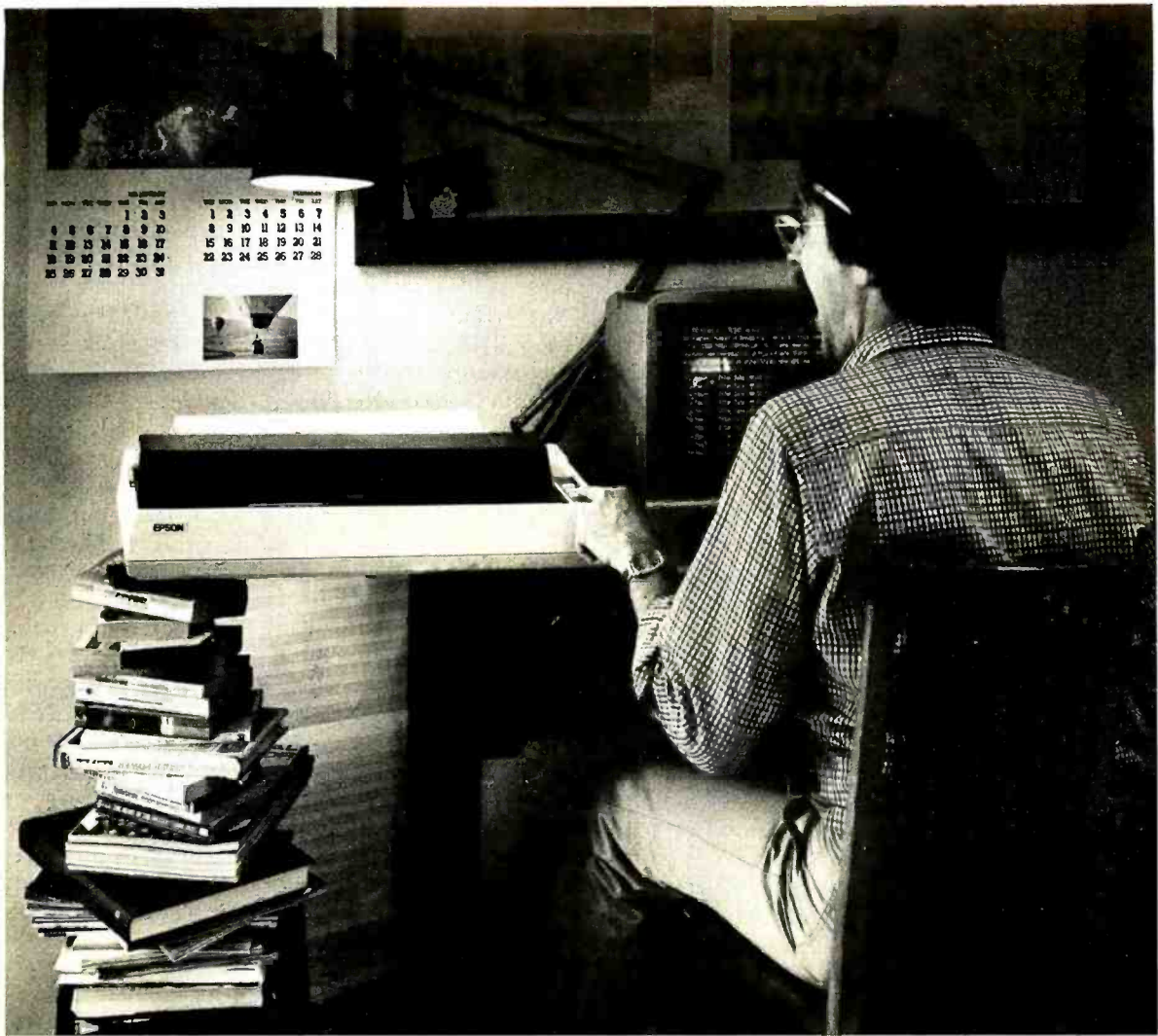


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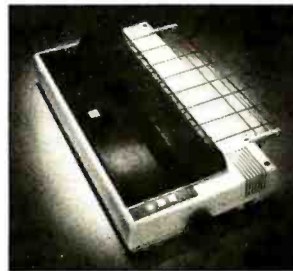
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Text continued from page 282:

contains 8. The next 8 characters are the exact line as typed: *bTEST.PD*. This buffer may now be scanned for valid commands by the user program; listing 4 illustrates a method of doing this.

If a second file name and file type had been specified, they would have been placed in the second 16 bits of the default FCB and written into the buffer. Any data placed in the buffer or FCB in this manner must be read by the user program before doing any disk access, or it will be lost. The first file name/file type may be left in the default FCB, but the second one must be moved elsewhere before accessing any file utilities (including directory utilities). In listing 4, valid commands are searched for, then the file type .DEM is placed in the FCB and bytes 12 thru 15 and 32 are zeroed. The file may now be opened and accessed.

Listing 4 illustrates one other important point about the FCB: the method of creating additional FCBs. TFCB1 is thirty-three reserved locations that serve as a second FCB in the same manner as the default FCB. The file name is moved into bytes 1 thru 8, the file type .RES is placed in bytes 9 thru 11, and the remaining bytes are defined in a similar manner to the default FCB. Using this method, additional FCBs may be created as needed. The address of the FCB of the file to be operated on is sent in the call to the CP/M entry point in register pair DE.

One other important consideration in actually reading and writing to a disk file is the need to set the DMA (direct memory access) address. This is the beginning memory address for the next disk access. The 128-byte record read from (or written to) the disk is placed into (or taken from) memory beginning at this location. When the disk system is initialized, using functions 13 or 14, the DMA address is set to hexadecimal 0080, the default buffer. It is possible to read one record to this buffer and then transfer the data to where it is needed; however, there is a simpler way illustrated in listing 4. Set the DMA address to the desired destination address and read a record. Put this function in a loop to read an entire file. Files may also be written in a similar manner (see listing 4).

Possibilities

In the course of experimenting with CP/M—trying to discover the hidden meaning in commands not thoroughly explained in the manuals—I discovered a few interesting features. These features often have no explanation in the manual. First, the directory of any disk can be read by placing ???????? and ??? in the file-name and file-type bytes of an FCB, then doing a SEARCH and SEARCH NEXT (functions 17 and 18). These two functions write directory information into the default buffer at hexadecimal location 0080, where it may be accessed for printout.

The OPEN function first finds a file name/file type match, then copies the disk map into the FCB. If a disk map is supplied with an extent, record count, and next record, the READ or WRITE functions will work without first using OPEN. The CLOSE statement merely matches the file name/file type and writes the FCB disk map to the directory.

These last two items should suggest some interesting but dangerous possibilities. The fact that CP/M marks a file as deleted by placing the hexadecimal character E5 in the entry-type field suggests a possible way to protect a file simply by making it disappear. The FCB still appears in the directory, but no longer matches any search string. This one needs more experimentation, since writing to a disk with files erased in this manner can result in destroying files only meant to be hidden.

Conclusion

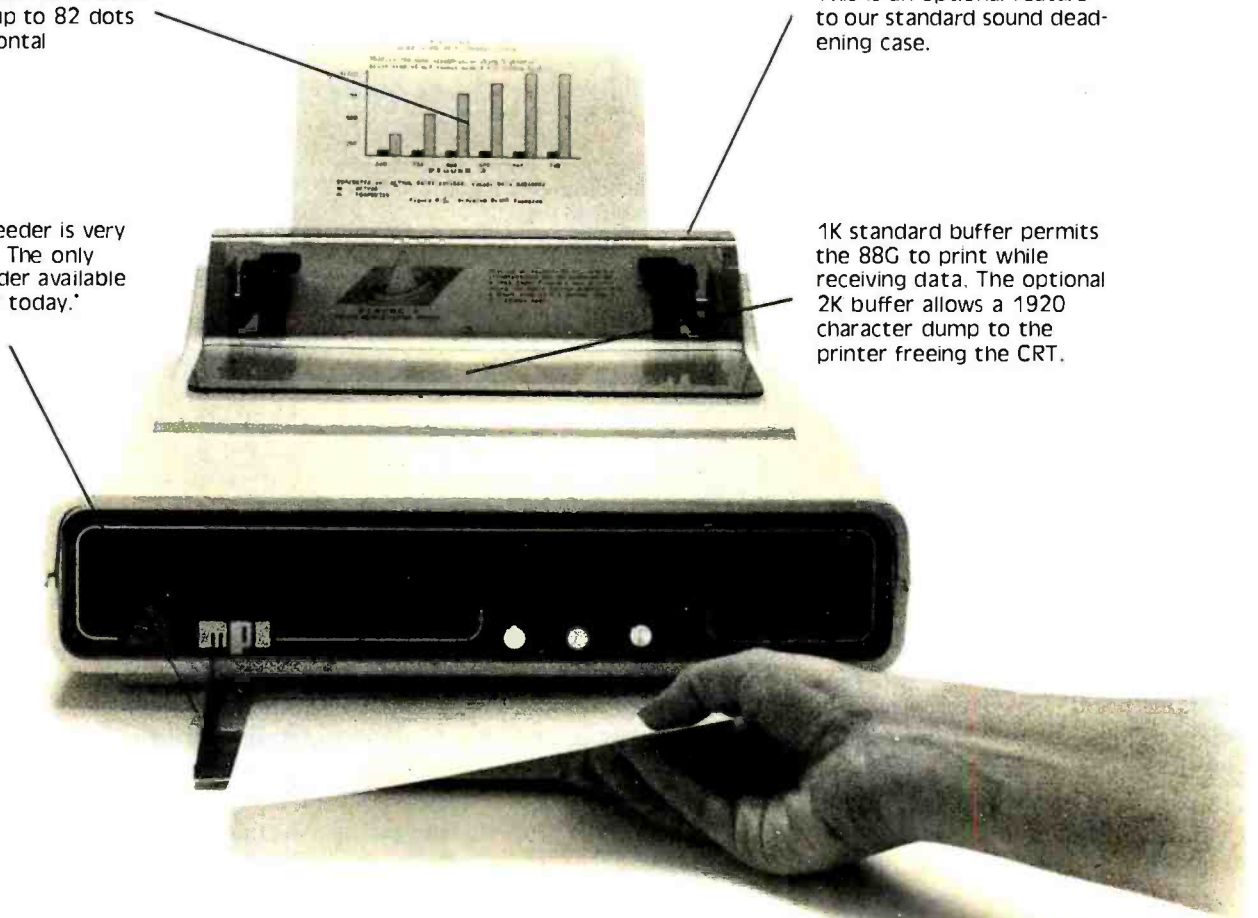
This article has presented the use of the CP/M-utility routines, typical calling sequences, applications sub-routines, sent and returned values, and examples of their uses. Although written specifically for CP/M, it illustrates the general method of using utility routines supplied with an operating system. In addition, some possibilities for further experimentation with CP/M have been suggested. It is not meant to supplant the Digital Research manuals, but to supplement and clarify a portion of them. You should refer to the manuals for additional information. ■

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Build a Super Simple Floppy-Disk Interface

Part 2: Software

James Nicholson and Roger Camp
1046 Gaskill
Ames IA 50010

The first part of this article presented basic floppy-disk technology and a description of a simple controller design with its circuit details. This controller provides a great deal of function and flexibility when combined with some simple software.

Software

The software shown in listing 1 provides disk-formatting, reading, writing, and error-recovery functions. The software can be reassembled to allow relocation of program or page zero variables. Various entry points are shown in table 4.

Before using the FD1771 to read and write data within the sectors on the floppy disk, the disk must be formatted to conform to a certain structure. A program (entry point FORMAT) is supplied that formats all 77 tracks of a standard 8-inch disk in a standard IBM-compatible 128-bytes-per-sector arrangement (each track contains 26 sectors).

The program, when called, initializes all 6520 and 1771 electronic interfaces before writing the standard track. The initialization process guarantees that the head is positioned over the outermost track. Each track is written from a standard pattern contained in programmable memory. A 40 ms delay is generated following a step-in function to move the head to the next track. This guarantees the proper head-settling time required by the floppy-disk drive. This process

continues until all tracks have been formatted.

Sector sizes other than 128 bytes can be selected by initializing the 1771 differently. (A sector size other than 128 can lead to incompatibilities with other floppy-disk systems.) For sector lengths greater than 128, the FORMAT program must be rewritten to use an entire track image in memory. This is required because of an indexing limit of 256 using the 6502 microprocessor. Our system, using sixteen 256-byte sectors per track, has proven to be a convenient alternative.

When a disk is properly formatted, the basic I/O (input/output) program (entry point FDENT) can be used. If the system has just been turned on, entry point FDENT should be called first to initialize all interface and drive electronics. To perform disk

operations, certain variables must be set up before calling FDENT. They include the desired *command*, *track number*, and *sector number*, as well as the address in memory used for data transfer (see table 5).

The program begins by analyzing the command to determine which segment of the program must be used in response. There are three basic command types:

- head movement
- read/write sectors
- read/write raw tracks

In the case of read/write commands, the program ascertains if the head is positioned properly and, if necessary, provides the seek command to move it.

Following execution of the command by the 1771, completion

Name	Purpose
FORMAT	Write proper track format on all 77 tracks
FDINT	Initialize 6520 and 1771 interface
FDENT	Perform basic floppy-disk operations using established variables
FDIO	Uses FDENT, followed by error checking and retry

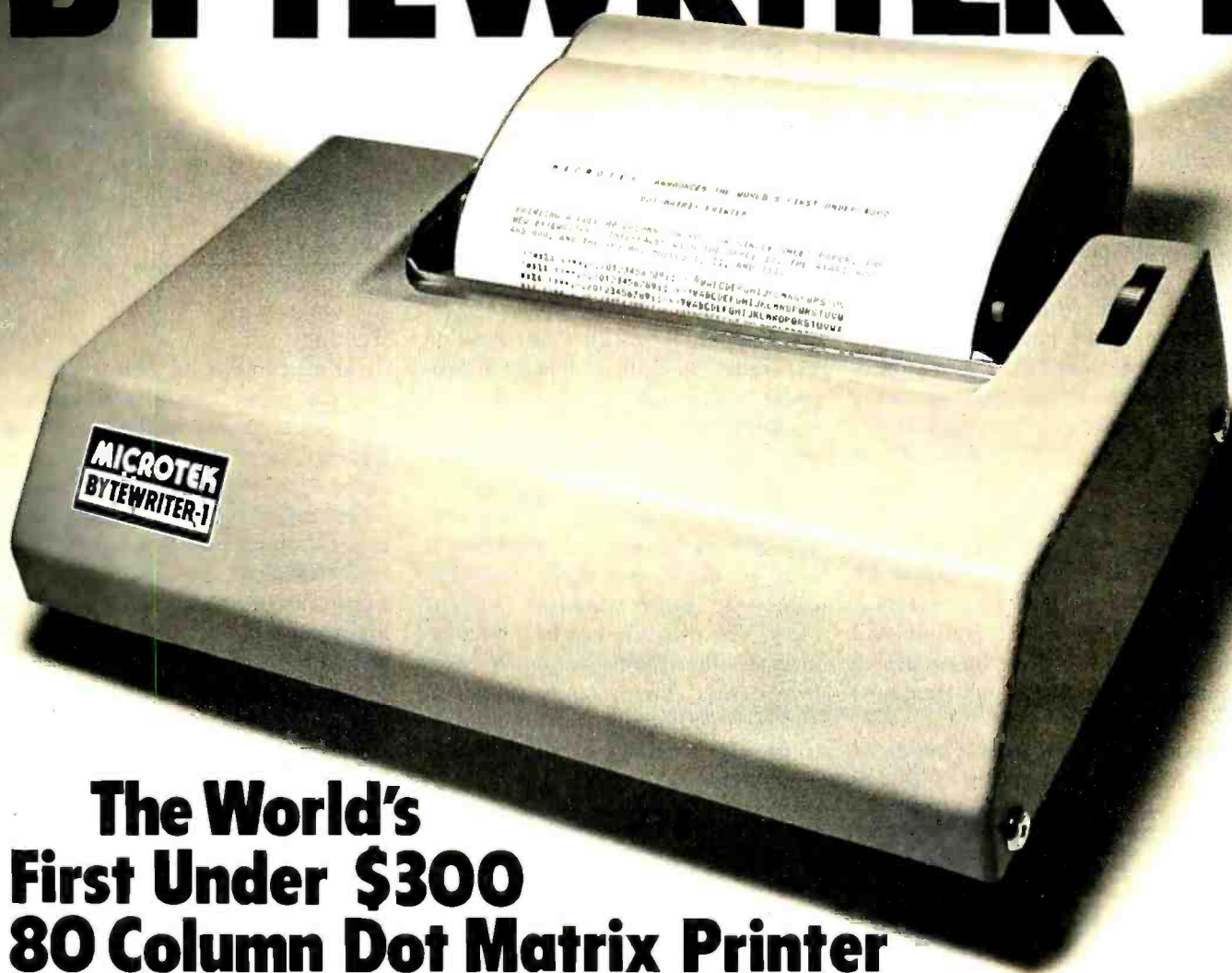
Table 4: Entry points for various floppy-disk controller operations.

Name	Length in Bytes	Purpose
DVCODE	1	Device-selection byte 00 = DVC 0, 80 = DVC 1
ERRCODE	1	FF = Error, 00 = Normal Set by FDIO
COMMAND	1	1771 Command byte
STATUS	1	1771 Completion status
TRACK	1	Desired track value
SECTOR	1	Desired sector value
FDBUF	2	Address of data buffer

Table 5: Variables used to perform floppy-disk operations. All values are listed in hexadecimal.

The numbering of all nontext material is continued from part 1 of this article.

BYTEWRITER-1



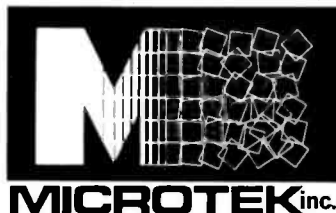
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analysis is performed to read back and store the status, track number, and sector number from the 1771. The status can then be examined by the user program to determine if the operation was successful. No registers are saved by any of the routines previously discussed.

Although the hardware design has proven to be very reliable, an error occasionally occurs. Since it would be a great burden for each application to concern itself with error recovery, another program has been provided. Using entry point FDIO, a user program can add the error-recovery function to that provided by FDENT.

After storing all the registers, FDIO calls FDENT to perform the requested operation. Following completion, FDIO examines the status to determine if an error occurred, and, if so, the operation may be retried. Generally, read/write operations will be retried up to five times before assuming a "hard" (ie: nontransient) error.

A nonrecoverable error is indicated with hexadecimal FF in the ERRCD

COMMAND	TRACK	Variables (all values in hexadecimal)			TEST
		SECTOR	BUFADR	BUFADR + 1	
02	—	—	—	—	RESTORE
1A	20	—	—	—	SEEK
16	10	—	—	—	VERIFY
8C	10	01	00	10	READ

Table 6: Values to be set in variables for testing the controller (with the routine in listing 3). All values are listed in hexadecimal.

variable (see listing 2). This condition generally causes the application program to terminate so the error can be researched. The STATUS variable provides details about the specific problem.

Certain nonrecoverable conditions will not be retried. For example, a *busy* or *device not ready* condition causes an error condition without retry. The program can be altered to increase the sophistication to any level desired. Errors can be cataloged and recorded on another floppy disk to provide a history of all abnormal conditions.

Testing

After completing construction of the controller circuit and verifying the proper timing of the 74123 components, some simple tests can be performed to verify proper operation. These tests can be conducted with the aid of a simple program (listing 3) and table (table 6). Set your monitor to begin execution at INIT. When the break occurs, set the variables as shown for each specific test and allow program execution to continue. This procedure requires you to load the software previously discussed. Initial testing requires a *preformatted* IBM-compatible disk. Examination of the status byte following each test helps diagnose any existing problems.

The restore-drive procedure should generate stepping pulses that move the head to the track 0 position. The head-drive lead screw can be moved manually off the track 0 position to verify proper operation.

Directing the head to seek to a specific track requires the desired track value to be set in the data register of the 1771. This test also loads the head but does not attempt to perform a track verification. This test can be repeated several times with different track values to determine if the 1771 properly seeks in both directions.

If the controller moves the head correctly, the third test performs a track verification. Following the seek movement, the head is loaded, and the 1771 reads the address information recorded on the track to verify that it has located the proper track.

The fourth test attempts to read a specific sector. The data is stored beginning at location hexadecimal

Text continued on page 340

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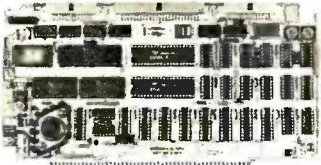
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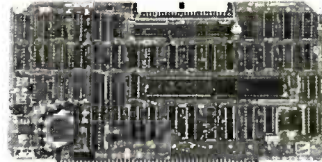
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 - 16 VDC @ 25 ma
- Built-in parity with LED indicator and vector interrupt
- Memory addressable in four 16K banks
- Hidden refresh
- Gold contacts for high reliability
- 72 hour Burn-in
- 15 hours mapped via DIP switch
- Built-in programmable wire probed
- Programmable control port for parity and bank control
- Alpha Micro Cleanmate

INFLATION FIGHTER

4116's (200 ns.)
Apple, TRS-80, Heath
8 for \$20⁰⁰

16-49 \$2.35
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100 Up \$2.15

2114 L-2/200 NS

1-16 \$3.05 ea.
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COMPONENTS

74LS240 1.25 ea.
74LS241 1.10 ea.
74LS244 1.25 ea.
74LS373 1.25 ea.
74LS374 1.25 ea.
8T245 1.45 ea.

2708/450 NS

\$4.75 ea.

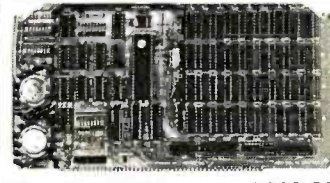
OR

8/\$36⁰⁰

2716/5 VOLT

\$6.95 ea.

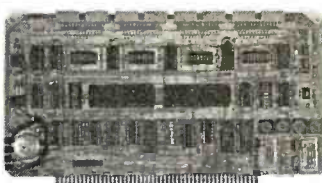
Major Manufacturer



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Assembled & Tested
CPM Available (Optional)

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- DMAC within 16M byte of memory
- State of the art NEC75C LSI Controller
- IEEE S-100 compatible
- DMAC operation allows use of multiple boards within a system
- PLL data recovery for totally reliable operation
- Write pre-compulsed at mid disc for reliable double density operation
- Supports up to four disk drives
- Power On, Power Off or Reset del. selects pre- or post-damaging files
- Drive select. Time Out detected drives not in use
- Single or double sided operation
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- 8" Standard drives
- Separate VCC supply for dual rec. elim. all possible noise problems



I/O Board \$289.00
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- Quad RS-232C Serial Ports, One 20mA Current Loop Port
- Fully IEEE S-100 Bus Compatible
- Asynchronous Communications with Z80A Data/IO or Synchronous Communications with Z80A SIO/DM
- Full Serial Modem Control Signals including RI (Ring Indicator)
- Easily Configurable to Any Type of Terminal Interface
- I/O Sensing Environments: (1) Polled, (2) Bus Vector, (3) Z80 Mode 2 Vector
- On Board Interrupt Daisy Chain Capability
- Special Receive Conditions: (1) Framing Error, (2) Parity Error, (3) Receiver Overrun Error
- Baud Rates Selectable Individually from 50 Baud to 3000 Baud
- 72 Hour Burn-In

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EXPANDRAM I 16K \$240.00
2MHZ DYNAMIC RAM BOARD KITS 32K \$260.00
48K \$280.00
64K \$300.00

EXPANDRAM II 16K \$250.00
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S-100 BUS COMPATIBLE

VERSAFLOPPY II KIT \$350.00
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 - 2065 64K DYNAMIC RAM BRD.
 - 2116 16K STATIC RAM BRD.
 - 2200 MAINFRAME
 - 2422 DISK CONTROLLER
 - 2501 MOTHERBOARD
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 - 2718 2 SER. PORT & 2 PAR.
 - 2720 4-PORT PARALLEL I/O
 - 2802 6502 CPU BOARD
 - 2810 Z-80 CPU BOARD
 - 7114A 12K ROM/PROM BRD.
 - 7424A CALENDAR CLOCK BRD.
 - 7440A PROGRAMMABLE TIMER
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 - 7712A SERIAL SYNCH. BOARD
 - 7720A PARALLEL INTERFACE
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Ceramic
8¢ ea.

OR
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CONNECTORS

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GOLD/S-100
SOLDER TAIL
\$2.40 ea.
OR
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14 PIN .10	.09
16 PIN .12	.11
18 PIN .15	.13
20 PIN .23	.21
24 PIN .26	.24
28 PIN .30	.28
40 PIN .40	.38
(BURN/DY/TIN SOLDER TAIL)	

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ANADEX DP8000
ANADEX DP9500
ANADEX DP9501
TEXAS INST 810
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830	Acoustic Modem	\$ 159.00
850	Interface Module	\$ 175.00
CX853	16K RAM Module	\$ 140.00
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- Double-sided/Single-Double Density
 - IBM-compatible 1.2 Mbytes/Disk
 - Fast — 3 ms. Track to Track
 - 154 Tracks/Daisy Chain 4 Drives
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	Part #	Price Box of 10
Verbatim 5 1/4" (soft)	MD525-01	\$26.50
Scotch 5 1/4" (soft)	744-0	\$33.00
Scotch 5 1/4" (10-sec)	744-10	\$33.00
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Scotch 8" DS (soft)	743-0	\$49.95
Maxell 8" DS/DD	FD-2D	\$55.00

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MODEL X5 — Desktop Mainframe — 5 Cards — Small Power Supply \$200
Cabinet size: 9 1/2" x 15 1/2" x 11 1/2" Cabinet painted dove grey, front panel is black. No optional colors! 5 position motherboard, 5 connectors installed, card cage with all guides, Reset switch on front panel, Power switch, 4 DB25 outputs, 1 BNC mounting hole, 70CFM fan, EMI filter, 6" power cord, line fuse, and clamped flat cable exit on rear panel. P/S4 power supply (+8@10A, +16@1 5A, -16@1 5A) Power supply is a removable module.

MODEL 7000 — Horizontal Desktop Disk/Cover — 2 Eight Inch Drives — Drives Horizontal \$250
Cabinet size: 20" x 23" x 7 1/2" Cabinet painted dove grey, front panel is black. Mounting for 2 eight-inch Shugart SA801R Floppy Disk Drives (or mechanical equivalent). Drive mounting brackets supplied. Drives not supplied. 70CFM fan, 6" three-wire line cord, power switch, line fuse, EMI filter and clamped flat cable exit on rear panel. P/S4 power supply (+5@4A, +24@5A—6A Peak, -5@ 75A All voltages regulated. Power supply is a removable module.

MODEL 8000 — Desktop Main/Frame — 15 Cards — Standard Power Supply \$255
Cabinet size: 17" x 20 1/2" x 11 1/2" Cabinet painted dove grey, front panel is black (other color schemes optional). 15-position IEEE compatible motherboard (will accept T801 terminator kit, optional), card cage with all guides, Reset switch on front panel, Power switch, 8 DB25 outputs, 2 BNC mounting holes, 70CFM fan, EMI filter, 6" power cord, line fuse, and clamped flat cable exit on rear panel. P800 power supply (+8@15A, +16@3A, -16@3A). Power supply is a removable module. Motherboard connectors optional.

MODEL 7000S — Vertical Desktop Disk/Cover — 2 Eight Inch Drives — Drives Vertical \$250
Cabinet size: 13 1/2" x 23" x 11 1/2" Cabinet painted dove grey, front panel is black. Mounting for 2 eight-inch Shugart SA801R Floppy Disk Drives (or mechanical equivalent). Drive mounting brackets supplied. Drives not supplied. 70CFM fan, 6" three-wire line cord, power switch, line fuse, EMI filter and clamped flat cable exit on rear panel. P/S4 power supply (+5@4A, +24@5A—6A Peak, -5@ 75A All voltages regulated. Power supply is a removable module.

Listing 1: Software to provide fundamental high-level operations for the disk controller (written for the 6502 microprocessor).

```

FD400/FD1771B FLOPPY DISK CONTROL                                PAGE 1
CARD # LOC      CODE      CARD 10      20      30      40      50      60      70
 2 0000          ;          .OPT CNT,XREF,MEM,LIST,ERR,GEN
 3 0000          ;
 4 0000          ; J.H.NICHOLSON 1-22-79
 5 0000          ;
 6 0000          ;
 7 0000          ; THIS SEGMENT PROVIDES BASIC CONTROL FUNCTIONS FOR EXECUTING
 8 0000          ; COMMANDS TO A PERTEC FD400 FLOPPY DISK DRIVE CONTROLLED WITH
 9 0000          ; A WESTERN DIGITAL FD1771B-01 FLOPPY DISK CONTROLLER. THE BASIC
10 0000          ; ROUTINES PROVIDE AN INTERFACE VIA A 6520 PIA TO THE FD400/FD1771B
11 0000          ; SYSTEM.
12 0000          ; THE FD1771B COMMAND, TRACK, AND SECTOR VALUES ARE PROVIDED IN
13 0000          ; PAGE ZERO VARIABLES. THE COMMAND AND OTHER NECESSARY DATA IS
14 0000          ; WRITTEN TO THE FD1771B AND THE COMMAND IS EXECUTED. FOLLOWING
15 0000          ; THE COMPLETION OF THE COMMAND(INTRQ FROM FD1771B) THE STATUS,
16 0000          ; TRACK, AND SECTOR VALUES ARE READ FROM THE FD1771B. NO ERROR
17 0000          ; RECOVERY IS PERFORMED BY THIS SEGMENT. IF THE DEVICE IS BUSY
18 0000          ; WHEN THIS SEGMENT IS GIVEN CONTROL, NORMAL COMPLETION ANALYSIS
19 0000          ; WILL BE DONE.
20 0000          ; TWO ENTRY POINTS TO THIS SEGMENT PROVIDE COMMAND EXECUTION AND
21 0000          ; PIA INITIALIZATION.
22 0000          ; FDINT.....ENTRY FOR FD1771B COMMAND EXECUTION.
23 0000          ; FDINT.....ENTRY FOR INITIALIZATION OF FD400/FD1771B.
24 0000          ;
25 0000          ;
26 0000          ; ALL FD1771B COMMANDS ARE VALID AND ARE LISTED BELOW BY FUNCTIONAL
27 0000          ; CATAGORY AS WELL AS TYPE GROUPS.
28 0000          ;
29 0000          ; BASIC : RESTORE          TYPE 1.  RESTORE
30 0000          ;          STEP          SEEK
31 0000          ;          STEP IN       STEP
32 0000          ;          STEP OUT      STEP IN
33 0000          ;          FORCE INTRQ    STEP OUT
34 0000          ;
35 0000          ; READ  : READ SECTOR     TYPE 2.  READ SECTOR
36 0000          ;          READ TRACK    WRITE SECTOR
37 0000          ;          READ ADDR
38 0000          ;          TYPE 3.  READ ADDR
39 0000          ; WRITE : WRITE SECTOR   READ TRACK
40 0000          ;          WRITE TRACK   WRITE TRACK
41 0000          ;
42 0000          ; SEEK  : SEEK          TYPE 4.  FORCE INTRQ

```

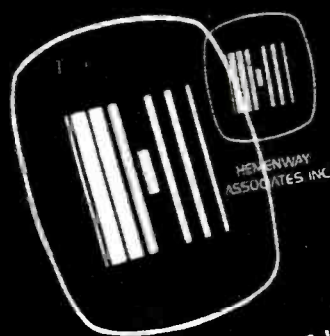
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FD400/FD1771B FLOPPY DISK CONTROL                                PAGE 2
CARD # LOC      CODE      CARD 10      20      30      40      50      60      70
44 0000          ;
45 0000          ;
46 0000          ; WHEN GIVEN CONTROL, THIS SEGMENT ANALYZES THE COMMAND TYPE
47 0000          ; TO DETERMINE THE FUNCTIONS WHICH MUST BE PERFORMED. THE COMMANDS
48 0000          ; CAN BE SEGMENTED INTO FOUR LOGICAL FUNCTION GROUPS WHICH ARE
49 0000          ; SIMILAR TO THE FD1771B COMMAND TYPES.
50 0000          ;
51 0000          ;
52 0000          ; CMD TYPE          FUNCTION
53 0000          ; -----          -----
54 0000          ; TYPE 1(EX.SEEK)  BASIC FUNCTION
55 0000          ;
56 0000          ; TYPE 1(SEEK)     WRITE NEW TRACK, THEN BASIC
57 0000          ;
58 0000          ; TYPE 2           WRITE SECTOR REGISTER
59 0000          ;                   SPLIT TO READ OR WRITE
60 0000          ;
61 0000          ; TYPE 3           SPLIT TO READ OR WRITE
62 0000          ;
63 0000          ; TYPE 4           BASIC FUNCTION
64 0000          ;

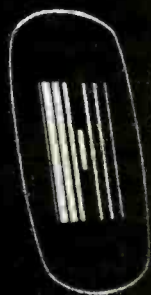
```

Listing 1 continued on page 308

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Listing 1 continued:

```

65 0000 ;
66 0000 ; BASIC FUNCTION :
67 0000 ; 1. WRITE COMMAND TO THE FD1771B.
68 0000 ; 2. WAIT FOR COMPLETION(INTRQ).
69 0000 ; 3. COMPLETION ANALYSIS(READ STATUS, TRACK, AND SECTOR)
70 0000 ; 4. EXIT
71 0000 ;
72 0000 ; SEEK FUNCTION :
73 0000 ; 1. WRITE NEW TRACK TO DATA REGISTER.
74 0000 ; 2. WRITE SECTOR TO SECTOR REGISTER.
75 0000 ; 3. GO TO BASIC FUNCTION.
76 0000 ;
77 0000 ; READ FUNCTION :
78 0000 ; 1. SEEK TO PROPER TRACK IF NECESSARY
79 0000 ; 2. WRITE SECTOR TO SECTOR REGISTER.
80 0000 ; 3. WRITE COMMAND TO FD1771B.
81 0000 ; 4. WAIT & LOOP FOR DRQ/INTRQ READING DATA ON DRQ.
82 0000 ; 5. ON INTRQ DO COMPLETION ANALYSIS(BASIC FCTN, STEP 3)
83 0000 ;
84 0000 ; WRITE FUNCTION :
85 0000 ; 1. SEEK TO PROPER TRACK IF NECESSARY
86 0000 ; 2. WRITE SECTOR TO SECTOR REGISTER.
87 0000 ; 3. WRITE COMMAND TO FD1771B.
88 0000 ; 4. WAIT & LOOP FOR DRQ/INTRQ WRITING DATA ON DRQ.
89 0000 ; 5. ON INTRQ DO COMPLETION ANALYSIS(BASIC FCTN, STEP 3)

```

FD400/FD1771B FLOPPY DISK CONTROL

CARD #	LOC	CODE	CARD 10	20	30	40	50	60	70
91	0000								
92	0000		***** 6520 PIA						
93	0000								
94	0000	SADD	=%CC0C		6520 PIA A DATA DIRECTION				
95	0000	SAD	=%CC0C		6520 PIA A DATA REGISTER				
96	0000	CRA	=%CC0D		6520 PIA A CONTROL REGISTER				
97	0000	SBDD	=%CC0E		6520 PIA B DATA DIRECTION				
98	0000	SBD	=%CC0E		6520 PIA B DATA REGISTER				
99	0000	CRB	=%CC0F		6520 PIA B CONTROL REGISTER				
100	0000								
101	0000		***** PIA CONNECTIONS						
102	0000								
103	0000		CA1	<--	UNUSED				
104	0000		CA2	-->	PULSE(-RE CLR)				
105	0000		PA7	<-->	DAL7				
106	0000		PA6	<-->	DAL6				
107	0000		PA5	<-->	DAL5				
108	0000		PA4	<-->	DAL4				
109	0000		PA3	<-->	DAL3				
110	0000		PA2	<-->	DAL2				
111	0000		PA1	<-->	DAL1				
112	0000		PA0	<-->	DAL0				
113	0000								
114	0000		PB7	<--	INTRQ				
115	0000		PB6	<--	DRQ				
116	0000		PB5	-->	READ				
117	0000		PB4	-->	WRITE				
118	0000		PB3	-->	-MR				
119	0000		PB2	-->	A1				
120	0000		PB1	-->	A0				
121	0000		PB0	-->	-ENABLE R/W				
122	0000		CB1	<--	UNUSED				
123	0000		CB2	-->	DEVICE SELECT				
124	0000								
125	0000		***** FD1771B COMMANDS						
126	0000								
127	0000	FDRST	=%02		RESTORE				
128	0000	FDSK	=%12		SEEK				
129	0000	FDST	=%22		STEP				
130	0000	FDSTI	=%42		STEP IN				
131	0000	FDSTO	=%62		STEP OUT				
132	0000	FDRD	=%80		READ SECTOR				
133	0000	FDWT	=%A0		WRITE SECTOR				

Listing 1 continued on page 310



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Listing 1 continued:

```

134 0000      FDRDA  = $C4          READ ADDRESS
135 0000      FDRDT  = $E4          READ TRACK
136 0000      FDWTT  = $F4          WRITE TRACK
137 0000      FDFI   = $D0          FORCE INTERRUPT
138 0000      ;
139 0000      ; ***** COMMAND QUALIFIERS
140 0000      ;
141 0000      QV     = $04          VERIFY
142 0000      QH     = $08          LOAD HEAD
143 0000      QU     = $10          UPDATE TRK REG
144 0000      QM     = $10          MULTIPLE RECORDS
145 0000      QB     = $08          IBM FORMAT

```

FD400/FD1771B FLOPPY DISK CONTROL

PAGE 4

CARD #	LOC	CODE	CARD 10	20	30	40	50	60	70
146	0000	QS	=\$01			NOT SYNC TO AM			
147	0000	QI0	=\$01			NR TO R TRANS.			
148	0000	QI1	=\$02			R TO NR TRANS.			
149	0000	QI2	=\$04			INDEX PULSE			
150	0000	QI3	=\$08			EACH 10 MS.			
151	0000	QE	=\$04			ENABLE HLD + HLT DELAY			
152	0000	QFB	=\$00			FB DATA MARK			
153	0000	QFA	=\$01			FA DATA MARK			
154	0000	QF9	=\$10			F9 DATA MARK			
155	0000	QF8	=\$11			F8 DATA MARK			
156	0000	;							
157	0000	;	***** INITIALIZATION CTL BYTES						
158	0000	;							
159	0000	QCRC	=\$F7			WRITE CRC			
160	0000	QIAM	=\$FC			INDEX ADDR MARK			
161	0000	QIDM	=\$FE			ID ADDR MARK			
162	0000	QAFB	=\$FB			FB DATA MARK			
163	0000	QAFA	=\$FA			FA DATA MARK			

Listing 1 continued on page 312

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Mountain Hardware		
AC Control Apple	132.00	189.00
AC Remote	95.00	149.00
S-100 AC Control Kit	104.00	149.00
AC Remote Kit	67.00	99.00
AC Control-Apple Kit	104.00	145.00
Micromation Dual Memorex 8" disk drive	1467.00	1990.00
Micromation Dual Density disk controller Card	310.00	500.00
MS Corp. Apple FR-40 Interface	87.00	87.00
National Multiplex Digital Cassette Recorder	150.00	200.00
Novation 1200 Baud Modem (4202T)	274.00	375.00
Radio Shack TRS-80 Disk Drive	399.00	499.00
TRS-80 16K Computer	479.00	599.00
TRS-80 Expansion Interface	239.00	299.00

Polymorphic Systems		
8K Assembled	289.00	385.00
8K Memory Board	225.00	300.00
Poly KBD	169.00	225.00
8813	2880.00	3250.00
88-System 2	529.00	735.00
System 12 Kit	846.00	1128.00
System 6	1134.00	1575.00
Video Card	210.00	280.00
Processor Tech		
8K Dynamic Ram	175.00	250.00
16K Dynamic Ram	300.00	429.00
64K Dynamic Ram	878.00	1350.00
Extended Basic Cassette	21.00	45.00
SOL 20 W/O Memory	1270.00	1895.00
System II Kit	1262.00	1905.00
Panasonic Monitor	143.00	210.00
SD Sales 32K Dynamic Ram Board Kit	332.00	475.00
Solid State Music 16K Static Ram Board Kit	300.00	325.00
Southwest Technical (SWTPC)		
MF-68 Dual 5" Floppy	796.00	995.00
Graphics Terminal	79.00	98.50
Technical Design Labs (TDL-Xitan)		
I/O board - SMB-II	257.00	395.00
32L Series K Memory Board	559.00	799.00
Fortran IV Ser.37	279.00	349.00
Fortran IV Ser.41	279.00	349.00
Xitan Alpha 1.5	823.00	1138.00
Xitan Alpha 1	576.00	769.00
Xitan Alpha 3	854.00	1181.00
Xitan Alpha 1.5	571.00	868.00
Video Board	277.00	369.00
Technico Super Starter Assembled	293.00	300.00
Technico Super Starter Kit	199.00	299.00
Trace Elec. 32K RAM Board Assem	599.00	999.00

MULTI-USER OASIS HAS THE FEATURES PROS DEMAND. READ WHY.

Computer experts (the pros) usually have big computer experience. That's why when they shop system software for Z80 micros, they look for the big system features they're used to. And that's why they like Multi-User OASIS. You will too.

DATA INTEGRITY: FILE & AUTOMATIC RECORD LOCKING

The biggest challenge for any multi-user system is co-ordinating requests from several users to change the same record at the same time.

Without proper co-ordination, the confusion and problems of inaccurate or even destroyed data can be staggering.

Our File and Automatic Record Locking features solve these problems.

For example: normally all users can view a particular record at the same time. But, if that record is being updated by one user, automatic record locking will deny all other users access to the record until the up-date is completed. So records are always accurate, up-to-date and integrity is assured.

Pros demand file & automatic record locking. OASIS has it.

SYSTEM SECURITY: LOGON, PASSWORD & USER ACCOUNTING

Controlling who gets on your system and what they do once they're on it is the essence of system security.

(THEN COMPARE.)

Without this control, unauthorized users could access your programs and data and do what they like. A frightening prospect isn't it?

And multi-users can multiply the problem.

But with the Logon, Password and Privilege Level features of Multi-User OASIS, a system manager can specify for each user which programs and files may be accessed—and for what purpose.

Security is further enhanced by User Accounting—a feature that lets you keep a history of which user has been logged on, when and for how long.

Pros insist on these security features. OASIS has them.

EFFICIENCY: RE-ENTRANT BASIC

A multi-user system is often not even practical on computers limited to 64K memory.

OASIS Re-entrant BASIC makes it practical.

How? Because all users use a single run-time BASIC module, to execute their compiled programs, less

memory is needed. Even if you have more than 64K, your pay-off is cost saving and more efficient use of all the memory you have available—because it services more users.

Sound like a pro feature? It is. And OASIS has it.

AND LOTS MORE...

Multi-User OASIS supports as many as 16 terminals and can run in as little as 56K memory. Or, with bank switching, as much as 784K.

Multi-Tasking lets each user run more than one job at the same time.

And there's our BASIC—a compiler, interpreter and debugger all in one.

An OASIS exclusive.

Still more: Editor; Hard & Floppy Disk Support; Keyed (ISAM), Direct & Sequential Files; Mail-Box; Scheduler; Spooler; all from OASIS.

Our documentation is recognized as some of the best, most extensive, in the industry. And, of course, there's plenty of application software.

Put it all together and it's easy to see why the real pros like OASIS. Join them. Send your order today.

OASIS IS AVAILABLE FOR SYSTEMS: Altos; CompuCorp; Cromemco; Delta Products; Digital Group; Digital Microsystems; Dynabyte; Godbout; IBC; Index; Intersystems; North Star; Onyx; SD Systems; TRS 80 Mod II; Vector Graphic; Vorimex

CONTROLLERS: Bell Controls; Cameo; Corvus; Konan; Micromation; Micropots; Tarbell; Teletek; Thinkertoys; X Comp

Write for complete, free Application Software Directory.

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Product	Price with Manual	Manual Only
OPERATING SYSTEM (Includes: EXEC Language; File Management; User Accounting; Device Drivers; Print Spooler; General Text Editor; etc.) SINGLE-USER MULTI-USER	\$150 350	\$17.50 17.50
BASIC COMPILER/INTERPRETER/DEBUGGER	100	15.00
RE-ENTRANT BASIC COMPILER/INTERPRETER/DEBUGGER	150	15.00
DEVELOPMENT PACKAGE (Macro Assembler; Linkage Editor; Debugger)	150	25.00
TEXT EDITOR & SCRIPT PROCESSOR	150	15.00
DIAGNOSTIC & CONVERSION UTILITIES (Memory Test; Assembly Language; Converters; File Recovery; Disk Test; File Copy from other OS; etc.)	100	15.00
COMMUNICATIONS PACKAGE (Terminal Emulator; File Send & Receive)	100	15.00
PACKAGE PRICE (All of Above) SINGLE-USER MULTI-USER	500 850	60.00 60.00
FILE SORT	100	15.00
COBOL-ANSI '74	750	35.00

Order OASIS from:

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7700 Edgewater Drive, Suite 830
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(Attach system description; add 53 for shipping; California residents add sales tax)
 Check enclosed VISA
 UPS C.O.D. Mastercharge
Card Number _____
Expiration Date _____
Signature _____



MAKES MICROS RUN LIKE MINIS

Listing 1 continued:

```

164 0000 QAF9  =F9          F9 DATA MARK
165 0000 QAF8  =F8          F8 DATA MARK
166 0000 ;
167 0000 ; ***** PIA CONTROL COMMANDS(-MR ON)
168 0000 ;
169 0000 READ   =$29          READ FD1771B
170 0000 WRITE  =$19          WRITE FD1771B
171 0000 STAT   =$00          A1=0,A0=0  STATUS REGISTER
172 0000 TRK    =$02          A1=0,A0=1  TRACK REGISTER
173 0000 SECT   =$04          A1=1,A0=0  SECTOR REGISTER
174 0000 DATA  =$06          A1=1,A0=1  DATA REGISTER
175 0000 CMD    =$00          A1=0,A0=0  COMMAND REGISTER
176 0000 ;
177 0000 ; ***** PAGE ZERO VARIABLES/EQUATES
178 0000 ;
179 0000 TIME1  *=*+1
180 0001 TIME2  *=*+1
181 0002      *=E0
182 00E0 DVCODE *=*+1          DVC/FILE CODE
183 00E1 ERRCD  *=*+1          ERROR CODE
184 00E2 COMAND *=*+1  FD1771B COMMAND
185 00E3 STATUS *=*+1          STATUS
186 00E4 TRACK  *=*+1          TRACK
187 00E5 SECTOR *=*+1          SECTOR
188 00E6 FDBUF *=*+2          BUFFER PTR
189 00E8 ;
190 00E8      *=E200

```

FD400/FD1771B FLOPPY DISK CONTROL

PAGE 5

CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
192	0200									
193	0200									
194	0200									
195	0200	A5 E2	TYPE1	LDA	COMAND	IF NOT SEEK				
196	0202	C9 20		CMP	#\$20	ASSUME				
197	0204	B0 3A		BCS	BASIC	BASIC				
198	0206	C9 10		CMP	#\$10	IF RESTORE				
199	0208	90 36		BCC	BASIC	ASSUME BASIC				
200	020A	A9 1F		LDA	#WRITE+DATA	PIA CTL CMD				
201	020C	20 DE 02		JSR	SETUP	SET-UP PIA				
202	020F	A5 E4		LDA	TRACK	TRACK ADDR				
203	0211	C9 4D		CMP	#\$4D	IF PAST END				
204	0213	B0 33		BCS	COMPANL	RETURN				
205	0215	20 CD 02		JSR	PULSE	WRITE TRACK				
206	0218	A9 1D		LDA	#WRITE+SECT	PIA CTL CMD				
207	021A	20 DE 02		JSR	SETUP	SET-UP PIA				
208	021D	A5 E5		LDA	SECTOR	SECTOR ADDR				
209	021F	20 CD 02		JSR	PULSE	WRITE SECTOR				
210	0222	4C 40 02		JMP	BASIC	CONTINUE				
211	0225									
212	0225									
213	0225									
214	0225	A9 29	FDENT	LDA	#READ+STAT	PIA CTL CMD		** ENTRY **		
215	0227	20 DE 02		JSR	SETUP	SET-UP PIA				
216	022A	20 CD 02		JSR	PULSE	READ STATUS				
217	022D	6A		ROR	A	IF DEVICE BUSY				
218	022E	B0 18		BCS	COMPANL	DO COMPLETION				
219	0230									
220	0230									
221	0230									
222	0230	A9 10		LDA	#\$10	CMD MASK				
223	0232	24 E2		BIT	COMAND	CHECK FOR				
224	0234	10 CA		BPL	TYPE1	TYPE 1				
225	0236	50 23		BVC	TYPE2	TYPE 2				
226	0238	F0 4A		BEQ	RDATA	TYPE 3 READ				
227	023A	A9 20		LDA	#\$20	SEPERATE				
228	023C	24 E2		BIT	COMAND	FORCE INTRQ FROM				
229	023E	D0 63		BNE	WDATA	TYPE 3 WRITE				
230	0240									
231	0240									
232	0240									
233	0240	20 C2 02	BASIC	JSR	WRTCMD	WRITE CMD TO FD1771B				
234	0243	2C DE CC		BIT	SBD	WAIT FOR				

Listing 1 continued on page 314

Computers Designed for the Professional

Billings Computer Division designs and supports a complete line of computer systems for the professional user which includes an impressive library of professional applications software.

WORD/FORMS PROCESSOR PACK is a screen oriented context editor featuring word underlining, variable line spacing, right margin justification, proportional pitch, block moves, search and replace, column alignment, super- and subscripting, plus many others.

BOOKKEEPER SERIES ACCOUNTING PACK includes Payroll, Accounts Payable, Accounts Receivable, and General Ledger. Easily tailored reports make this a very versatile package designed to meet the needs of a wide variety of businesses.

LEGAL ACCOUNTING PACK is a complete cash accounting system including Fees Manager, Cash Receipts, Statements, and Check Manager. Payroll and General Ledger from Bookkeeper series also are compatible.

INVENTORY MANAGEMENT PACK is a powerful manufacturing inventory package designed to eliminate parts shortages and overstocking. Ordering and expediting reports are generated from a 52-week production schedule. Cost calculations are made for up to 19 different models.

SCREEN ASIST PACK is a program development tool which simplifies the formatting of information on the CRT screen. A special editor allows the creation of a template with protected and unprotected fields.

FORTRAN PACK includes all of the normal features plus special subroutines to allow enhanced file access and manipulation, sorting, use of screen ASIST, and many others. Overlay capability allows development of many programs normally too large for a small computer.

BASIC PACK has both EBasic for fast Basic applications and BBasic for applications requiring capabilities not normally available to Basic users, such as indexed files, structured "if-then-else" statements, Trace debug feature, formatted input and output, and others.

COBOL PACK is an ANSI 1974 version with many level two features plus the same enhancements as the FORTRAN PACK.



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Listing 1 continued:

```

235 0246 10 FB          BPL *-3      INTRQ
236 0248                ;
237 0248                ; ***** COMPLETION ANALYSIS
238 0248                ;
239 0248 A0 02        CMPANL LDY #2      LOOP CNT + INDEX
240 024A 98          CPLP   TYA          USE INDEX TO
241 024B 0A          ASL    A           SET A1,A0
242 024C 09 29        ORA   #READ      SET READ
243 024E 20 DE 02    JSR   SETUP      SET-UP PIA
244 0251 20 CD 02    JSR   PULSE      READ REGISTER
245 0254 99 E3 00    STA   STATUS,Y    STORE DATA
246 0257 88          DEY           DECR INDEX

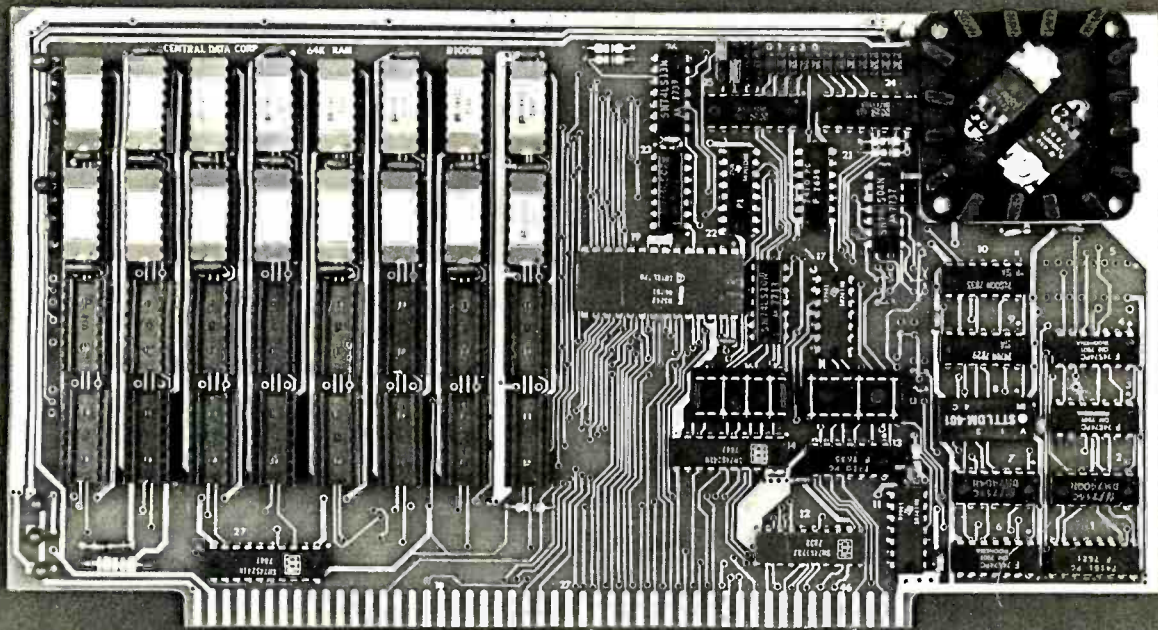
```

FD400/FD1771B FLOPPY DISK CONTROL

PAGE 6

CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
247	0258	10 F0	BPL	CPLP	CONTINUE					
248	025A	60	RTS		RETURN					
249	025B									
250	025B									
251	025B									
252	025B	A9 2B	TYPE2	LDA	#READ+TRK	PIA CTL CMD				
253	025D	20 DE 02	JSR	SETUP	SET-UP PIA					
254	0260	20 CD 02	JSR	PULSE	READ TRACK					
255	0263	C5 E4	CMP	TRACK	IF NOT EQUAL					
256	0265	F0 0D	BEQ	TYPE2A	SEEK TO TRACK					
257	0267	A5 E2	LDA	COMAND	SAVE COMMAND					
258	0269	48	PHA		FOR LATER					
259	026A	A9 12	LDA	#FDSK	SEEK COMMAND					
260	026C	85 E2	STA	COMAND	SET IT					
261	026E	20 25 02	JSR	FDENT	DO SEEK					
262	0271	68	PLA		RESTORE					
263	0272	85 E2	STA	COMAND	COMMAND					
264	0274									
265	0274									
266	0274									
267	0274	A9 1D	TYPE2A	LDA	#WRITE+SECT	PIA CTL CMD				
268	0276	20 DE 02	JSR	SETUP	SET-UP PIA					
269	0279	A5 E5	LDA	SECTOR	SECTOR ADDR					
270	027B	20 CD 02	JSR	PULSE	WRITE SECTOR					
271	027E	A9 20	LDA	#S20	SEPERATE					
272	0280	24 E2	BIT	COMAND	READ					
273	0282	D0 1F	BNE	WDATA	FROM WRITE					
274	0284									
275	0284									
276	0284									
277	0284	20 C2 02	RDATA	JSR	WRTCMD	WRITE COMMAND				
278	0287	A0 00	LDY	#0	BUFFER INDEX					
279	0289	A9 2F	LDA	#READ+DATA	PIA CTL CMD					
280	028B	20 DE 02	JSR	SETUP	SET-UP PIA					
281	028E	2C 0E CC	RDL	BIT	SBD	WAIT FOR	4			
282	0291	30 B5	BMI	CMPANL	INTRQ OR		2			
283	0293	50 F9	BVC	RDL	DRQ		2			
284	0295	AD 0C CC	LDA	SAD	GET DATA BYTE		4	25 CYCLES		
285	0298	49 FF	EOR	#\$FF	INVERT DATA		2			
286	029A	91 E6	STA	(FDBUF),Y	SAVE BYTE		6			
287	029C	C8	INY		INCR BUFFER PTR		2			
288	029D	D0 EF	BNE	RDL	IF ZERO		3	2		
289	029F	E6 E7	INC	FDBUF+1	INCR BASE AND		5	+ 9 CYCLES		
290	02A1	D0 EB	BNE	RDL	CONTINUE		3			
291	02A3									
292	02A3									
293	02A3									
294	02A3	20 C2 02	WDATA	JSR	WRTCMD	WRITE COMMAND				
295	02A6	A0 00	LDY	#0	BUFFER INDEX					
296	02A8	A9 1F	LDA	#WRITE+DATA	PIA CTL CMD					
297	02AA	20 DE 02	JSR	SETUP	SET-UP PIA					
298	02AD	B1 E6	WTL	LDA	(FDBUF),Y	GET DATA BYTE	6			
299	02AF	49 FF	EOR	#\$FF	INVERT DATA		2			
300	02B1	8D 0C CC	STA	SAD	WRITE IT		4			
301	02B4	2C 0E CC	WTL1	BIT	SBD	WAIT FOR	4	25 CYCLES		

Listing 1 continued on page 317



32K Board Pictured Above

Why Not the Best?

From The Dynamic RAM Company.

2MHz	4MHz
16K—\$249	\$259
32K—\$375	\$395
48K—\$500	\$530
64K—\$625	\$665

We have now been shipping our 2MHz dynamic RAM boards for over two years. Hundreds of 4MHz boards have been going out every month since early 1979. Our reliability is proven in the thousands of systems which contain our board. Many quality-minded systems houses across the country and overseas are using our boards for their equipment.

Our prices still beat all. Despite rising 16K memory chip prices (at least from reputable suppliers), Central Data continues to give you the best buy in memory today. Nobody offers a board with a capacity of 64K, assembled, tested, and guaranteed for a full year at the price we do.

Deselect around PROMs. Our boards have the important deselect feature which lets you overlap any fixed memory in your system with no interference.

Our features make the board easily used and expanded. You address our boards on 16K boundaries with mini-jumps (small shorting plugs that slide over wire-wrap pins) near the top of the board for easy access. If you want to expand your board after you have purchased it, all that you need to do is add memory. We can supply you with expansion packages (\$150-2MHz, \$160-4MHz) which include eight RAMs that you can depend on as well as two mini-jumps for addressing. And of course, our board **never** generates wait states.

Low power consumption keeps your computer running cool and reliable. The total power consumption of our 16K board is typically less than 4 watts (+8V @ 300ma, +16V @ 150ma and

–16V @ 20ma). Boards with additional memory typically increase power consumption only 1 watt per 16K!

Standard S-100 Interface. Our board is designed to interface with any standard S-100 CPU. All of the timing of the board is independent of the processor chip, and the board is set up for different processors by changing two plugs on the board.

Call or write us today. That will guarantee a fast response with more information on the board. Or make an order — you'll probably have the board in two weeks! **If you're interested, also ask for a catalog on our Z8000 16-bit processor board designed for the MULTIBUS.** All of these products are available to your local dealer, also.

Central Data Corporation, 713 Edgebrook Drive, PO Box 2530, Station A, Champaign, IL 61820. (217) 359-8010

Central Data

The A2-3D1 Graphics Family...

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professional 3D and 2D graphics for the Apple II

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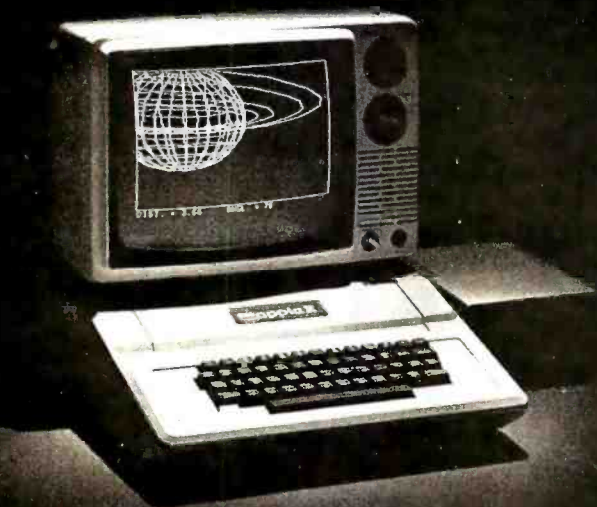
Now this versatility is available for the non-programmer with the **A2-GE1** graphics editor and programmer. Create images as you view them. Scan them, animate them, combine them, or add text or labels. With a minimum of fuss, you can prepare all sorts of scientific, business, or educational presentations.

Add the **A2-3D2** enhancement package for color, and as a bonus you'll also be able to manipulate images independently of each other—as many different objects at once as your memory will accommodate.

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required)

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A2-3D1 required)

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Listing 1 continued:

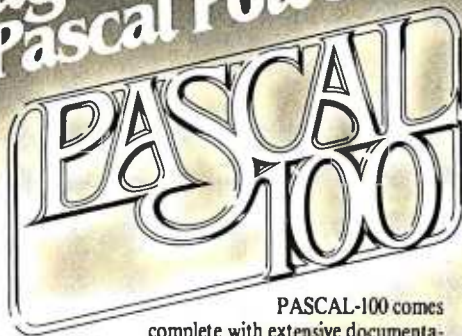
FD400/FD1771B FLOPPY DISK CONTROL

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CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
302	02B7	30 SF		BMI	CMPANL	INTRQ OR		2		
303	02B9	50 F9		BVC	WTL1	DRQ		2		
304	02BB	CS		INY		INCR BUFFER PTR		2		
305	02BC	D0 EF		BNE	WTL	IF ZERO		3	2	
306	02BE	E6 E7		INC	FDBUF+1	INCR BASE AND		5	+ 9 CYCLES	
307	02C0	D0 EB		BNE	WTL	CONTINUE		3		
308	02C2									
309	02C2									
310	02C2									
311	02C2									
312	02C2	A9 19	WRTCMD	LDA	#WRITE+CMD	PIA CTL CMD				
313	02C4	20 DE 02		JSR	SETUP	SET-UP PIA				
314	02C7	A5 E2		LDA	COMAND	GET COMMAND				
315	02C9	20 CD 02		JSR	PULSE	AND WRITE IT				
316	02CC	60		RTS		RETURN				
317	02CD									
318	02CD									
319	02CD									
320	02CD									
321	02CD	49 FF	PULSE	EOR	#\$FF	INVERT DATA				
322	02CF	8D 0C CC		STA	SAD	DATA OUT				
323	02D2	CE 0E CC		DEC	SBD	ENABLE				
324	02D5	EE 0E CC		INC	SBD	READ/WRITE				
325	02D8	AD 0C CC		LDA	SAD	DATA IN				
326	02DB	49 FF		EOR	#\$FF	INVERT DATA				
327	02DD	60		RTS		CONTINUE				
328	02DE									
329	02DE									
330	02DE									
331	02DE	A2 00	SETUP	LDX	#\$00	ASSUME READ				
332	02E0	8D 0E CC		STA	SBD	SET DVC CTL REG				
333	02E3	0A		ASL	A	CHECK				
334	02E4	0A		ASL	A	IF READ AND				
335	02E5	30 01		BMI	SET1	SET FOR INPUT				
336	02E7	CA		DEX		ADJUST DIR TO OUTPUT				
337	02E8	A9 00	SET1	LDA	#0	SET CTL FOR				
338	02EA	SD 0D CC		STA	CRA	DIR REGISTER				
339	02ED	8E 0C CC		STX	SADD	SET DATA DIRECTION				
340	02F0	A9 2C		LDA	#\$2C	RESET PIA CTL				
341	02F2	SD 0D CC		STA	CRA	TO DATA REG				
342	02F5	60		RTS		RETURN				
343	02F6									
344	02F6									

Listing 1 continued on page 318

Plug in Pascal Power...



Microengine Power

Plug in PASCAL-100™ new CPU Boardset for S-100 computers. Go with the power of the Pascal Micro-engine. Run UCSD Pascal[®] up to 10 times faster than typical implementations—with twice the memory capacity. You've got the best hardware for the best software around.

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- 128K byte memory capacity, 1 Megabyte with Extended Memory Map
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Want to know more? Just circle our number on the reader service card. For fast action, call or write us directly.

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[®]Registered Trademark of Zilog, Inc. [®]Registered Trademark of Digital Research

Listing 1 continued:

```

345 02F6 ;
346 02F6 A2 00 FDINT LDX #000 A DIR AS INPUT ** ENTRY **
347 02F8 20 E8 02 JSR SET1 SET-UP A SIDE
348 02FB AD 0C CC LDA SAD CLEAR -RE
349 02FE A0 04 LDY #004 CTL FOR B SIDE
350 0300 8C 0F CC STY CRB DATA REGISTER
351 0303 86 E0 STX DVCODE CLEAR DEVICE CODE
352 0305 E8 INX SET B SIDE
353 0306 8E 0E CC STX SBD DATA REGISTER
354 0309 CA DEX CTL FOR B SIDE
355 030A 8E 0F CC STX CRB DIR REGISTER
356 030D A2 3F LDX #03F SET B SIDE

```

FD400/FD1771B FLOPPY DISK CONTROL

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CARD #	LOC	CODE	CARD 10	20	30	40	50	60	70
357	030F	8E 0E CC	STX	SBDD		DIR REGISTER			
358	0312	A2 3C	LDX	#03C		SELECT			
359	0314	8E 0F CC	STX	CRB		DEVICE 1			
360	0317	A9 02	LDA	#FDRST		RESTORE CMD			
361	0319	85 E2	STA	COMAND		SAVE IT			
362	031B	20 40 02	JSR	BASIC		RESTORE DEVICE 1			
363	031E	A2 34	LDX	#034		SELECT			
364	0320	8E 0F CC	STX	CRB		DEVICE 0			
365	0323	4C 40 02	JMP	BASIC		RESTORE DEVICE 0			
366	0326								
367	0326								

FLOPPY DISK I/O & ERROR RECOVERY

PAGE 9

CARD #	LOC	CODE	CARD 10	20	30	40	50	60	70
369	0326								
370	0326								
371	0326								
372	0326								
373	0326								
374	0326								
375	0326								
376	0326								
377	0326								
378	0326								
379	0326								
380	0326								
381	0326								
382	0326								
383	0326								
384	0326								
385	0326								
386	0326								
387	0326								
388	0326								
389	0326								
390	0326								
391	0326								
392	0326								
393	0326	48	FDIO	PHA		SAVE ACC			** ENTRY **
394	0327	98		TYA		SAVE Y			
395	0328	48		PHA		REGISTER			
396	0329	8A		TXA		SAVE X			
397	032A	48		PHA		REGISTER			
398	032B	A9 05		LDA	#5	SET ERROR			
399	032D	85 E1		STA	ERRCDE	COUNT			
400	032F	A9 34		LDA	#034	START W/DVC 0			
401	0331	24 E0		BIT	DVCODE	IF NOT 0			
402	0333	50 02		BVC	SETDVC	SET TO ONE			
403	0335	09 08		ORA	#08	SET DVC 1			
404	0337	8D 0F CC	SETDVC	STA	CRB	SET PIA			
405	033A	A5 E7	RETRY	LDA	FDBUF+1	SAVE ADDR HIGH			
406	033C	48		PHA		FOR RECOVERY			
407	033D	A5 E5		LDA	SECTOR	SAVE SECTOR			
408	033F	48		PHA		FOR RECOVERY			
409	0340	20 25 02		JSR	FDENT	EXEC CMD			

Listing 1 continued on page 320

If you can't find the right program in our new catalog, it probably hasn't been written.

As the world's largest publisher of professional software for micro-computers, Lifeboat Associates offers the largest selection of state-of-the-art programs. And our new catalog has more to offer than ever. We also add the crucial dimension of after-sales service and full support to everything we sell. Order your free catalog today.



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CB681

Our catalog contains full descriptions and specifications of the following:

DISK OPERATING SYSTEMS	TELECOMMUNICATIONS	MAIL LIST APPLICATIONS	THE PASCAL HANDBOOK
CP/M CONFIGURED FOR: APPLE II DATAPOINT 1550/2150 ICOM MICRO DISK ICOM 3712 ICOM 3812 ICOM 4511/PERTEC D3000 INTEL MDS MICROPOLIS FLOPPY DISK MITS/ALTAIR MOSTEK MDX NORTH STAR OSI C3 OSI C3B OSI C3C Prime TRS-80 MODEL II MP/M FOR INTEL MDS	BSTAM BSTMS LANGUAGES ALGOL-80 muSIMP APL/V80 NEVADA COBOL BASIC-80 PASCAL/M (COMPILER) PASCAL/MT BASIC-80 PASCAL/MT+ (INTERPRETER) PASCAL/Z BDS C COMPILER PL/I-80 CBASIC-2 S-BASIC CIS COBOL TINY C COBOL-80 TINY-C TWO FORTRAN-80 W'SMITHS C JRT PASCAL COMPILER muLISP XYBASIC	MAILING ADDRESS (PTREE) MAILMERGE FOR WORDSTAR NAO POSTMASTER BUSINESS APPLICATIONS ACCOUNTS PAYABLE (PTREE) ACCOUNTS PAYABLE (SSG) ACCOUNTS RECEIVABLE (PTREE) ACCOUNTS RECEIVABLE (SSG) GENERAL LEDGER II (CPAIDS) GENERAL LEDGER (PTREE) GENERAL LEDGER (SSG) GLECTOR FOR SELECTOR III-C2 INVENTORY (PTREE) INVENTORY (SSG) PAYROLL (PTREE) PAYROLL (SSG)	PASCAL USER MANUAL AND REPORT PAYROLL WITH COST ACCOUNTING-CBASIC STRUCTURED MICROPROCESSOR PROGRAMMING USING CP/M-A SELF-TEACHING GUIDE ACCESSORIES DC 300 DATA CARTRIDGE HEAD CLEANING DISKETTE FLOPPY DISK KIT FLOPPY SAVER Program names and computer names are generally trademarks or service marks of the author or manufacturing company. All software products have specific requirements for hardware and additional associated software (e.g. operating system or language). All products are subject to terms and conditions of sale. Prices and specifications are subject to change without notice. All Lifeboat software requires CP/M unless otherwise stated. Copyright © 1981 Lifeboat Associates. No portion of this advertisement may be reproduced without prior permission.
HARD DISK INTEGRATION MODULES CORVUS WITH APPLE II SOFTCARD CORVUS WITH S100 AND TRS-80 MODEL II ICOM 4511/PERTEC D3000 KONAN PLUS CDC PHOENIX XCOMP SM/S PLUS CDC PHOENIX XCOMP DFC10 FOR PERTEC D3000	LANGUAGE AND APPLICATIONS TOOLS BASIC UTILITY MOBS DRS DISK MOBS.RTL DATASTAR M/SORT FOR FABS COBOL-80 FORMS 1 FOR CIS PEARL COBOL PSORT FORMS 2 FOR CIS QSORT COBOL STRING BIT MAGSAM III STRING /80 MAGSAM IV SUPER-SORT ULTRASORT II	NUMERICAL PROBLEM-SOLVING TOOLS ANALYST STATPAK FPL T/MAKER muMATH OTHER SPECIALIZED APPLICATIONS DATEBOOK ESQ-3 DENTAL PAS-3 MEDICAL PROPERTY MANAGEMENT (PTREE) BOOKS AND PERIODICALS APL - AN INTERACTIVE APPROACH ACCOUNTS PAYABLE & ACCOUNTS RECEIVABLE-CBASIC 8080/Z80 ASSEMBLY LANGUAGE THE CP/M HANDBOOK THE C PROGRAMMING LANGUAGE CRASH COURSE IN MICROCOMPUTERS FIFTY BASIC EXERCISES GENERAL LEDGER-CBASIC INTRODUCTION TO PASCAL LIFELINES	
SYSTEMS TOOLS BUG AND uBUG SIO DESPOOL TRS-80 MODEL II DISLOG CP/M DISTEL CUSTOMIZATION EDIT UNLOCK EDIT-80 WORD-MASTER FILETRAN XASM-18 IBM/CPM XASM-48 MAC XASM-65 MACRO-80 XASM-68 PASM XMACRO-86 PLINK Z80 DEVELOPMENT PMATE PACKAGE RAID ZSD RECLAIM ZSD	WORD PROCESSING SYSTEMS AND AIDS MAGIC WAND TEX LETTERIGHT TEXTWRITER III MICROSPELL WORDSTAR SPELLGUARD WORDINDEX DATA MANAGEMENT PACKAGES CONDOOR MOBS MOBS MOBS.ORS GENERAL PURPOSE APPLICATIONS CBS SELECTOR IV SELECTOR III-C2		
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Lifeboat Associates

Software with full support.

Listing 1 continued:

```

410 0343 38          SEC          ASSUME ERROR
411 0344             ;
412 0344             ; ***** CHECK FOR BUSY/NOT READY
413 0344             ;
414 0344 A9 01       LDA  #01       CHECK
415 0346 24 E3       BIT  STATUS     FOR
416 0348 D0 3F       BNE  ER1        BUSY OR
417 034A 30 3D       BMI  ER1        NOT READY
418 034C             ;
419 034C             ; ***** DETERMINE CMD TYPE
420 034C             ;
421 034C A9 10       LDA  #010      CMD MASK
422 034E 24 E2       BIT  COMAND     SPLIT INTO
423 0350 10 19       BPL  TYP1      TYPE 1

```

FLOPPY DISK I/O & ERROR RECOVERY

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```

CARD # LOC  CODE          CARD 10      20      30      40      50      60      70
424 0352 50 29          BVC  TYP2      TYPE 2
425 0354 F0 37          BEQ  RDT      TYPE 3 READ
426 0356 A9 20          LDA  #020     SEPERATE
427 0358 24 E2          BIT  COMAND     FORCE INTRQ FROM
428 035A D0 27          BNE  WRT      TYPE 3 WRITE
429 035C             ;
430 035C             ; ***** RETURN
431 035C             ;
432 035C 18           RTN1  CLC          NO ERROR
433 035D A9 00          LDA  #0        CLEAR
434 035F 85 E1          RTN2  STA  ERRCODE  ERROR CODE
435 0361 68           PLA          CLEAR STACK
436 0362 85 E5          STA  SECTOR     OF SECTOR
437 0364 68           PLA          AND ADDR HIGH
438 0365 68           RTN3  PLA          RESTORE X
439 0366 AA           TAX          REGISTER
440 0367 68           PLA          RESTORE Y
441 0368 A6           TAY          REGISTER
442 0369 68           PLA          RESTORE ACC
443 036A 60           RTS          RETURN
444 036B             ;
445 036B             ; ***** TYPE 1 RECOVERY
446 036B             ;
447 036B A9 18          TYP1  LDA  #018     CHECK FOR
448 036D 25 E3          AND  STATUS     BOTH CRC AND
449 036F F0 EB          BEQ  RTN1
450 0371 C9 18          CMP  #018     NOT FOUND
451 0373 F0 14          BEQ  ER1      ERRORS
452 0375 A9 30          LDA  #030     STOP IF
453 0377 24 E2          BIT  COMAND     STEP IN
454 0379 D0 0E          BNE  ER1      OR STEP OUT
455 037B F0 26          BEQ  RDT1     RETRY SEEK AND RESTORE
456 037D             ;
457 037D             ; ***** TYPE 2 SEPERATION
458 037D             ;

```

Listing 1 continued on page 322



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\$5500.	\$5800.	\$6300.	\$7900.	\$8110.	\$9195.

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TELEVIDEO 912 C	CALL
TELEVIDEO 920 B	CALL
TELEVIDEO 920 C	CALL
SOROC IQ-120	675
ZENITH A-19	750
HAZELTINE 1500	995
TELEVIDEO 950	CALL



NORTHSTAR

HRZ-1D-32K	CALL
HRZ-2D-32K	CALL
HRZ-1Q-32K	CALL
HRZ-2Q-32K	CALL
ADDITIONAL 16K RAM	CALL
ADDITIONAL 32K RAM	CALL
HARD DISK SYSTEM	CALL
SPECIAL MEMORY CONFIGURATIONS AVAILABLE, INCLUDING SYSTEMS GROUP.	



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NEC 5515 (TRACT., RIB., THIM)	2600
NEC 5520 (TRACT., RIB., THIM)	2900
NEC 5530 (TRACT., RIB., THIM)	2540
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TI-820	1625
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EPSON MX 80	CALL
EPSON MX 70	CALL
ANADEX DP-9500/9501	CALL

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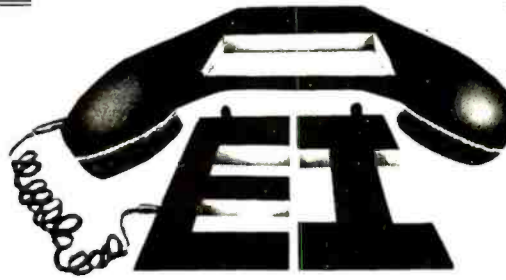
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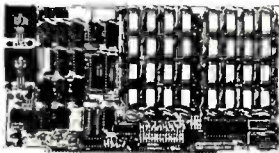
sity of Virginia, U.S. Dept. of Interior, University of Kentucky, University of California, Massachusetts Institute of Technology, U.S. Air Force, Naval Air Development Center, Brown University, University of Oregon, University of Utah, Ohio State University, University of Southern California, California State Dept. of Water Resources, University of Michigan, and Princeton University.

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VB2 VIDEO	155	210
VB3 VIDEO	375	440
IO4 INTERFACE	165	225
SB1 SYNTHESIZER	195	270

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DM6400 64K 4MHZ	595
DMB3200 32K 4MHZ BANK SELECT	630
DMB6400 64K 4MHZ BANK SELECT	745

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VERBATUM 5 1/4 1 SIDE	\$27
VERBATUM 5 1/4 2 SIDE	45
VERBATUM 8 1 SIDE	35
VERBATUM 8 2 SIDE	55
OTHERS	CALL
PLASTIC STORAGE BOXES	3

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Circle 32 on inquiry card.

Listing 1 continued:

```

459 037D A9 20      TYP2  LDA  #$20      SEPERATE
460 037F 24 E2      BIT  COMAND      READ
461 0381 F0 0A      BEQ  RDT         FROM WRITE
462 0383           ;
463 0383           ; ***** WRITE RECOVERY
464 0383           ;
465 0383 A9 60      WRT   LDA  #$60      ERROR MASK
466 0385 24 E3      BIT  STATUS      STOP IF WRITE
467 0387 F0 04      BEQ  RDT         PROTECT/FAULT
468 0389 A9 0F      ER1   LDA  #$FF      SET ERROR CODE
469 038B D0 D2      BNE  RTN2       RETURN
470 038D           ;
471 038D           ; ***** COMMON RECOVERY
472 038D           ;
473 038D A9 0C      RDT   LDA  #$0C      ERROR MASK
474 038F 24 E3      BIT  STATUS      IF ERROR
475 0391 D0 10      BNE  RDT1       RETRY
476 0393 A9 10      LDA  #$10      CHECK FOR
477 0395 24 E3      BIT  STATUS      NOT FND
478 0397 F0 C3      BEQ  RTN1       NONE RETURN

```

FLOPPY DISK I/O & ERROR RECOVERY

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```

CARD # LOC      CODE      CARD 10      20      30      40      50      60      70
479 0399           ;
480 0399 24 E2      BIT  COMAND      IF MULTIPLE
481 039B F0 06      BEQ  RDT1       SECTOR OPERATION
482 039D A9 1B      LDA  #$1B       CHECK
483 039F C5 E5      CMP  SECTOR     FOR END OF
484 03A1 F0 B9      BEQ  RTN1       TRACK
485 03A3           ;
486 03A3           ; ***** CHECK ERROR COUNT
487 03A3           ;
488 03A3 C6 E1      RDT1  DEC  ERRUDE  DECR ERROR CNT
489 03A5 10 05      BPL  RDT2       RETURN
490 03A7 68         PLA         WITH
491 03A8 68         PLA         ERROR
492 03A9 4C 65 03  JMP  RTN3       CONDITION
493 03AC           ;
494 03AC           ; ***** RETRY OPERATION
495 03AC           ;
496 03AC 68         RDT2  PLA         RESTORE
497 03AD 85 E5      STA  SECTOR     SECTOR
498 03AF 68         PLA         RESTORE
499 03B0 85 E7      STA  FDBUF+1   ADDR HIGH
500 03B2 4C 3A 03  JMP  RETRY     RETRY

```

Listing 1 continued on page 324

IMPOSSIBLE! 32K OF S-100

STATIC RAM FOR \$399 !?!?!?

No, it's not impossible; in fact, we think we've lucked into the S-100 value of the year.

Recently a leading manufacturer of static memory for S-100 systems (we can't say who) received a batch of electrically perfect 32K static RAM boards with some minor cosmetic defects. Intended for sale as Assembled / Tested units, the company got as far as soldering the sockets in place before the problem was discovered. We were in the right place at the right time and bought the entire lot; we're offering these memories in kit form with all components and complete documentation. Simply insert the ICs into the appropriate sockets, solder in a few other parts - and you're up and running. Best of all, you'll have the same reliable, ultra-high speed, fully static, and low power performance you've come to expect from the boards made by this prominent company.

Don't miss out on the memory deal of the year - these are limited quantity, first-come-first-served.

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\$59 Kit, \$79 Assembled/Tested.

With built-in logic probe for painless troubleshooting, large "kluge" area for building custom circuits or testers, edge connector label that identifies all pins, jumper links in power lines for easy current measurement/fusing, and gold plated connector surfaces for optimized electrical contact. New interlaced ground and signal traces improves performance and reduces noise; even works with the new generation of high clock frequency boards.

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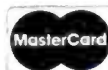
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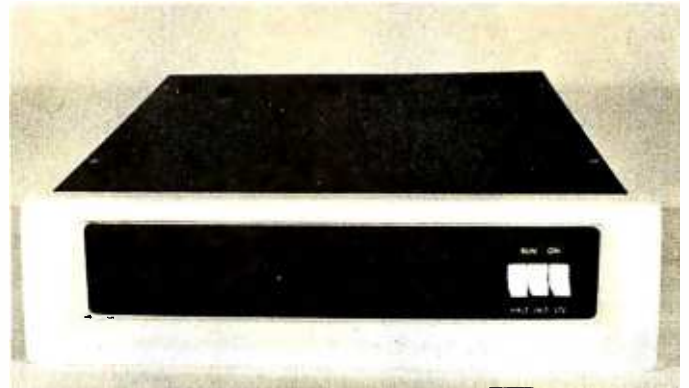
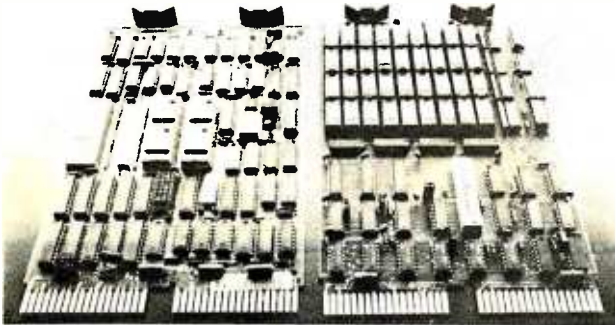
CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
502	03B5									
503	03B5									
504	03B5									
505	03B5									
506	03B5									
507	03B5									
508	03B5									
509	03B5									
510	03B5									
511	03B5									
512	03B5									
513	03B5	20 F6 02	FORMAT	JSR	FOINT	INIT SYSTEM			** ENTRY **	
514	03B6	A2 00		LDX	#0	A SIDE				
515	03BA	8E 00 CC		STX	CRA	DIRECTION				
516	03BD	CA		DEX		SET TO				
517	03BE	8E 0C CC		STX	SADD	OUTPUT				
518	03C1	A2 2C		LDX	#12C	A SIDE				
519	03C3	8E 0D CC		STX	CRA	DATA				
520	03C4									
521	03C4									
522	03C4									
523	03C4	A9 4C		LOA	#14C	SET				
524	03C8	8D 00 05		STA	REND	TRACK COUNT				
525	03CB	A9 FF		LOA	#1FF	SET TRK				
526	03CD	8D 03 05		STA	RTN	TO ZERO				
527	03DD	A9 FE	GD	LDA	#1FE	SET SECTOR				
528	03D2	8D 01 05		STA	RSN	TO ONE				
529	03D5	A2 1A		LDX	#1A	SECTOR CNT				
530	03D7	A0 FD		LDY	#RSTR-REND	WRITE LENGTH				
531	03D9									
532	03D9									
533	03D9									
534	03D9	A9 0B		LOA	#255-FDWT	STOR FD1771B				
535	03DB	8D 0C CC		STA	SAD	COMMAND				
536	03DE	A9 19		LDA	#WRITE+CMD	STORE PIA				
537	03E0	8D 0E CC		STA	SBD	COMMAND				
538	03E3	CE 0E CC		DEC	SBD	ENABLE				
539	03E6	EE 0E CC		INC	SBD	READ/WRITE				
540	03E9	A9 1F		LDA	#WRITE+DATA	STORE PIA				
541	03EB	8D 0E CC		STA	SBD	COMMAND				
542	03EE									
543	03EE									
544	03EE									
545	03EE									
545	03EE	EE FE 05	WDT	INC	RSTR+1	DELAY 6 CYCLES				
546	03F1	89 00 05		LOA	REND,Y	STORE A				
547	03F4	8D 0C CC		STA	SAD	DATA BYTE				
548	03F7	2C 0E CC	MWP	BIT	SBD	WAIT FOR				
549	03FA	30 12		BMI	NEXT	INTRQ				
550	03FC	50 F9		BVC	MWP	DR DRQ				
551	03FE	88		DEY		DECR INDEX				
552	03FF	0D ED		BNE	WDT	CONTINUE				
553	0401	CE 01 05		DEC	RSN	INC SECTOR				
554	0404	A0 8A		LDY	#RDRM-REND	INDEX VALUE				
555	0406	CA		DEX		DECR SECTOR CNT				
556	0407	0D E8		BNE	WDT+3	CONTINUE				

CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
557	0409									
558	0409									
559	0409									
560	0409	2C 0E CC	TRKEND	BIT	SBD	WAIT FOR				
561	040C	1D FB		BPL	TRKEND	INTRQ				
562	040E									
563	040E									
564	040E									
565	040E	20 35 04	NEXT	JSR	DELAY	DELAY 40 MS.				
566	0411	A9 B5		LOA	#255-POSTI-QN	STORE FD1771B				
567	0413	8D 0C CC		STA	SAD	COMMAND				
568	0416	A9 19		LOA	#WRITE+CMD	STORE PIA				

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Listing 1 continued:

```

569 0418 8D 0E CC      STA  SBD      COMMAND
570 041B CE 0E CC      DEC  SBD      ENABLE
571 041E EE 0E CC      INC  SBD      READ/WRITE
572 0421 2C 0E CC      SLP  BIT  SBD  WAIT FOR
573 0424 10 FB          BPL  SLP      INTRQ
574 0426 20 35 04      JSR  DELAY    DELAY 40 MS.
575 0429 CE B3 05      DEC  RTN      INCR TRACK
576 042C CE 00 05      DEC  REND     DEC TRK CNT
577 042F 10 9F          BPL  GO       CONTINUE
578 0431 20 F6 02      JSR  FDINT    RESTORE DRIVE
579 0434 60             RTS          STOP
580 0435                ;
581 0435                ; ***** DELAY 40 MS.
582 0435                ;
583 0435 A9 40          DELAY LDA #40    MAJOR LOOP VALUE
584 0437 85 00          STA  TIME1     MAJOR LOOP CNT
535 0439 A9 4A          DL2  LDA #4A    MINOR LOOP VALUE
586 043B 85 01          STA  TIME2     MINOR LOOP CNT
587 043D C6 01          DL1  DEC TIME2  DECR MINOR CNT
588 043F D0 FC          BNE  DL1      CONTINUE
589 0441 C6 00          DEC  TIME1     DECR MAJOR CNT
590 0443 D0 F4          BNE  DL2      CONTINUE
591 0445 60             RTS          RETURN

```

FD400/FD1771B FLOPPY DISK FORMAT

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```

CARD # LOC      CODE      CARD 10      20      30      40      50      60      70
593 0446                *****255/256*256
594 0500                ;
595 0500                ; ***** RECORD FORMAT
596 0500                ; (REVERSED AND INVERTED)
597 0500 00          REND  .BYTE $00
598 0501 00                .BYTE $00,$00,$00,$00,$00,$00,$00,$00,$00
598 0502 00
598 0503 00
598 0504 00
598 0505 00
598 0506 00
598 0507 00
598 0508 00
599 0509 00                .BYTE $00,$00,$00,$00,$00,$00,$00,$00,$00
599 050A 00
599 050B 00
599 050C 00
599 050D 00
599 050E 00

```

Listing 1 continued on page 328

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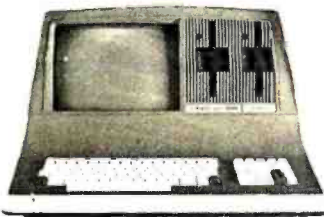
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Listing 1 continued:

```

599 050F 00
599 0510 00
600 0511 00          . BYTE $00,$00,$00,$00,$00,$00,$00,$00
600 0512 00
600 0513 00
600 0514 00
600 0515 00
600 0516 00
600 0517 00
600 0518 00
601 0519 00          . BYTE $00,$00,$00
601 051A 00
601 051B 00
602 051C 08          . BYTE $08
603 051D FF          . BYTE $FF,$FF,$FF,$FF,$FF,$FF,$FF,$FF
603 051E FF
603 051F FF
603 0520 FF
603 0521 FF
603 0522 FF
603 0523 FF
603 0524 FF
604 0525 FF          . BYTE $FF,$FF,$FF,$FF,$FF,$FF,$FF,$FF
604 0526 FF
604 0527 FF
604 0528 FF
604 0529 FF
604 052A FF
604 052B FF
604 052C FF
605 052D FF          . BYTE $FF,$FF,$FF,$FF,$FF,$FF,$FF,$FF
605 052E FF
605 052F FF
605 0530 FF
605 0531 FF
605 0532 FF

```

Listing 1 continued on page 330

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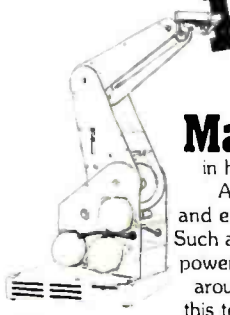
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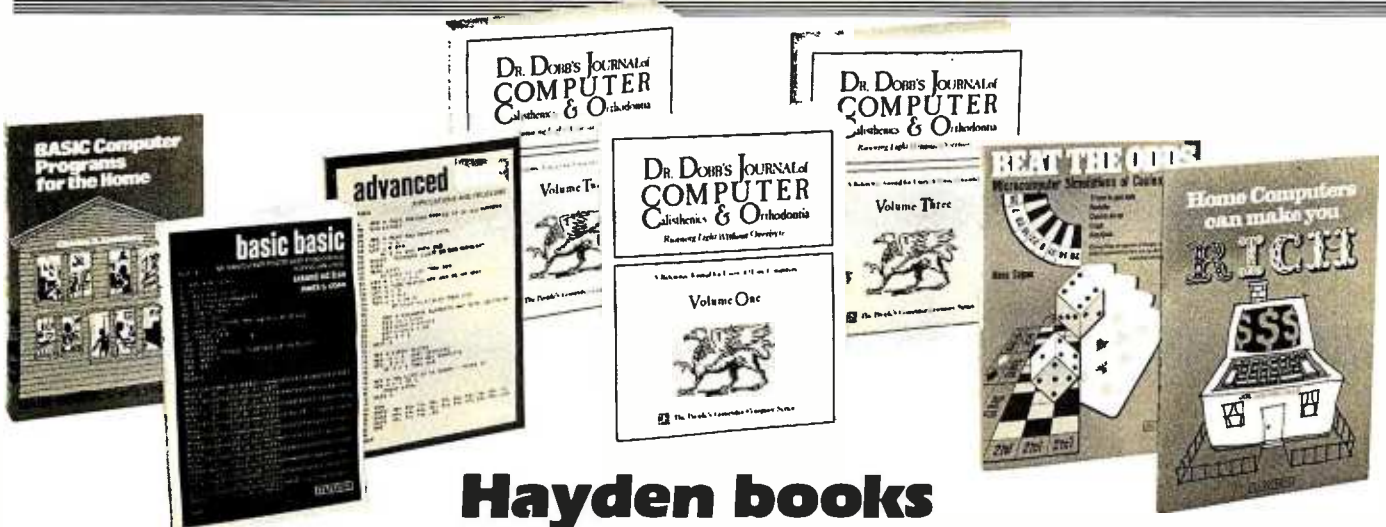
CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
605	0533	FF								
605	0534	FF								
606	0535	FF			.BYTE	\$FF,\$FF,\$FF,\$FF,\$FF,\$FF,\$FF,\$FF				
606	0536	FF								
606	0537	FF								
606	0538	FF								
606	0539	FF								
606	053A	FF								
606	053B	FF								
606	053C	FF								
607	053D	FF			.BYTE	\$FF,\$FF,\$FF,\$FF,\$FF,\$FF,\$FF,\$FF				
607	053E	FF								
607	053F	FF								
607	0540	FF								
607	0541	FF								
607	0542	FF								
607	0543	FF								
607	0544	FF								
608	0545	FF			.BYTE	\$FF,\$FF,\$FF,\$FF,\$FF,\$FF,\$FF,\$FF				
608	0546	FF								
608	0547	FF								
608	0548	FF								
608	0549	FF								
608	054A	FF								
608	054B	FF								
608	054C	FF								
609	054D	DF			.BYTE	\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF				
609	054E	DF								
609	054F	DF								
609	0550	DF								
609	0551	DF								
609	0552	DF								
609	0553	DF								
609	0554	DF								
610	0555	DF			.BYTE	\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF				
610	0556	DF								
610	0557	DF								
610	0558	DF								
610	0559	DF								
610	055A	DF								
610	055B	DF								
610	055C	DF								
611	055D	DF			.BYTE	\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF				
611	055E	DF								
611	055F	DF								
611	0560	DF								
611	0561	DF								
611	0562	DF								
611	0563	DF								
611	0564	DF								
612	0565	DF			.BYTE	\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF				
612	0566	DF								
612	0567	DF								
612	0568	DF								
612	0569	DF								

FD400/FD1771B FLOPPY DISK FORMAT

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CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
612	056A	DF								
612	056B	DF								
612	056C	DF								
613	056D	DF			.BYTE	\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF,\$DF				
613	056E	DF								
613	056F	DF								
613	0570	DF								
613	0571	DF								
613	0572	DF								
613	0573	DF								
613	0574	DF								

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THE JOYS OF MINIS AND MICROS: Data Processing with Small Computers (Stein and Shapiro) Covers technical and management aspects of the use of small computers. Discusses the size of the computer and how to choose the right machine for you. #5156-5, \$9.95

INTRODUCTION TO VSAM (Atkinson-DeSanctis) Shows the manager and technician working with a COBOL DRIVEN IBM 370 DOS/VS how to convert the files and accessing program of a data base supported by the indexed Sequential Access Method. #5159-X, \$11.95

HOME COMPUTERS CAN MAKE YOU RICH (Weisbecker) Teaches the home computer owner and non-owner how to make money by consulting, programming, inventing. #5177-8, \$6.50

BASIC COMPUTER PROGRAMS FOR BUSINESS: Vol. 1 (Stenberg) With more than 35 programs ranging from budgets to accounts payable, each program has a description of its functions, a listing in BASIC, a symbol table and samples. #5162-X, \$9.95

BEAT THE ODDS: Microcomputer Simulations Of Casino Games (Sagan) Provides simulations of Trente-et-Quarante, Roulette, Chemin-de-Fer, Craps, and Blackjack, all written in BASIC. #5181-6, \$7.95

DR. DOBB'S JOURNAL OF COMPUTER CALISTHENICS & ORTHODONTIA: Running Light Without Overbyte Vols. 1, 2, & 3 (The People's Computer Company) Vol. 1 (1976) holds the first ten issues of Dr. Dobb's Journal and reflects the changes that took place in personal computing. Vol. 2 (1977) documents the growth of the small computer as a tool. Vol. 3 (1978) details the new interest in programming languages. Vol. 1, #5475-0; Vol. 2, #5484-X; Vol. 3, #5490-4; each \$18.95 each.

HOW TO PROFIT FROM YOUR PERSONAL COMPUTER: Professional, Business, and Home Applications (Lewis) Describes the uses of personal computers in business applications, such as accounting, inventory, mailing lists and others. #5761-X, \$10.75

PASCAL WITH STYLE: Programming Proverbs (Ledgard, Nagin and Hueras) Helps PASCAL users write more accurate programs with guidelines and samples of programs. #5124-7, \$7.70

BASIC COMPUTER PROGRAMS FOR THE HOME (Stenberg) Offers more than 75 programs such as finances, kitchen, automotive, recreational and a listing in BASIC, a symbol table and sample data. #5154-9, \$9.95

THE FIRST BOOK OF MICROCOMPUTERS: The Home Computer Owner's Best Friend (Moody) Chapters discuss language, architecture, machine functions, home applications and much more. #5121-2, \$5.95

BASIC BASIC: An Introduction to Computer Programming In Basic Language, Second Edition (Coan) Contains more than 100 sample problems complete with results. #5106-9, \$10.50

SIXTY CHALLENGING PROBLEMS WITH BASIC SOLUTIONS, Second Edition (Spencer) Contains sixty games, puzzles, mathematical recreations and science and business problems. #5180-8, \$7.70

ADVANCED BASIC: Applications And Problems (Coan) A useful book for the programmer acquiring BASIC as a second or third language or a student seeking more about BASIC. #5855-1, \$10.75

SMALL COMPUTER SYSTEMS HANDBOOK (Libes) Enables the small computer user to purchase, assemble and interconnect components and program the microcomputer. #5678-8, \$9.95

COMPUTERS IN ACTION: How Computers Work, Second Edition (Spencer) Features microprocessors, floppy disks, COM units and languages. #5757-1, \$7.25

HOW TO BUILD A COMPUTER-CONTROLLED ROBOT (Loofbourn) Contains an introduction to the robot and construction of the basic framework, power supply, speed control and directional control circuits. #5681-8, \$9.75

THE S-100 BUS HANDBOOK (Bursky) Discusses CPU, memory, input/output, computer fundamentals and more. #0897-X, \$14.50

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- 0897-X 5154-9 5181-6 5681-8
- 5106-9 5156-5 5475-0 5753-9
- 5121-2 5159-X 5484-X 5757-1
- 5180-8 5162-X 5490-4 5761-X
- 5124-9 5177-8 5678-8 5855-1

Name _____

Address _____

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BYTE 6/81-009

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Listing 1 continued:

```

614 0575 DF .BYTE $DF,$DF,$DF,$DF,$DF,$DF,$DF,$DF
614 0576 DF
614 0577 DF
614 0578 DF
614 0579 DF
614 057A DF
614 057B DF
614 057C DF
615 057D DF .BYTE $DF,$DF,$DF,$DF,$DF,$DF,$DF,$DF
615 057E DF
615 057F DF
615 0580 DF
615 0581 DF
615 0582 DF
615 0583 DF
615 0584 DF
616 0585 DF .BYTE $DF,$DF,$DF,$DF,$DF,$DF,$DF,$DF
616 0586 DF
616 0587 DF
616 0588 DF
616 0589 DF
616 058A DF
616 058B DF
616 058C DF
617 058D DF .BYTE $DF,$DF,$DF,$DF,$DF,$DF,$DF,$DF
617 058E DF
617 058F DF
617 0590 DF
617 0591 DF
617 0592 DF
617 0593 DF
617 0594 DF
618 0595 DF .BYTE $DF,$DF,$DF,$DF,$DF,$DF,$DF,$DF
618 0596 DF
618 0597 DF
618 0598 DF
618 0599 DF
618 059A DF
618 059B DF
618 059C DF
619 059D 04 .BYTE $04 DATA AM
620 059E FF .BYTE $FF,$FF,$FF,$FF,$FF,$FF DATA FLD SYNC
620 059F FF
620 05A0 FF

```

FD400/FD1771B FLOPPY DISK FORMAT

PAGE 17

CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
620	05A1	FF								
620	05A2	FF								
620	05A3	FF								
621	05A4	00								
621	05A5	00								
621	05A6	00								
621	05A7	00								
621	05A8	00								
621	05A9	00								
622	05AA	00								
622	05AB	00								
622	05AC	00								
622	05AD	00								
622	05AE	00								
623	05AF	08								
624	05B0	FF	RSL							
625	05B1	FE	RSN							
626	05B2	FF								
627	05B3	FF	RTN							
628	05B4	01								
629	05B5	FF								
629	05B6	FF								
629	05B7	FF								
629	05B8	FF								
629	05B9	FF								

Listing 1 continued on page 334

Does timesharing on a small system make sense?

It does with OS-9™ Level One!

Now two (or more) acts can share your microcomputer stage. You will no longer have to walk away from your computer while it is busy running a long program. Because OS-9 is a multitasking operating system, you can be running a BASIC program while editing a PASCAL program, for example. This lets you make more efficient use of your time and your system, even if you only use one terminal. If your application requires multiple, independent terminals, one OS-9 system can do the work of several single-user systems.

The convenience of an advanced operating system

Sophistication does not require complexity. Many OS-9 users say that it is actually easier to use than the older 6800-type operating systems. Consider how easy it is to run multiple programs: to run a program you just type its name and hit 'return.' To run a program as a separate job, you type its name, an '&' character, then hit return. The program runs as usual, but OS-9 comes back immediately and is ready for your next command. Simple commands let you see each program's status, set its priority, or abort it.

The file management system has fast, byte-addressable random-and sequential-access files. The tree-structured multiple directory system lets you create separate disk directories for each user, project, or

application. Command line I/O file redirection means you specify what device and/or files a program will use when you run it, not when you write it.

Efficiency and hardware versatility

No other operating system can run on such a broad range of hardware: the overall RAM requirement for Level One is 32K to 56K RAM. Memory utilization is superlative because OS-9 lets multiple tasks "share" the same reentrant program. For example, if two users run BASIC09, only one "copy" is actually loaded into memory. The Level Two version of OS-9 can utilize up to a megabyte of memory on systems having memory management hardware (both versions come with complete timesharing support).

OS-9's device independent I/O system can handle almost any number and combination of I/O

devices: five or eight inch diskettes, winchester disks, disk cartridges, serial and parallel ports, memory-mapped video displays, and more.

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Each OS-9 package comes with a User's Manual and a System Programmer's Manual that cover every aspect of OS-9. If you have special requirements, you can even purchase the Source Code for most of OS-9 and related software. At Microware® we take pride in offering the best customer support in the business. Technical advice and assistance by phone, mail or telex is available during all business hours.

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Listing 1 continued:

```

629 05BA FF
630 05BB RNORM =*-1
631 05BB 00 .BYTE $00,$00,$00,$00,$00,$00,$00,$00
631 05BC 00
631 05BD 00
631 05BE 00
631 05BF 00
631 05C0 00
631 05C1 00
631 05C2 00
632 05C3 00 .BYTE $00,$00,$00,$00,$00,$00,$00,$00
632 05C4 00
632 05C5 00
632 05C6 00
632 05C7 00
632 05C8 00
632 05C9 00
632 05CA 00
633 05CB 00 .BYTE $00,$00,$00,$00,$00,$00,$00,$00
633 05CC 00
633 05CD 00
633 05CE 00
633 05CF 00
633 05D0 00
633 05D1 00
633 05D2 00
634 05D3 00 .BYTE $00,$00
634 05D4 00
635 05D5 03 .BYTE $03 INDEX MARK
636 05D6 00 .BYTE $00,$00,$00,$00,$00,$00,$00,$00

```

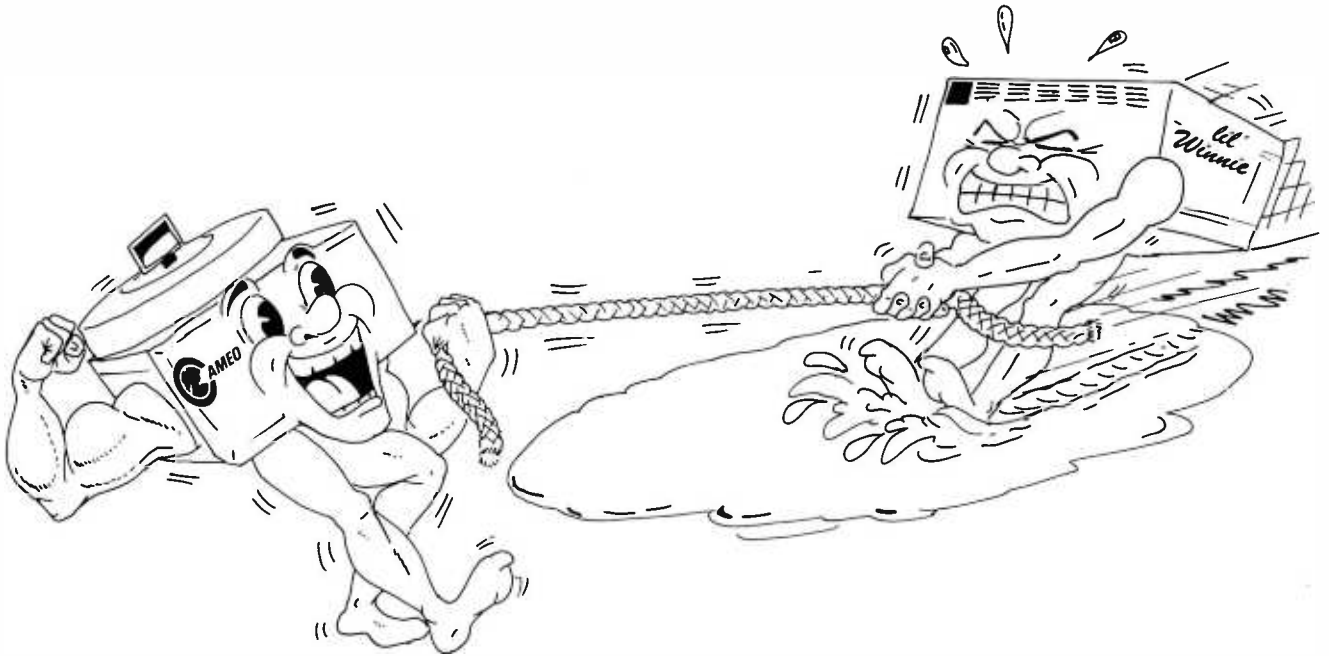
FD400/FD1771B FLOPPY DISK FORMAT

PAGE 18

CARD #	LOC	CODE	CARD	10	20	30	40	50	60	70
636	05D7	00								
636	05D8	00								
636	05D9	00								
636	05DA	00								
636	05DB	00								
636	05DC	00								
636	05DD	00								
637	05DE	00								
637	05DF	00								
637	05E0	00								
637	05E1	00								
637	05E2	00								
637	05E3	00								
637	05E4	00								
637	05E5	00								
638	05E6	00								
638	05E7	00								
638	05E8	00								
638	05E9	00								
638	05EA	00								
638	05EB	00								
638	05EC	00								
638	05ED	00								
639	05EE	00								
639	05EF	00								
639	05F0	00								
639	05F1	00								
639	05F2	00								
639	05F3	00								
639	05F4	00								
639	05F5	00								
640	05F6	00								
640	05F7	00								
640	05F8	00								
640	05F9	00								
640	05FA	00								
640	05FB	00								
640	05FC	00								
640	05FD	00								
641	05FE		RSTR	=*-1						
642	05FE			.END						

Listing 1 continued on page 336

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*with fast, reliable,
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- The Cameo cartridge disk subsystem provides 40 to 100 times the storage capacity of floppy disks. Data transfer rates and reliability are correspondingly faster.
- Our cartridge feature lets you . . . COPY . . . BACK UP . . . EXTEND . . . or REMOVE your data base easily by just removing the disk pack as you now remove your floppy.
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Listing 1 continued:

END OF MDS/TECHNOLOGY 650X ASSEMBLY VERSION 5
 NUMBER OF ERRORS = 0. NUMBER OF WARNINGS = 0

SYMBOL TABLE

SYMBOL	VALUE	LINE	DEFINED	CROSS-REFERENCES									
BASIC	0240	233	197	199	210	362	365						
CHD	0000	175	312	536	568								
CHPANL	0248	239	204	218	282	302							
CDMAND	00E2	184	195	223	228	257	260	263	272	314	361	422	
			427	453	460	480							
CPLP	024A	240	247										
CRA	CC00	96	338	341	515	519							
CRB	CC0F	99	350	355	359	364	404						
DATA	0006	174	200	279	296	540							
DELAY	0435	583	565	574									
DL1	0430	587	588										
DL2	0439	585	590										
DVCODE	00E0	182	351	401									
ERRCODE	00E1	183	399	434	488								
ERJ	0389	468	416	417	451	454							
FDBUF	00E6	188	286	289	298	306	405	499					
FDEMT	0225	214	261	409									
FOFL	0000	137	****										
FOINT	02F6	346	513	578									
FOID	0326	393	****										
FDRD	0080	152	****										
FORDa	00C4	134	****										
FORDT	00E4	135	****										
FORSF	0002	127	360										
FDSK	0D12	128	259										
FDST	0022	129	****										
FDST1	0042	130	566										
FDSTD	0062	131	****										
FDMT	00A0	133	****										
FDMTT	00F4	136	534										
FDRMAT	0385	513	****										
GD	0300	527	577										
NEXT	040E	565	549										
PULSE	02C0	321	205	209	216	244	254	270	315				
QAFa	0DFA	163	****										
QAFB	0DFB	162	****										
QAF8	0DF8	165	****										
QAF9	0DF9	164	****										
Q0	0008	145	****										
QCRC	0DF7	159	****										
QE	0004	151	****										
QFA	0001	153	****										
QFB	0000	152	****										
QF8	0011	155	****										
QF9	0010	154	****										
QH	0008	142	566										
QIAH	0DFC	160	****										
QIDH	0DFE	161	****										
QID	0001	147	****										
QI1	0002	148	****										
QI2	0004	149	****										
QI3	0008	150	****										
QH	0010	144	****										
QS	0001	146	****										

SYMBOL	VALUE	LINE	DEFINED	CROSS-REFERENCES				
QU	0010	143	****					
QV	0004	141	****					
ROATA	0284	277	226					
ROL	028E	281	283	288	290			
ROT	038D	473	425	441	447			
ROFI	03A3	488	455	475	481			
ROF2	03AC	496	489					
READ	0029	169	214	242	252	279		

Listing 1 continued on page 338

IF YOU CAN WAIT A MINUTE, WE CAN SAVE YOU \$1,000.

With the Starwriter™ Daisy Wheel 25 cps printer from C. Itoh.

A business letter, written on a 45 cps word-processing printer, might take about two minutes to print.

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Listing 1 continued:

REND	0500	597	524	546	576	530	554															
RETRY	033A	405	500																			
RNORM	05BA	630	554																			
RSL	05B0	624	****																			
RSN	05B1	625	528	553																		
RSTRT	05FD	641	530	545																		
RTN	05B3	627	526	575																		
RTN1	035C	432	449	478	484																	
RTN2	035F	434	469																			
RTN3	0365	438	492																			
SAD	CC0C	95	284	300	322	325	348	535	547	567												
SADD	CC0C	94	339	517																		
SBD	CC0E	98	234	281	301	323	324	332	353	537	538	539										
			541	548	560	569	570	571	572													
SBDD	CC0E	97	357																			
SECT	0004	173	206	267																		
SECTOR	00E5	187	208	269	407	436	483	497														
SETDVC	0337	404	402																			
SETUP	02DE	331	201	207	215	243	253	268	280	297	313											
SET1	02E8	337	335	347																		
SLP	0421	572	573																			
STAT	0000	171	214																			
STATUS	00E3	185	245	415	448	466	474	477														
TIME1	0000	179	584	589																		
TIME2	0001	180	586	587																		
TRACK	00E4	186	202	255																		
TRK	0002	172	252																			
TRKEND	0409	560	561																			
TYPE1	0200	195	224																			
TYPE2	025B	252	225																			
TYPE2A	0274	267	256																			
TYP1	036B	447	423																			
TYP2	037D	459	424																			
WDATA	02A3	294	229	273																		
WDT	03EE	545	552	556																		
WLP	03F7	548	550																			
WRITE	0019	170	200	206	267	296	312	536	540	568												
WRT	0383	465	428																			
WRTCMD	02C2	312	233	277	294																	
WTL	02AD	298	305	307																		
WTL1	02B4	301	303																			

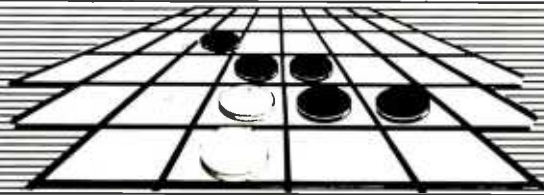
INSTRUCTION COUNT

ADC	0
AND	1
ASL	3
BCC	1
BCS	3
BEQ	11
BIT	19
BMI	5
BNE	15
BPL	8
BRK	0
BVC	6
BVS	0
CLC	1
CLD	0
CLI	0
CLV	0
CMP	6
CPX	0
CPY	0
DEC	9
DEX	4
DEY	2
EOR	4
INC	6
INX	1
INY	2
JMP	4
JSR	27
LDA	52
LDX	8
LDY	6

Listing 1 continued on page 340

First SARGON,

And now... REVERSAL



Hayden Games and Gameware

★ **REVERSAL** (Spracklens) Winner of the software division of the First International Man-Machine OTHELLO™ Tournament, this version of the 200 year old game Reversi, features 27 levels of play and high-resolution color graphics and sound. Special "Kibitz" option gives you hints in playing. Written by the authors of SARGON II, the first great computer chess program! **07004, Apple II tape, \$29.95; 07009, Apple II disk, \$34.95.**

★ **BLACKJACK MASTER: A Simulator/Tutor/Game** (Wazaney) A serious game that performs complex simulations and evaluations of playing and betting strategies. **05303, TRS-80 Level II tape, \$24.95; 05308, TRS-80 Disk Version, \$29.95**

★ **SARGON II** (Spracklen) The first great computer chess program! "...an excellent program which will provide a true challenge for many players... Save your money and buy SARGON II..." '80 Software Critique. **03403, TRS-80 Level II; 03404, Apple II; 03410, OSI C1P; 03440, OSI C4P; each tape \$29.95. 03408, TRS-80 Level II Disk; 03409, Apple II Disk; 03414, PSI C1P Disk; 03444, OSI C4P Disk; 03484, C8P Disk; each \$34.95**

MICROSAIL (Johnson) A true test of your nautical skills as you race against wind, tides, and time. **04401, PET tape, \$11.95**

GRIDIRON: A Microfootball Game (Microllair Associates) Be both offensive and defensive quarterbacks. Includes time-outs, penalties, and the two-point conversion option used in college football. **03003, TRS-80 Level II tape, \$12.95**

MAYDAY (Breitenbach) Out of fuel! Try to avoid crashing with this challenging airplane flight simulation. **02601, PET tape, \$9.95**

STARCLASH (Walton) An exciting game of galactic strategy for one or two players. **05903, TRS-80 Level II tape, \$16.95**

ROYAL FLUSH: Competitive Poker Solitaire (Wazaney) A game you can play alone or with any number of players. High score wins in this poker-based, fun-filled card game. Choose from possible game variations. **07101, PET; 07103, TRS-80 Level II, each tape, \$14.95**

BACKGAMMON (Wazaney) A classic game of skill and luck played against a preprogrammed opponent. **02501, PET; 02503, TRS-80 Level II; each tape, \$10.95**

BATTER UP!!: A Microbaseball Game (Savon) Action-packed baseball with 3 levels of play. **02801, PET; 02803, TRS-80 Level II; each tape, \$10.95**

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★ ★ **HISTO-GRAPH** (Boyd) A calendar-based histogram or bar-graph production system. Allows the user to enter numeric data that relates to a date, and reproduces that data as a high-resolution histogram. **09009, Apple II Disk, \$29.95**

★ ★ **OP-AMP DESIGN** (Gabrielson) Provides the necessary values for your design and will suggest appropriate op-amp types. Includes a choice of six op-amps, and the program will then determine if your selection of an op-amp will be acceptable within your chosen parameters. Can be updated to accommodate future op-amps. **09704, Apple II tape, \$16.95**

★ ★ **DOUBLE PRECISION FLOATING POINT FOR APPLESOFT™** (S-C Software) Extends the accuracy of the arithmetic available on the Apple from nine digits to a full 21-digit precision on all functions in Applesoft compatible format. **09409, Apple II Disk, \$49.95**

★ ★ **DATA-GRAPH** (Boyd) Aids in the preparation of graphs and charts. Numeric data can be entered into Data-Graph and used to create colorful one-, two-, or four-quadrant graphs. **09109, Apple II Disk, \$49.95**

More from Hayden

FINPLAN: A Financial Planning Program for Small Businesses (Montgomery) Allows you to enter data from a balance sheet into the program, to make assumptions about the 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 be used only with TRSDOS Vers on 2.3. **05103, TRS-80 Level II tape, \$69.95; 05108, TRS-80 Level II Disk Version, \$74.95**

DATA MANAGER: A Data Base Management System and Mailing List (Lutus) Store information on a floppy disk, and retrieve it quickly and easily by specific names, or by category. **04909, Apple II Disk Version, \$49.95.**

PROGRAMMING IN APPLE™ INTEGER BASIC: Self-Teaching Software (Banks & Coan) Teach yourself Apple Integer BASIC and control your own progress at all times with this interactive programmed instruction format. **05004, Apple II, tape, \$29.95; 05009, Apple II Disk Version, \$39.95**

APPLE™ ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM: An Assembler/Editor/Formatter (Lutus) Write and modify your machine language programs quickly and easily. **04609, Apple II Disk Version, \$39.95.**

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81-009

- | | | |
|--------------------------------|--------------------------------|--------------------------------|
| <input type="checkbox"/> 02501 | <input type="checkbox"/> 03444 | <input type="checkbox"/> 05409 |
| <input type="checkbox"/> 02503 | <input type="checkbox"/> 03484 | <input type="checkbox"/> 05509 |
| <input type="checkbox"/> 02601 | <input type="checkbox"/> 04401 | <input type="checkbox"/> 05903 |
| <input type="checkbox"/> 02801 | <input type="checkbox"/> 04609 | <input type="checkbox"/> 07004 |
| <input type="checkbox"/> 02803 | <input type="checkbox"/> 04909 | <input type="checkbox"/> 07009 |
| <input type="checkbox"/> 03003 | <input type="checkbox"/> 05004 | <input type="checkbox"/> 07101 |
| <input type="checkbox"/> 03403 | <input type="checkbox"/> 05009 | <input type="checkbox"/> 07103 |
| <input type="checkbox"/> 03404 | <input type="checkbox"/> 05103 | <input type="checkbox"/> 09009 |
| <input type="checkbox"/> 03408 | <input type="checkbox"/> 05108 | <input type="checkbox"/> 09109 |
| <input type="checkbox"/> 03414 | <input type="checkbox"/> 05303 | <input type="checkbox"/> 09409 |
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Listing 1 continued:

```

LSR      0
NOP      0
ORA      2
PHA      6
PHP      0
PLA      10
PLP      0
ROL      0
ROR      1
RTI      0
RTS      7
SBC      0
SEC      1
SED      0
SEI      0
STA      27
STX      10
STY      1
TAX      1
TAY      1
TSX      0
TXA      1
TXS      0
TYA      2

```

SYMBOLS = 101 (LIMIT = 800) # BYTES = 837 (LIMIT = 8192)

LINES = 853 (LIMIT = 3000) # XREFS = 257 (LIMIT = 1600)

Listing 2: Example of a routine that reads disk track 3 into memory, starting at location hexadecimal 1000. This routine also illustrates the use of the ERRCODE variable.

```

JSR FDINT      Initialize
LDA #$9C      Read multiple
STA COMMAND   sector command
LDA #$03      Request track
STA TRACK     number 3
LDA #0        Set buffer
STA FDBUF     address
LDA #$10      at
STA FDBUF + 1 hexadecimal 1000
JSR FDIO      Do I/O
LDA STATUS    check for
BNE ERROR     error

```

Listing 3: Simple testing program for a disk controller/6502 microprocessor combination. When the BRK (break) occurs, the variables listed in table 6 can be set to test the various controller functions.

```

INIT  JSR FDINT
      BRK
      BRK
GO    JSR FDINT
      BRK
      BRK
      JMP GO

```

Text continued from page 304:

1000. The status byte indicates if the read operation was successful. If the read test appears good, various other commands should be attempted to increase your familiarity with the 1771 and drive operation.

Extensions

With the addition of an external multiplexing circuit to switch the floppy-disk control lines, multiple drives can be controlled. Multiple drives, however, add a new software-control problem. Since the 1771 re-

tains the current head location, it is necessary to update the track register when switching between drives. A memory variable to contain the head location of each drive can be used to adjust the 1771's register.

A simplified version of the floppy-disk controller can be used to operate 5-inch disk drives in either single- or dual-density. In addition, this disk design is extensible to a more elaborate controller that uses a dedicated 6502 to communicate over a parallel or serial interface to a host computer.

Conclusion

Floppy-disk drives provide sufficient capacity and performance to meet the needs of most microcomputer users. By combining hardware and software, a floppy-disk system can be constructed economically without sacrificing any function or performance. The 6502 microprocessor, with a few hundred bytes of program, can control head movement and data transfer by utilizing the 1771 controller. The software provides a flexible, yet economic, solution to mass-storage problems. ■

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Ask BYTE

Conducted by Steve Ciarcia

Easy Data Entry?

Dear Steve,

I enjoyed your article "Build a Low-Cost, Remote Data-Entry Terminal." (See the September 1980 BYTE, page 26.) Your idea is close to the type of device I need: a simple data-entry terminal that has a ten-character display and can be used to record data, ten characters at a time, using an audio-cassette recorder. Is there an easy way to use your device for this?

Roy Pittman
Stillwater OK

The remote data-entry terminal described in that article will do some of the things

you want, but not everything. It cannot support more than an 8-bit display without circuit modification. It can, however, easily store and send up to fourteen characters entered sequentially on the keypad (refer to the last paragraph, on page 32 of the article).

Although it is a little involved and requires some extra button pushes to load the characters, the data-entry terminal could be used as you have suggested. To do it, you first press the Control-Escape to enter the storage mode (the remote terminal sends a hexadecimal FA output to the recorder). Decoding the FA code will allow automatic turn-on of the recorder. The

next one to fourteen keys pressed will be stored. They are automatically sent as a single message when a Control-semicolon is typed.

As designed, the data rate is 1200 bps (bits per second). To lower the data rate to something more manageable, say 300 bps, you simply lower the crystal frequency proportionately. To remotely switch a tape recorder on and off, you can use the keyboard function decoder that I described in a previous article. (See "Build a Keyboard Function Decoder," July 1978 BYTE, page 98.) . . . Steve

Backup Supplies

Dear Steve,

Allow me to add another request for backup power supplies. I want to use a computer for Bible translating for tribal people, but our electric power not only blacks out for a few minutes to several days, but when the local welder starts work, the lights dim each time he strikes an arc.

My son had a computer damaged when a copying machine was turned on, so I wonder about the welder. I had decided on a solution similar to the ideas you have mentioned, but I felt that I couldn't design a sine-wave inverter and that a computer probably wouldn't accept the square wave from a Heathkit inverter. How about the motor/generator rigs used by the military for B+ power supplies? A 1974 McMaster-Carr catalog shows that they were available in 24, 28, 32, 63, and 110 VDC input and 250 to 2000 W output at 115 V 60 Hz. Prices ranged from \$200 to \$600.

Of course, this wouldn't be

as efficient as a solid-state inverter, and would need maintenance (since the rigs have brushes) but it might be easier and cheaper to buy equipment on the surplus market.

Also, who publishes *Digital Design*?

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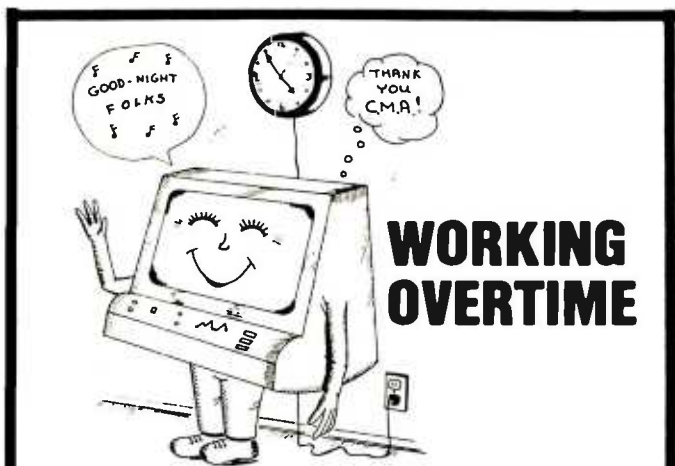
Motor/generator combinations are definitely a reasonable backup power system. That was all there was before solid-state converters. I cannot speak for the condition of a World War II surplus unit, but if it operates, it can be an economical solution to your problem. In fact, many computer manufacturers (such as Control Data) frequently use motor/generators in their installations. Be careful to monitor the output frequency as well as the voltage when you first start it. The years may have taken their toll on the regulator section.

Digital Design is published by Benwill Publishing Corporation, 1050 Commonwealth Ave, Boston MA 02215. The issue covering uninterruptible power supplies was February 1980 (Volume 10, Number 2). . . . Steve

Bank Switching

Dear Steve,

With the recent price reduction of dynamic memory circuits, a 64 K-byte memory system can be built with 32 devices (at \$96) or 128 devices (for \$64). I read BYTE and other fine publications and I keep coming across an interesting concept called bank switching. What exactly is bank switching? Also, an idea I have is to latch the data at a port bus to provide a



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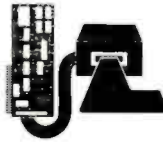
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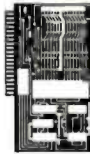
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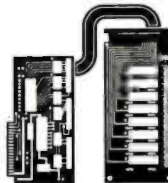
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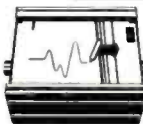
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Ask BYTE

total address bus of 24 bits. Can I do this?
Simon Chapman
 Petaluma CA

Memory is indeed becoming inexpensive these days. Many personal computers will soon contain more than 64 K bytes of memory. To use the extra memory, they must, of course, use bank switching.

A bank of memory is some portion of memory that can be directly addressed by the processor. If you had an Apple II computer with 48 K bytes of memory, all 64 K bytes (including read-only memory) would be in the same bank of memory. Addressing the 64 K requires 16 address bits. If you were to add another 64 K of directly addressable memory, 17 bits would be required. Since the 6502 microprocessor (and the Z80 for that matter) has only 16 address bits, the additional bit must be created under program control.

The typical method is to dedicate a latched output port to this function. To access this second bank of memory, a program in the first bank sets the port output high, simulating the seventeenth address bit. The computer then works exclusively in the second bank. To return to the first bank, a program in the second bank resets the port to a low level.

As you can see, it can get complicated switching back and forth. Mirror images of the operating-system software would have to be resident in both banks. The solution to this problem is to bank-switch memory in 32 K-byte increments rather than 64 K bytes. The typical system would have the first 32 K-byte bank contain the operating system and switch up to eight individual 32 K banks occupying the second 32 K range. Activation of one of the eight boards is

handled by setting a bit on an output port (each bit is a separate memory-bank enable) through the always resident operating system. In most cases, the bank-switching is transparent to the user and takes only a few instructions.

Perhaps as soon as I get some of the new 64 K-byte integrated circuits, I'll discuss this topic in greater depth in an article. . . . Steve

Computer Stores

Dear Steve,

I have a degree in electronics and my fiancée has a degree in business management. We live in a small town and would like to open a computer store, for small businesses, homes, and industry. Where can I get some help and ideas on getting started? There are no computer-related jobs around here, and I feel like I'm being left out.

Bill Bass
 Bristol TN

Starting a computer store is a costly and tough job. When you first open a computer store, most personal-computer manufacturers will only ship cash-on-delivery, and many items must be in stock for you to sell them. When hobbyists walk into a computer store, rather than ask if you have it in stock. Your advantage is not price—mail-order houses are generally much cheaper—so it must be demonstration and availability that sells your products.

Turnover of stock is the key to success. Make sure there is a large enough market in your area before committing to this endeavor, and only believe about a quarter of the people who say they will buy something from you if you open a store.

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Ask BYTE

puter store is to visit one in another town (make sure it's not close enough to be a competitor) and ask the owner the questions you are posing to me. This is a new field and, unfortunately, there are as many failures as there are successes. Be careful, but don't hesitate to strike out on your own. . . . Steve

Double Characters

Dear Steve,

I would like to acquire a home terminal, since terminal time at school is sometimes difficult to get. Is it possible to build a circuit to connect between the output of a TRS-80 Color Computer or a Videotex and my television or monitor that would double the number of characters per line that these machines display?

The Videotex seemed like the answer to my problems, but I need more than 32 characters to log on to the

system I use.

Eric Lutz
Columbia PA

When you buy a computer, you get what you pay for. The hardware to produce 32 characters is cheaper than that to produce 64. While it's quite possible that some hobbyist will design a circuit to do the conversion you suggest, it hasn't happened yet. Also, I wouldn't buy equipment on the presumption that you can easily redesign it.

As for logging onto a computer, the number of characters displayed on the screen is usually immaterial. The software-terminal program used with the computer should "wrap around" at the end of 32 characters onto the next line (even though you haven't hit the carriage-return key yet). The length of the line you send is entirely determined by when you type a carriage return (after 50, 75, or any number characters).

I wouldn't be especially concerned about a 32-character display given the price/performance ratio of the machine. . . . Steve

Comparing Frequency

Dear Steve,

I am looking for a circuit that compares two input signals and detects which has the greater frequency. The project I am building has a +5 V supply, so it would be handy to use TTL (transistor-transistor logic). Are there single integrated circuits to perform this function?

Marvin Green
Tualatin OR

There are various ways to compare frequencies. The comparison can be either analog or digital. One analog method is to use frequency-to-voltage converters and simple "window" comparators. (This technique is reliable only at lower frequen-

cies.)

Since you mentioned +5 V, you're probably more interested in a digital-frequency comparator. Generally this is accomplished by comparing the phases of the two signals. An integrated circuit specifically designed for this purpose is the Motorola MC4044 Phase Comparator. (Determining $A > B$ or $B > A$ requires additional circuitry.)

If you know the ranges of the frequencies that you wish to compare, often it is easier to compare one unknown to some preset limits. (See figure 1.) Two retriggerable one-shots have their periods set for the upper limit (F_1) and lower limit (F_2) of the capture range. When the unknown frequency (F_0) is applied, it is gated through the remaining circuitry to provide logic outputs such as $F_0 > F_1$, $F_0 > F_2$, $F_0 < F_1$, or $F_0 < F_2$ Steve

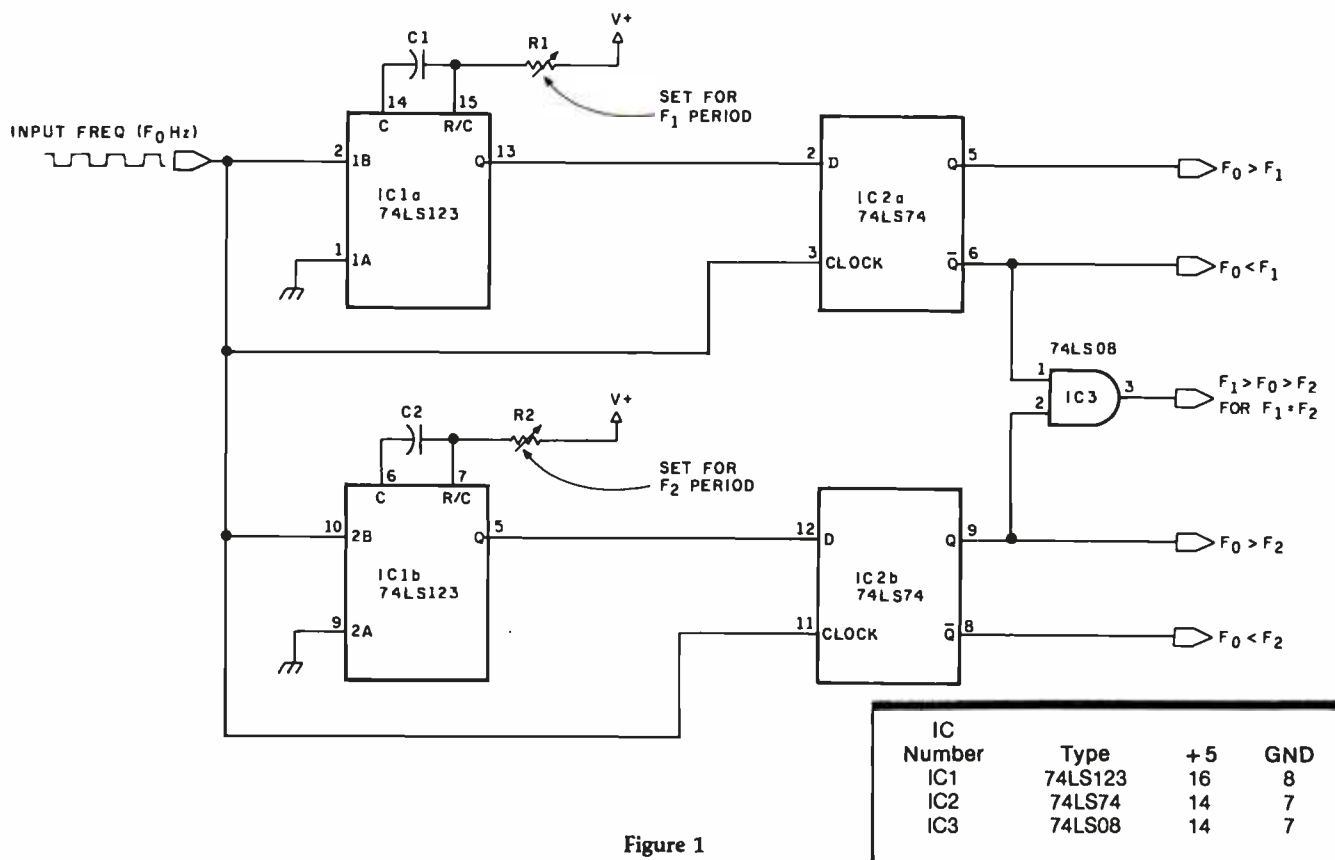


Figure 1



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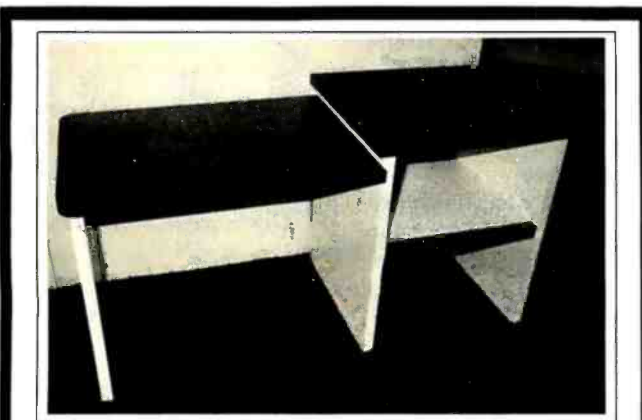
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Software Received

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This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Apple

Address Book, name and address file and telephone dialer for the Apple II. Floppy disk, \$49.95. Muse Software Company, 330 N Charles St, Baltimore MD 21201.

Data Fixer, disk software-repair utility for the Apple II. Floppy disk, \$29.95. Image Computer Products, 615 Academy Dr, Northbrook IL

60062.

Data Plot, on-screen data-graphing program for the Apple II. Floppy disk, \$59.95. Muse Software Company, (see above).

Invasion Force, graphics game for the Apple II. Cassette, \$19.95. Compu-Things, 708 Broadway, Chelsea MA 02150.

Monitor Extender, machine-language utility for the

Apple II. Cassette, \$19.95. Image Computer Products (see above).

Spelling, three educational games for the Apple II. Floppy disk, \$21.95. Software by Witzel, POB 2123, Littleton CO 80161.

Super Bar and Wine Guide, wine selection guide and bar recipe program for the Apple II. Floppy disk, \$24.95. Cine-Aero Productions, 1821 N Frederic St, Burbank CA 91505.

Super Text Form Letter Module, add-on module to Super Text II word-processing package for the Apple II. Floppy disk, \$100. Muse Software Company (see above).

Super Text II, word processor for the Apple II. Floppy disk, \$150. Muse Software Company (see above).

Atari

Shuttle Ascent Simulation, space-shuttle simulation for the Atari 800. Cassette, \$9.95. Starbound Software, POB 214, Cocoa Beach FL 32931.

Commodore

Addition, educational program for the Commodore PET. Cassette, \$20. Teaching Tools, POB 12679, Research Triangle Park NC 27709.

Create-A-Base, data-base management program for the Commodore CBM. Floppy disk, \$360. Micro Computer Industries Ltd, 1520 E Mulberry, Fort Collins CO 80524.

Subtraction, educational program for the Commodore PET. Cassette, \$20. Teaching Tools (see above).

Exidy

Toolkit, screen editor and enhancements for the Exidy Sorcerer. Cassette, \$69.95. North American Software, POB 1173 Station B, Downsview, Ontario, M3H 5V6, Canada.

Sword, word processor for the Exidy Sorcerer. Cassette, \$34.95. North American Software (see above).

Super Graphic Scratch Pad Version 2.2, graphics utilities for the Exidy Sorcerer. Cassette, \$24.95. North American Software (see above).

Radio Shack

Aviation, aviation-calculation package for the TRS-80 Pocket Computer. Cassette, \$24.95. Radio Shack, 1 Tandy Ctr, Fort Worth TX 76102.

Cheaptalk, voice-output routines for the TRS-80 Model I. Cassette, \$19.95. Alan Saville, POB 5190, San Diego CA 92105.

Income Property Analysis System, business-analysis program for the TRS-80 Model I or III. Floppy disk, \$225. Advanced Business Microsystems, 5801 Marvin D Love Fwy, #103, Dallas TX 75237.

LDOS, disk operating system for the TRS-80 Model I. Floppy disk, \$149. Galactic Software Ltd, 11520 N Port Washington Rd, Mequon WI 53092.

Olympic Decathlon, multi-player graphics game for the TRS-80 Model I. Floppy disk, \$24.95. Microsoft Consumer Products, 400 108th Ave NE, Suite 200, Bellevue WA 98004.

RSM Patch, modification package to Small Systems Software's RSM for the TRS-80 Model III. Cassette, \$9.95. Remarkable Software, POB 1192, Muskegon MI 49443.

SECS, full-screen editor for the TRS-80 Color Computer. Cassette, \$29.95. Datasoft Inc, 16600 Schoenborn St, Sepulveda CA 91343.

SIGMON, machine-language monitor for the TRS-80 Color Computer. Cassette, \$29.95. Datasoft Inc (see above). ■

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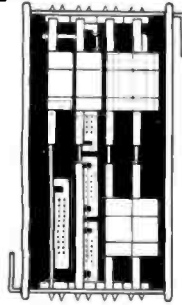
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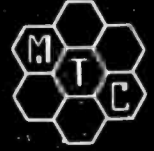


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CALL FOR INFORMATION ON OTHER PRODUCTS

Books Received

BASIC, A Hands-On Method, Second Edition, Herbert D Peckham. New York: McGraw-Hill, 1981; 17.5 by 23.5 cm, 306 pages, softcover, ISBN 0-07-049160-7, \$12.95.

BASIC-Pack Statistics Programs for Small Computers, Dennie Van Tassel. Englewood Cliffs NJ: Prentice-Hall, 1981; 21 by 28 cm, 230 pages, softcover, ISBN 0-13-066381-6, \$16.95.

Basically Speaking, A Guide to BASIC Programming for the Interact Computer, Micro Video Corporation. Ann Arbor MI: Micro Video Corporation, POB 7357, 1980; 23 by 28 cm, 201 pages, softcover, ISBN-none, \$14.95.

Data Structures Using Pascal, Aaron M Tenenbaum and Moshe J Augenstein. Englewood Cliffs NJ: Prentice-Hall, 1981; 18.5 by 24.5 cm, 545 pages, hardcover, ISBN 0-13-196501-8, \$23.95.

The 8085 Microprocessor, Fundamentals and Applications (Hands-On), Howard Boyet. New York: MTI Publications, 1980; 18 by 25.5 cm, 420 pages, softcover, ISBN-none, \$17.95.

First Course in Data Processing with BASIC, J Daniel Couger and Fred McFadden. Somerset NJ: John Wiley & Sons, 1981; 21.5 by 28 cm, 443 pages, softcover, ISBN 0-471-08046-2, \$17.95.

First Course in Data Processing with BASIC, COBOL, FORTRAN, and RPG, J Daniel Couger and Fred McFadden. Somerset NJ: John Wiley & Sons, 1981; 21.5 by 28 cm, 532 pages,

softcover, ISBN 0-471-05581-6, \$20.95.

Fundamentals of Programming in BASIC, Robert C Nickerson. Cambridge MA: Winthrop Publishers, 1981; 17.5 by 23.5 cm, 400 pages, softcover, ISBN 8-87626-305-8, \$12.95.

Introduction to Computer Operations, Second Edition, W M Fuori; A D'Arco; and L Orilia. Englewood Cliffs NJ: Prentice-Hall, 1981; 18.5 by 24.5 cm, 620 pages, hardcover, ISBN 0-13-480392-2, \$19.

Introduction to Computer Data Processing, Third Edition, Wilson T Price. New York: Holt, Rinehart and Winston, 1981; 19 by 24 cm, 577 pages, hardcover, ISBN 0-03-056728-9, \$18.95.

Invitation to Pascal, Harry Katzan Jr. Princeton NJ: Petrocelli Books, 1981; 16.5 by 24 cm, 233 pages, hardcover, ISBN 089433-103-5, \$17.50.

MA-2 Microcomputer Applications, Volume 1, Howard Boyet and Ron Katz. New York: MTI Publications, 1979; 15.5 by 23 cm, 461 pages, softcover, ISBN 0-89704-026-0, \$16.

MA-2 Microcomputer Applications, Volume 2, same as above, 290 pages, ISBN 0-89704-027-9, \$9.

Microprocessor System Debugging, Noordin Ghani and Edward Farrell. Somerset NJ: John Wiley & Sons, 1980; 18.5 by 28.5 cm, 143 pages, softcover, ISBN 0-471-27860-2, \$43.50.

Microprogrammed Control and Reliable Design of

Small Computers, George D Kraft and Wing N Toy. Englewood Cliffs NJ: Prentice-Hall, 1981; 16 by 24 cm, 428 pages, hardcover, ISBN 0-13-581140-6, \$21.95.

The Pascal Handbook, Jacques Tiberghien. Berkeley CA: Sybex, 1981; 18 by 23 cm, 500 pages, softcover, ISBN 0-89588-053-9, \$14.95.

Programming with FORTRAN/WATFOR/ WATFIV, David T Basso and Ronald D Schwartz. Cambridge MA: Winthrop Publishers, 1981; 17.5 by 23.5 cm, 407 pages, softcover, ISBN 0-87626-638-3, \$12.95.

Systems Analysis and

Management: Structure, Strategy and Design, Donald V Steward. Princeton NJ: Petrocelli Books, 1981; 16.5 by 24 cm, 287 pages, hardcover, ISBN 0-89433-106-X, \$25.

TRS-80 Assembly Language, Hubert S Howe Jr. Englewood Cliffs NJ: Prentice-Hall, 1981; 18.5 by 24.5 cm, 186 pages, hardcover, ISBN 0-13-931139-4, \$15.95.

Using Microprocessors and Microcomputers: The 6800 Family, J D Greenfield and W C Wray. Somerset NJ: John Wiley & Sons, 1981; 19.5 by 24.5 cm, 460 pages, hardcover, ISBN 0-471-02727-8, \$22.95. ■

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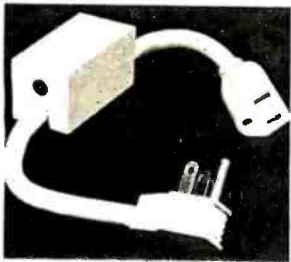
Some partially sighted individuals can now work with computer terminals thanks to M Daniel Simkovitz, a partially sighted Wayne State University researcher in electrical engineering. The device, called the Low Vision Terminal System (LVTS), allows people with poor vision to see and read computer output.

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Dr Edward R Fisher, associate dean for research and graduate programs at the College of Engineering, assisted Mr Simkovitz with the patent process. A US patent is pending in Wayne State University's name. The two are now searching for a manufacturer that will help develop and market the LVTS. For more information, contact Dr Fisher, (313) 577-3861, or Dan Simkovitz, (313) 577-3902, at Wayne State University, Detroit MI 48202. ■

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Startrek 4.0 and Startrek 3.5

Scott Mitchell, 346 S Taylor St, Manchester NH 03103

Startrek 3.5 is the descendant of Lance Micklus's Startrek 3.0. It has been revised five times and is thoroughly debugged. It is the most widely distributed Startrek game. At first I thought it was unfair to compare Startrek 4.0 by Jeff Hamilton with Startrek 3.5, but after playing version 4.0, I found features in it that I liked, and many that BYTE readers might prefer.

Startrek 3.5 is a menu-driven program. After each sequence of events, you are returned to a list that has eleven command numbers and one invisible command. From this list, you pick and choose commands as if it were a menu. Commands include control of phasers, photon torpedoes, impulse and warp drives, long- and

short-range sensor scans, and alert status. You can display the ship's current status, call up damage control to see what is or isn't functioning, call for repairs, or have the science computer tell you what objects are in your quadrant. The ship's computer command takes you into a subsystem that scans its data base for data on Klingon warships, starbases, class F stars, planets, unexplored areas, etc. The computer obtains this information each

At a Glance

Name
Startrek 4.0

Type
Game

Author
Jeff Hamilton

Manufacturer
The Programmers Guild
POB 66
Peterborough NH 03458

Price
\$14.95 tape, \$19.95 disk

Format
Cassette or 5-inch floppy
disk

Language
BASIC

Computer
TRS-80 Model I

Documentation
Two pages, 11.5 by 18 cm
(4½ by 7 inches)

Audience
All space-war game fans

Challenge
Very good

Name
Startrek 3.5

Type
Game

Author
Lance Micklus

Manufacturer
Adventure International
POB 3435
Longwood FL 32750

Price
\$14.95 tape, \$19.95 disk

Format
Cassette or 5-inch floppy
disk

Language
BASIC

Computer
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Documentation
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by 15.5 cm (2½ by 6 inches)

Audience
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Challenge
Excellent

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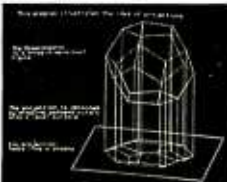


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time you request a sensor scan. The invisible command saves the game on disk or cassette.

Startrek 4.0 is not a menu-driven game; instead it runs in real time. To compare the two, let's say you were battling a Klingon warship and you fired your photon torpedoes and missed. The Klingon fired back and knocked out your science computer. At this point, 3.5 returns to the menu and waits for you to enter your next move. On the other hand, in version 4.0, you must think and act quickly because situations occur as in real-time events. For example, a Klingon can wander into your quadrant, spot and fire at you, and leave you dangling in space while you slipped out for a snack. Ship repairs also go on in real time. In general, Jeff Hamilton's Startrek 4.0 has the same commands as Startrek 3.5, but they are displayed in a small window on your control console as you enter them.

Startrek 3.5 has extensive and reasonably quick graphics. Sounds have been added to the game, but they are kept simple so as not to become tiring after many hours of play. Startrek 4.0 doesn't have sound and uses rather simple graphics. The screen accurately demonstrates what is happening, and it shakes wildly when you are hit.

The objective of 4.0 is to destroy all the Klingons within thirty-two stardates, while stopping at a starbase only twice. The objective of 3.5 is to destroy twenty Klingons by a certain stardate, but the game does not end there. You must also explore and collect as much data as you can about an entire region, and you must locate and orbit

all class M planets. As you're doing that, you must cope with pulsars, black holes, and, of course, the crafty Klingons. When you have destroyed twenty Klingons and feel you have collected enough data, you dock at a starbase, where Starfleet Command rates your performance on a scale of 1 to 100%.

Startrek 3.5 has a three-dimensional universe (8 by 8 by 3) with 192 quadrants; a quadrant has 64 (8 by 8) sectors. Startrek 4.0 has a two-dimensional universe (8 by 8) with 64 quadrants. Again, each quadrant has 64 (8 by 8) sectors.

In Startrek 4.0, the computer can be used to help you figure out the exact coordinates to fire photon torpedoes or to navigate the ship. This helps your accuracy when you first start playing the game. Klingon warships using a cloaking device that makes them seem invisible are an extra problem in version 4.0, because they are immune to the photon torpedoes when in this state. In 4.0, but not in 3.5, if a star is in your path, you must navigate around it. In version 3.5, you must be true to your Starfleet orders, and never destroy a planet, star, or starbase, or the game ends immediately. The Klingons can maneuver out of the way of photon torpedoes and phaser fire.

Conclusions

While Startrek 3.5 is my personal favorite, Startrek 4.0 has an interesting angle to it. To some, the real-time aspect of 4.0 may make all the difference, but, all in all, both games are smooth-running and well debugged. ■

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The BDS C Compiler

Christopher Kern, 201 I St SW, Apt 839
Washington DC 20024

The ubiquitous Pascal compiler has joined the ubiquitous BASIC interpreter as a staple of the microcomputer programming environment, bringing with it the concepts of hierarchical program design, orderly program development, and legibility that generally fall together under the heading "structured programming."

But for those who are not ideologically committed to the proposition that Pascal is the most congenial programming language—and who have access to an 8080-based computer and the CP/M operating system—I would like to suggest an alternative: a language created at Bell Laboratories, named, with characteristic concision, C. C provides the same structured programming approach as Pascal, but it has a cleaner and crisper syntax, one that

is both closer to the ultimate machine language of the computer and, paradoxically, somewhat easier to become familiar with than Pascal.

My recommendation is largely a product of my experience with one of the best and least expensive programming language packages I have come across: the C compiler developed by BD Software (by Leor Zolman of Cambridge, Massachusetts). I have been using the BDS C compiler for over a year, and I think many hobbyists who aren't already using a modern, high-level language could easily switch to C from their BASIC interpreter. C, like BASIC, can be learned quickly, but it has resources that BASIC, even in its ingeniously extended forms, can't match. And while the BDS C compiler does not provide as convenient a programming environment as BASIC—no compiled language really can—it comes about as close as possible to eliminating the worst annoyance of many compilers running on microcomputer systems: the long wait between idea and execution as the compiler cranks out an assembly-language file that must itself be compiled (run through an assembler) before the object program can be tested.

The operation of the compiler is relatively straightforward and quite fast. The command "CC1 filename.C" reads in the source program (which has been prepared using the host system's editing facilities and saved as a file on disk), parses it, and leaves the resultant intermediate file in memory. As CC1 goes out of business, it calls in another program, CC2, as an overlay (ie: it takes the place of the previous program). CC2 is the code generator: it saves the C machine-code program on disk in a special relocatable format. The relocatable machine-code program is turned into executable, absolute machine code by the linker, CLINK, which also merges the user's program with previously compiled program files (such as the standard C function library) if necessary. The entire source file is read into memory before compilation begins, but because it is possible to link separately compiled modules together, the available memory space of the computer does not limit source-program size. If the source code is too long to fit into the available memory at

At a Glance

Name
BDS C compiler

Type
8080 compiler

Distributor
Lifeboat Associates
1651 Third Ave
New York NY 10028

Price
Complete package,
\$145; documentation
only, \$25

Format
Available for all
CP/M systems

Computer
Any 8080-based com-

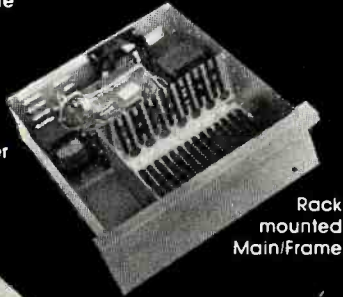
puter running Digital Research's CP/M operating system (programs compiled by the BDS C compiler can be tailored to run on any 8080-family computer)

Documentation
70 pages; 22 by 28 cm
(8½ by 11 inches)

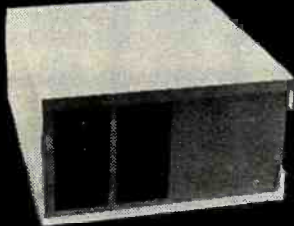
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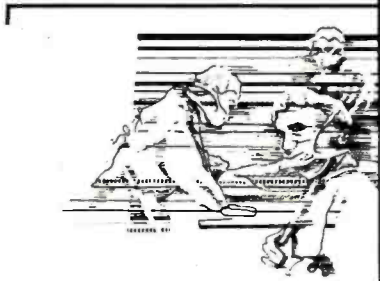
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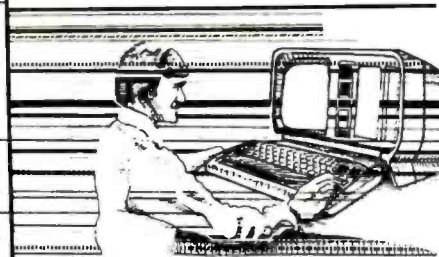
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one time, it can simply be divided up and compiled in pieces. The use of a separate linker also makes it possible to create libraries of compiled functions (such as the C standard library, which supplies a number of basic input/output and utility functions in every system that supports the C language) that can be used in the future as, essentially, part of the language itself.

The manual states that the parser (CC1) operates at about twenty lines of source code per second and that the code generator (CC2) runs at about seventy lines of source per second. In practice—at least on floppy-disk-based systems—the main limitation on compilation speed is the speed of disk input and output. On very long programs, there may be a wait of perhaps a minute while

CC1 crunches away. Obviously this can be shortened considerably by compiling only the part of the program that is being worked on and linking it with other, previously compiled, routines. Even with relatively long programs that are compiled as a unit, however, I did not find the delay in compilation to be objectionably long.

For most users, the speed at which a compiled program runs, not the length of time required to compile it, is what really matters. I am reluctant to express this in terms of a benchmark, since the proposed benchmarks I have seen (1) require assumptions about the type of program that will be compiled that cannot hold from one user to the next; (2) can be properly compared only between systems that have both the same processor throughput and the

A Comparison of C and Pascal

C programs and Pascal programs look quite a bit alike. They should—the two languages have a lot in common, including sets of similar primitive operations that make direct Pascal-to-C or C-to-Pascal translation feasible. Yet enough differences exist to give the two languages a distinctly different "feel."

The most visible difference is block structure; C programs do not have the true block structure found in Pascal programs. A C program is a collection of separate functions; thus one function cannot be nested within another and called as a separate entity. C functions may contain blocks of code that are either executed completely or not at all, but they are not named as functions themselves, and they must be included in-line as part of the normal program flow within the function.

C uses only functions, where Pascal distinguishes between functions and procedures. In practice, the only real difference is that any C function can return a value to its calling routine. This is but one example of C's relaxed programming philosophy. Other examples include the ability to assign freely between integers and characters, and between pointers and unsigned integers, the latter providing virtually unlimited opportunity to perform address arithmetic within the host system's available memory space. There are times when this flexibility is very convenient, but there is a price: the compiler won't prevent a foolish move if the programmer insists on it. Whereas Pascal takes a very rigid, protective, and rather mathematical attitude toward program construction, C allows the programmer a certain amount of freedom. This makes sense: Pascal was designed as a teaching language, and C is a production programming language that allows the programmer to do things that he may want to do, at the expense of some conceptual niceties.

Both C and Pascal allow parameters to be passed to subroutines by value and by reference. This means that the called subroutine can receive either its own local copy of a parameter (which it can alter at will without changing the value of the variable as far as the calling routine is concerned), or a reference to the calling routine's variable (which can be subsequently altered by the subroutine that has been called).

Each language also provides pointers—variables that point to memory locations, such as the beginnings of arrays. In

Pascal, pointers tend to be used sparingly, while in C they are much more common. Here again, C is unwilling to protect the programmer from himself. Pointers are risky. If they are misused, they can point somewhere entirely unexpected and clobber an innocent piece of unrelated code with predictably disastrous results. They can, however, make for extremely efficient programs, and C encourages their use.

C has been described as a relatively low-level language. It generally operates on the same primitive data objects as the computer itself, and it does not provide certain composite operations. For example, a string in C is a series of characters beginning at a given memory location, not a discrete entity that can be passed or assigned as a unit. Explicit functions are used to provide more sophisticated facilities for manipulating data objects, as well as for input and output. The more common primitive operations are provided in the C standard function library. Others must be written by the programmer.

One of C's most distinctive features is its unusual—and unusually concise—set of operators. C has multiple assignment operators that lead to expressions of the form $x += 1$ or $y >> = 4$. These mean, respectively, "let x equal x plus one" and "let y equal y logically shifted right 4 bits." Another unique C concision is the $?:$ (if... then) operator. It is used in expressions of the form $y = x > 0 ? 1 : 0$. This means "if x is greater than 0 let $y=1$; otherwise, let $y=0$."

BASIC exists in thousands of dialects. The same diffusion seems to be taking place—to a lesser extent, fortunately—with Pascal. Thus far, not many compilers operate on variations of C, so true portability between computers still exists. I know of three microcomputer C compilers: the BDS compiler (which implements a very complete subset of the language); one for a considerably more restricted (and slightly archaic) subset of C that was published, in C source code, in the May 1980 issue of Dr Dobb's Journal of Computer Calisthenics and Orthodontia (this compiler is available from Walt Bilofsky, 14478 Glorietta Dr, Sherman Oaks CA 91423, in CP/M and Heath HDOS formats); and Whitesmiths' C Compiler, which provides the full C language for various 8080-family and DEC LSI-11 systems (Whitesmiths Ltd, POB 1132, Ansonia Sta, New York NY 10023). An excellent C-like interpreter is available from tiny-c associates, POB 269, Holmdel NJ 07733 (see my review of tiny-c: "A User's Look at tiny-c," December 1979 BYTE, page 196). A tiny-c compiler is also available.

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same disk-access speed, and (3) are of dubious value when used to compare different programming languages because it is unlikely that the benchmark programs will be of equivalent efficiency in all languages.

Having said all that, I will venture the opinion (acknowledging that it may be even more misleading than a benchmark program) that programs compiled on the BDS compiler run very fast indeed. Not as fast as those coded in assembler, obviously, but much faster than any BASIC interpreter, considerably faster than any pseudo-code Pascal system (a technique that amounts to semi-compilation, with object code being generated for a "pseudo-machine" that is emulated by the host computer), and *about as fast* as those created by any microcomputer compiler I have seen. I have used BDS C to compile a rudimentary LISP interpreter, and while it's no match for a machine-coded LISP, the project demonstrated to my satisfaction that the BDS compiler is suitable for system-programming purposes.

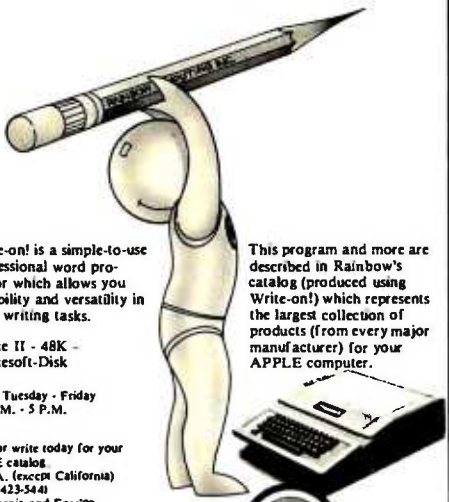
BDS C is a true subset of the standard C language. Very little is left out. The most serious omissions are the lack of static variables and initializers. Several library functions are supplied to remedy the latter, although initialization remains somewhat more awkward than in standard C. Also absent are floating-point real numbers and long (32-bit) integers. A series of subroutines to perform floating-point conversions and arithmetic is sup-

plied with the package, but this is not as convenient a way to provide real numbers as building them into the language the compiler accepts directly.

A considerable amount of work has been done to relieve the programmer of some of the more tedious aspects of the CP/M operating system. Library functions permit the use of the standard CP/M carriage-return/line-feed sequence to terminate a line or, at the user's option, the single newline character that is standard in other C programming environments. Buffered file routines are supplied as part of the standard library, which permits the programmer to write data to disk a character at a time instead of in blocks of 128 characters, as required by CP/M. Dynamic storage allocation and deallocation are also provided, so the user can create and dismantle complex data structures at run-time, and therefore reuse the memory area allocated to them (even though CP/M itself contains no allocation mechanism).

It's a shame the BDS compiler doesn't go one step further and provide redirected input and output; this would have permitted the user to write a program using a single I/O stream and then specify at run-time whether the program was to communicate with the console, a modem, a disk file, etc. Some high-level language compilers provide a debugging option that allows the user to trace program execution and print out variable values. Alas, BDS C is not one of them. Short of that, the best debugging tool I

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have found comes right out of the C standard library. It is the function "printf", which allows various data objects to be printed in appropriate formats and number bases while the program is being run.

The compiler accepts a number of optional directives that allow the user to:

- Place the generated code in any memory location (including read-only memory, as long as some program-mable memory will be available somewhere in the target system)
- Optimize the object code for speed (which increases the amount of code generated) or for size (which slows the object program down a bit), and to control the way the compiler allocates space
- Save an intermediate file on disk between the two compiler phases
- Display the source text on the user's console during compilation

The linker also supports a number of useful options, including several that permit the programmer to create overlay segments that use the same data elements. This feature is not commonly available in microcomputer compilers for high-level languages.

The assembly-language source code for the run-time package is also supplied (the run-time routines contain

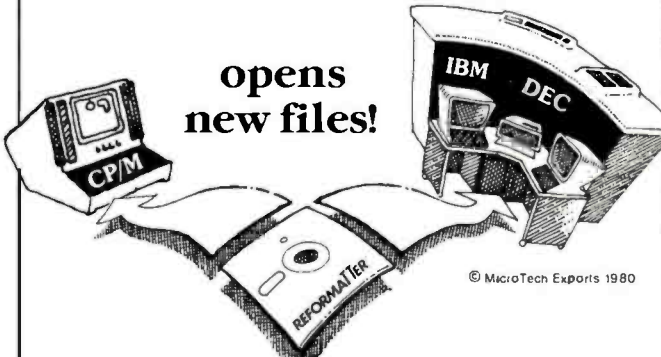
the interface to the CP/M operating system). This permits the user to create a customized run-time package that allows BDS C programs to run under other 8080 operating systems. Those who sell application programs will, no doubt, be happy to learn that there are no royalty requirements for programs that include the run-time package in either its original or customized form.

In addition to the compiler and the linker, the BDS C package contains a librarian program, CLIB (used to manipulate compiled function libraries), the C standard library along with some useful extensions for the microcomputer (and specifically the CP/M) environment, and a collection of sample programs that is of more than passing interest.

The precise sample programs that are delivered with any package may vary, but the copy of BDS C Version 1.4 that I received from Lifeboat Associates in New York contained a fairly sophisticated telecommunications program for connecting a microcomputer system through a modem to another microcomputer (or a time-sharing system), several impressive games (some requiring a cursor-addressable video terminal), and several utility programs, including two that permit the compiler to be used from terminals that generate uppercase characters only. The package also includes a lucidly written manual for the compiler and a copy of the outstanding C language manual, *The C Programming Language*, by Brian W Kernighan and Dennis M Ritchie. ■

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I recently purchased 2 of your Apple music boards. Out of the peripherals I have for my Apple, I enjoy them the most. It has to be the most enjoyable thing that has ever been invented. I hope you continue to develop products as clever and enjoyable as this one. The Entry program has to be one of the most sophisticated programs I have ever seen. It proves that a hardware manufacturer DOES have the ability to also produce quality software. It is almost worth the price of the boards just for the Entry program.

—Burbank, California

About ease of use:

I have had my Music Card MC1 for a little more than a week now and I have almost completed entering "The Maple Leaf Rag". I found it to be a lot simpler than I thought and so I am very, very pleased. My family isn't because I sit up to all ends of the night playing with the blasted thing!

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Recently, I purchased an [ALF] 9-voice board and a couple of music albums. . . . all I can say is that I wish I had listened and played with it before I purchased the Mtn. Hardware board. It sounds about the same and is vastly superior in software, ease of use, and price. The Entry program is a joy to use and it's easier than Mtn. Hardware's, but then, I guess you guys know that already. (Oh yes, you wouldn't happen to know of anyone that wants to buy a Mtn. Hardware system? \$450 or best offer?)

—Kirkland, Washington

I would like to tell you that after having used the system ONLY ONE DAY, that I am absolutely delighted with it. In addition, I purchased the three boards although I ALREADY own Mountain Hardware's music system. Now that I have seen and own your system, I am putting my "old" one up for sale. I think that your software makes it far easier to enter music, and that the software routines allow for far greater flexibility. Again, I extend my compliments to you. As I said, I have owned another music system, and consider myself therefore, qualified to make a judgement between the use of the two. Yours is the clear choice!

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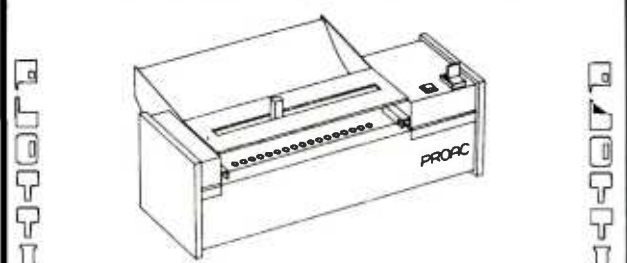


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Book Reviews

Musical Applications of Microprocessors

by Hal Chamberlin
Hayden Book Company, Inc
Rochelle Park, NJ
1980, 661 pages, hard-cover \$24.95

Reviewed by
Dick Moberg
404 S Quince St
Philadelphia PA 19147

This book is the culmination of many years of experimentation by one of the leaders in the field of computer music for small systems. Its depth of coverage and usefulness are unsurpassed by any other single publication.

A review cannot start without first looking at the book's author. Hal Chamberlin has been involved with microcomputers since their origin. His newsletter, *The Computer Hobbyist*, pioneered construction articles on tape, disk, and graphic interfaces long before there were any books or major publications on the subject. Combining his music and computer talents eventually led him to form a company, Micro Technology Unlimited, and to receive an award for his contributions at the 1979 Personal Computer Arts Festival. He is an avid writer for personal-computer magazines. His clear and often humorous style is prevalent throughout his book.

Before we look at the contents, let's discuss the book's intended audience. Being a long-time computer hobbyist with several years of childhood music lessons, I would target this book for the computer tinkerer or the musician with some syn-

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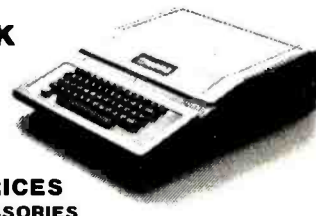
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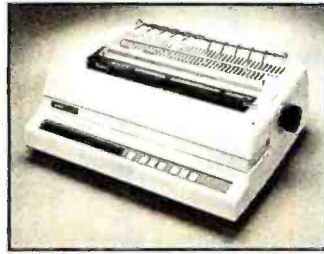
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Book Review

thesizer knowledge. The non-musician will find the introductory parts on waveforms and music theory sufficient for understanding the rest of the book. The musician with no background in computing or electronics should have available some of the excellent paperback volumes now available on op (operational) amps, TTL (transistor-transistor logic) circuits, and microcomputers. But, even for the computer-musician novice, this is a book that is readily understandable.

Musical Applications of Microprocessors is divided into three sections: "Background," "Computer-Controlled Analog Synthesis," and "Digital Synthesis and Sound Modification."

Section I covers background material in music synthesis and microprocessors. The first chapter, "Music Synthesis Principles," starts with a discussion on the goals of music making, comparing conventional instruments with electronic-synthesis techniques. It emphasizes that with electronic synthesis, a musician is limited only by his imagination as to the accuracy, complexity, and variety of sounds that can be achieved with this medium. Next, the author discusses the relationship of the physical parameters of waveforms — frequency, amplitude, and harmonics — to the musical concepts of pitch, loudness, and timbre. The chapter ends with a history of electronic sound synthesis from the teleharmonium to the microprocessor.

Chapter 2 presents the terminology and techniques of sound modification. It starts with a section on tape-recording techniques (re-arranging tape splices, speed transposition, etc) and then compares these to their electronic counterparts. Other electronic techniques such as

filtering, spectrum shifting, reverberation, and chorus synthesis are discussed. The chapter concludes with a discussion on analyzing natural sounds for subsequent modification.

The next chapter, on voltage-control methods, explains the conventional techniques of using voltage to control frequency, amplitude, and harmonics. Each of these techniques is later explained in regard to its implementation with analog and digital circuits or by using software programming. The modular nature of conventional synthesizers is also discussed.

Chapter 4 addresses waveform synthesis by the computer by digital-to-analog conversion and looks at the advantages and limitations of using this method. Music-programming systems and languages, including MUSIC V and Hal's NOTRAN (NOte TRANslation language), are briefly described.

The background section concludes with a chapter on microprocessors. There is an interesting comparison between the 8080, LSI-11, and 6502 microprocessors showing where each (and similar processors) should be used in the grand scheme of a music-synthesis system. The author claims that the 8-bit 8080/Z80 family are the optimal microprocessors for synthesizer control, the 16-bit LSI-11 for direct microprocessor synthesis of music, and the 8-bit 6502 for replacing dedicated logic. Although the choice of processor will vary from one designer to the next, this section gives the design criteria and the desired microprocessor parameters for each area of application.

The remaining two sections of the book offer technical how-to information regarding microcomputers in music synthesis. There's a discussion on the use of a

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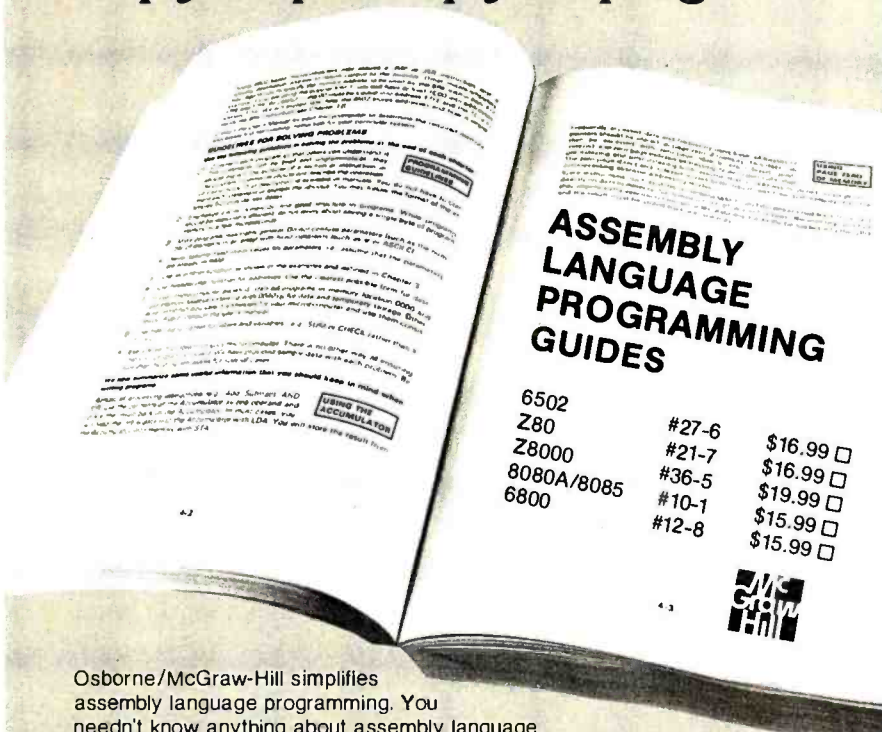
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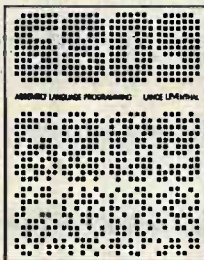
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Book Review

microcomputer as a controller of standard or custom analog sound-synthesizing equipment, and how a computer can simulate the analog module's functions in software to provide direct music synthesis.

The first chapter of the computer-controller section explains circuit details of the three voltage-controlled synthesizer modules—voltage-controlled oscillator, voltage-controlled amplifier, and voltage-controlled filter. Component values are provided along with construction tips for building those modules.

The next chapter, on data-conversion techniques, starts with a tutorial on the terminology regarding the use of D/A (digital-to-analog) and A/D (analog-to-digital) converters. All circuits for the various conversion techniques are given, along with component values and available devices. One impressive circuit shows how to make a 128-channel microcomputer-controlled D/A converter for less than \$50.

The remaining four chapters in this section deal with the "systems" aspects of a computer-controlled synthesizer. A chapter on signal routing shows how the computer and various switching devices can replace the ever-confusing patch cords on conventional analog synthesizers. Two chapters on input devices follow: one entirely on keyboard-input methods and one on other devices such as ribbon controllers, joysticks, and digitizers. The last chapter describes the role of computer-graphics displays as aids in computer music composition.

The last section of the book, on direct computer synthesis of music, gives details on digital sound generation and filtering techniques, and includes the techniques that the author

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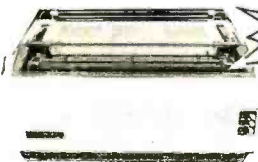


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has pioneered through much of his previous writings. The section opens with a discussion of quality data-conversion techniques. Three chapters follow on digital sound-generation methods, including separate chapters on filtering and percussive sound generation. The chapter on digital tone-generation techniques includes the author's table-look-up method for generating precomputed waveforms and algorithms, and includes uses of Fourier techniques for "synthesis from scratch." The digital-filtering chapter gives techniques for reverberation and chorus effects.

Direct computer synthesis of music is usually not a real-time technique. But, as the author points out, these techniques are very useful for those designing real-time systems for live performances.

A fascinating chapter follows on the analysis of natural sounds for modification and resynthesis. Methods of three-dimensional spectral plotting for harmonic visualization are covered. Also mentioned are some advanced techniques for sound analysis, such as linear prediction, autocorrelation, and homomorphic analysis.

The last two chapters deal with digital hardware and music-synthesis software. The digital synthesis of music can be accomplished by using either hardware or specific software techniques, or a combination of the two. These chapters discuss the trade-offs of each method. Among other topics the hardware chapter presents circuits for digital multiplexed oscillators, Fourier-series tone generators, and hybrid voice modules. Some of the available music-synthesis boards for small computer systems are also analyzed.

The last chapter describes

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Book Review

the hierarchy of music-software systems with examples from each level. Fixed-point-arithmetic routines for the 6502 processor are given, along with Fourier-series routines for waveform-table filling and much more. The chapter ends with a discussion of the high-level NOTRAN music-composition language.

In summary, this book is a milestone in microcomputer history. Its publication marks the progression — from novelty to serious instruments of expression — of musical applications of small computer systems. With little modification, the book could serve as a reference source on generalized data collection, signal processing, and process control using microcomputers. ■

BYTE's Bits

Errata Sheets for Osborne Books

If you have been having trouble running some of the CBASIC programs in Osborne/McGraw-Hill business books, a simple request will bring quick relief in the form of errata sheets. The sheets should have been sent with every ordered copy of *Payroll with Cost Accounting*, *Accounts Payable and Accounts Receivable*, and *General Ledger*. If errata sheets weren't included in your book, contact Sean Dugan, Customer Relations, Osborne/McGraw-Hill, 630 Bancroft Way, Department B10, Berkeley CA 94710, (415) 548-2805. ■

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Clubs and Newsletters

Atari Users Group

The Bay Area Atari Users Group meets on the first Monday and on the third Tuesday of each month at 7 PM. The Monday-night meeting takes place at Foothill College, and the Tuesday-night meeting is at Interim Electronics, 447 S Bascom Ave, San Jose, California. The group publishes a newsletter. The dues for the group are \$12 per year. The club currently has eight disks of public-domain software for sale at \$5 per disk. The monthly meetings feature speakers discussing micro-computer uses and the Atari. Write to the Bay Area Atari Users Group, c/o Foothill College, 12345 El Monte Rd, Los Altos Hills CA 94022.

Just for LAUGHS

The Louisville Apple User Group—Hardware and Software (LAUGHS) has separate meetings for the business, software, and special-interest subgroups. A monthly newsletter is published. The subscription rate is \$15 per year. For information, contact LAUGHS, c/o Pat Connelly, 3127 Kayelawn Dr, Louisville KY 40220.

Behavioral Sciences AIM-65 Users Group

Workers in the behavioral and biological sciences who are currently using or are interested in using the Rockwell AIM-65 are invited to participate in this group. Areas of study include hardware and software for experimental control, data acquisition, statistical analyses, and other applications. If you are interested, please write, out-

lining areas of interest and current or planned projects, to Dr J W Moore Jr, POB 539, Middle Tennessee State University, Murfreesboro TN 37132.

OSI Group In Northern California

The Ohio Scientific Users Group of Northern California has been formed. For details, write to Rod Freeland, c/o Public Interest Computer Services, POB 1061, Berkeley CA 94701; or call (415) 654-9880 after 1 PM.

68XX Users Group

This is a group for those hobbyists who have a strong interest in Motorola 68XX microprocessors. The group meets on the second Tuesday of each month in Santa Clara at American Microsystems Inc. Contact the 68XX Users Group at POB 18081, San Jose CA 95158.

Boston Group Promotes Artificial Intelligence

The Boston Subchapter of Robotics International of SME has been formed under the auspices of the Society of Manufacturing Engineers. The group has been developed to provide a forum for the exchange of information between engineers, scientists, industrial producers, and users of robotics technology.

For more information on the Boston chapter and the national group, contact Robotics International of SME, One SME Dr, POB 930, Dearborn MI 48128. ■

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June 1981

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Atlanta Small Computer Show, Atlanta Hilton, Atlanta GA. Producers of small computers, peripheral equipment, supplies, and services will be exhibiting at this show. Business owners, corporate and government executives, data processing managers, doctors, lawyers, and other professionals, are expected to attend. Obtain additional information from The Atlanta Small Computer Show, 4060 Janice Dr, Suite C-1, East Point GA 30344, (404) 767-9798.

June 7-19

Computer Camps, Northeast Louisiana University (NLU), Monroe LA. NLU is offering two one-week sessions for

students in grades nine thru twelve. Beginners and advanced programmers are welcome. The cost is \$125 per session for room, board, fees, and text materials. Contact Dr Paul Ohme, Department of Mathematics, NLU, Monroe LA 71209, (318) 342-2186.

June 9-11

Understanding and Using Computer Graphics, Chicago IL. This seminar will cover the latest technology on graphic systems. It will be headed by Carl Machover. Contact Bob Sanzo, Frost & Sullivan Inc, 106 Fulton St, New York NY 10038, (212) 233-1080.

June 14-18

The Second National Conference of the National Computer Graphics Association,

Baltimore Convention Center, Baltimore MD. Computer graphics demonstrations and workshops will be held along with exhibits and seminars. Contact the National Computer Graphics Association Inc, 2033 M Street NW, Suite 330, Washington DC 20036, (202) 466-5895.

June 16-18

NEPCON East '81, New York Coliseum, New York NY. This exposition is aimed at engineers, prototype developers, production specialists and testing personnel. Technical programs will be presented. Contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

June 17-19

National Educational Computing Conference, North Texas State University, Denton TX. This conference will provide a forum for discussion between individuals, and institutions with interests in educational computing. Computer literacy, computer education for teachers, and computers in education are some of the topics to be covered. Contact Dr Jim Poirot, NECC-81, General Chairman, Computer Sciences Department, North Texas State University, Denton TX 76203.

June 21-26

Computer Workshops for Educators, Northeast Louisiana University (NLU), Monroe LA. This program will cover a wide variety of topics. Room, board, and tuition is \$135. Contact Dr Paul Ohme, Department of Mathematics, NLU, Monroe LA 71209, (318) 342-2186.

June 22-23 and June 24-27

Digital Electronics for

Automation and Instrumentation and Microcomputer Design Interfacing, Programming, and Application Using the Z80, 8080, and 8085, Virginia Polytechnic Institute and State University, Blacksburg VA. These two workshops allow participants to design and test concepts with the actual hardware. For more information, contact Dr Linda Leffel, CEC, Virginia Tech, Blacksburg VA 24061, (703) 961-5241.

June 23-25

Comdex/Spring '81, Madison Square Garden and New York Statler Hotel, New York NY. Contact the Interface Group, 160 Speen St, Framingham MA 01701, (800) 225-4620; in Massachusetts (617) 879-4502.

June 29-July 1

The Nineteenth Annual Meeting of the Association for Computational Linguistics, Stanford University, Stanford CA. Syntax, parsing, and sentence generation, computational semantics, discourse analysis and speech acts, speech analysis and synthesis, machine translation and machine-aided translation, and mathematical foundations of computational linguistics are some of the topics that will be discussed. Contact Don Walker, Artificial Intelligence Center, SRI International, Menlo Park CA 94025, (415) 326-6200, ext 3071.

July 1981

July 9-10 and July 20-21

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ing. For more information, contact Battelle, Seminar and Studies Program, 4000 NE 41st St, POB C-5395, Seattle WA 98105, (206) 525-3130.

July 29-31

The 1981 Microcomputer Show, Wembley Conference Centre, London, England. Seminars on microcomputer applications in business, production, and in education will be presented. Topics for conference sessions include hardware availability, software packages and development, automatic test equipment, robotics, and process control. Exhibits from major European and American manufacturers will be featured. Contact TMAC, 680 Beach St, Suite 428, San Francisco CA 94109, (800) 227-3477; in California (415) 474-3000.

August 1981

August 24-27

Software Design, Reliability, and Testing, Sheraton Motor Inn, Lexington MA. This four-day seminar is for engineers, programmers, and technical managers. It examines concepts and tech-

niques for developing and testing reliable, cost-effective software. It also addresses management concerns and recommended policies. Tuition is \$600, which includes course notes, luncheon, refreshments, and an evening reception. Contact the Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158, (617) 964-1412.

August 24-28

The Seventh International Joint Conference on Artificial Intelligence, University of British Columbia, Vancouver, British Columbia, Canada. This conference examines computer applications of medical diagnosis, computer-aided design, robotics, programmable automation, speech understanding, vision, and other related topics. Tutorial programs and artificial-intelligence exhibits will be presented. For more information, contact Louis G Robinson, American Association for Artificial Intelligence, Stanford University, POB 3036, Stanford CA 94305, (415) 495-8825.

August 25-28

Vector and Parallel Pro-

cessors in Computational Science, Chester, England. This conference will concentrate on hardware, software, algorithms, applications, and case studies concerning vector and parallel processors. For information, contact Mrs S A Lowndes, Science Research Council, Daresbury Laboratory, Daresbury, Warrington, WA4 4AD, England.

August 26-29

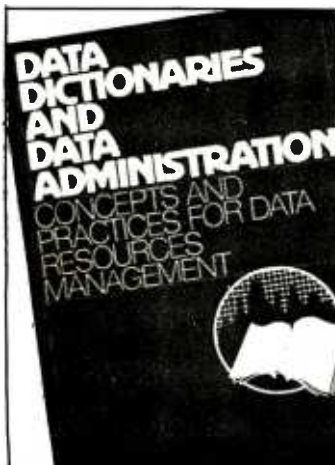
The Fifth Annual National Small Computer Show, New York Coliseum, New York NY. There will be daily lectures, and a five-hour seminar will be presented daily for executives who need an introduction to the understanding, acquisition, and use of computers in business. The registration fee for the show is \$10 per day. The seminar for executives is \$200, which includes all materials and show registration. For information, contact the National Small Computer Show, 110 Charlotte Pl, Englewood Cliffs NJ 07632, (201) 569-8542.

August 28-30

Personal Computer Arts Festival '81 (PCAF '81), Philadelphia Civic Center,

Philadelphia PA. This show will include technical sessions, demonstrations, and exhibits, as well as the annual computer-music concert and computer graphics film and video show. PCAF '81 is being held in conjunction with the Personal Computing '81 show. For complete details, contact the address below.

The PCAF '81 Committee invites persons interested in microcomputer-music and digital-sound synthesis, computer composition tools, signal processing, computer-generated visual art, and other computer-based creations, to talk, demonstrate, display, or perform at PCAF '81. To participate, send a half-page description of a topic or performance (include tapes, prints, or slides, if possible) before July 1 to PCAF '81, POB 1954, Philadelphia PA 19105. ■



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Book Reviews

**TEX and
METAFONT: New
Directions In
Typesetting**

by Donald E Knuth
Digital Press,
Bedford, MA 1979
\$12.00

Reviewed by
Richard Fritzon
25 Callodine Ave
Buffalo, NY 14226

TEX and METAFONT is primarily documentation for two programs that Donald E Knuth has written. TEX is a text-formatting program for preparing documents and METAFONT is a program for designing new fonts for digital typesetting devices (such as high-density raster-scan printers). The two manuals are preceded by a forty-page talk that Dr Knuth presented to the American Mathematical Society on the subject of mathematical typography.

Normally, program manuals are not very interesting, even to people who are using the program, and, unfortunately, most people are not yet using TEX or METAFONT. However, if you are interested in how a well-designed program can produce high-quality camera-ready text, if you are interested in mathematical methods for designing new type fonts, or if you are just interested in how a world-renowned computer scientist goes about designing, writing, and documenting his programs, read this book.

The introductory lecture, "Mathematical Typography," describes two aspects of the same subject: how to make it easy to compose mathematical papers of very high visual quality (ie: easy to read, beautiful to look at),

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and how to use mathematics in the design of good-looking type fonts. It contains very brief introductions to both TEX and METAFONT, but, more interestingly, Dr Knuth describes some of the history of typesetting and typefont design and some of the history of his investigations into mathematical typesetting and font design, including some of the decisions he made while designing the two programs. His prose is comfortable and enjoyable. If you find it necessary to skip the more technical mathematics, you're skipping only about one page of Dr Knuth's lecture.

Judged by its manual, TEX is unlike any other text-formatting program. The care and thought that went into its design set a standard for programs of this kind, and programs in general, that few can meet. It uses a novel algorithm for splitting text into equal-length lines which considers the appearance of the entire paragraph in which the line appears, not just the line itself. It has extensive facilities for handling mathematical formulas in a manner that is easy for the typist but yields professional-looking output. (Naturally it supports proportionally spaced type fonts, multiple-column page formats, footnote references, and other features which are essential for full typesetting capability.) The manual is easy to read, and while it certainly makes you wish you had a copy of TEX to run on your own computer, you don't need it to enjoy reading the manual. (Dr Knuth says that he intends to publish the programs in a book, putting them in the public domain.)

As far as I know, METAFONT, the typeface-design program, is unique. It allows you to write programs, in a special METAFONT language, that specify the shapes of a family of characters — that is, it allows you to design your own type fonts. Currently though, only high-density raster-scan

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Book Review

printers can print the new fonts, and these devices are still extremely expensive. Consequently, the micro-computer applications for a font-design program are limited. However, like the TEX manual, the META-FONT manual is both interesting and informative. It reads as though the author were standing at times in front of you lecturing and, at other times, behind you looking over your shoulder, helping. Even if you are just interested in the design of type fonts by Dr Knuth's analytic method, you will find this book useful. (The manual includes many exercises. While they are interesting to read, if you're not actually trying to learn to use TEX or META-FONT you may well want to skip them; I did.)

I used to think that only a hard-core, lost soul computer hacker could enjoy reading a manual for a program he might never use. This book has made me reconsider. ■

BYTE's Bugs

Correction

The name of the manufacturer of the wire-wrap prototyping board mentioned in "What's Inside Radio Shack's Color Computer?" (March 1981, BYTE, page 90) should have been Vector Electronic Company. We apologize for any confusion this may have caused. ■

Notice of Omission

Due to a processing error the Washington Computer Service ad which appeared on page 27 of the May Byte had no Reader Service Number.

For more information regarding their "no problem trial offer" circle 475 on the inquiry card in this issue.

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The papers will be judged by the editors of the magazine, and the winner will be announced on April 1, 1982, with publication of the winning paper in the July 1982 issue of *Cryptologia*. For information, contact *Cryptologia*, Albion College, Albion MI 49224. ■

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With the addition of an analog-to-digital converter and some simple sensors, a microcomputer can monitor analog voltages, read light levels, sense temperatures, or read the analog output from laboratory instruments. The six-channel A/D

(analog-to-digital) converter that I will describe reads positive voltages from 0 to 3 V, with either 8 or 10 bits of accuracy. It interfaces to the computer through an 8-bit bidirectional peripheral port whose I/O (input/output) lines are individually programmable and latched when used as outputs.

Conversion times are voltage-dependent, with an approximate range of 1 to 2 ms (milliseconds). A sample program segment and subroutine written in 6502 assembly language are included to illustrate the use of the converter.

About the Author

Robert Daggit is a Senior Research Technician at the Systems and Research Center of Honeywell Inc in Minneapolis. He is interested in the application of microprocessors to small, dedicated systems for laboratory use.

Once started, the converter operates asynchronously with respect to the computer and requires a minimum of code in the user's pro-

gram. Major components of the A/D converter unit, shown as a schematic diagram in figure 1, are a Fairchild Semiconductor $\mu A9708$ analog-to-digital-converter integrated circuit, a clock, a 12-bit counter, and a 16-bit output multiplexer. The $\mu A9708$ features an analog input multiplexer, controlled by address lines A0 thru A2, that selects one of eight input sources. Address 0 selects the internal zero voltage, and address 7 selects the internal reference voltage. Addresses 1 thru 6 select user inputs I1 thru I6, as shown in figure 1. Although the manufacturer rates the $\mu A9708$ at 8 bits of accuracy, it performs well at 10 bits of accuracy. A series of voltage readings taken at 0.1 V intervals from 0 to 3 V compared favorably with readings taken with a Fluke Model 8000A Digital Multimeter. Voltage differences ranged from 2 to 11 mV (millivolts). The greatest relative error, defined as the absolute value of the voltage difference divided by the multimeter reading, was less than 2%.

In order to read one of the analog channels, the channel address is placed on the address lines, and the ramp-start input (pin 3) is set low. The ramp-stop output (pin 7) goes high at this time. With the address lines stable for a signal-acquisition time of about 1 ms, the ramp capacitor, C1, charges to the voltage

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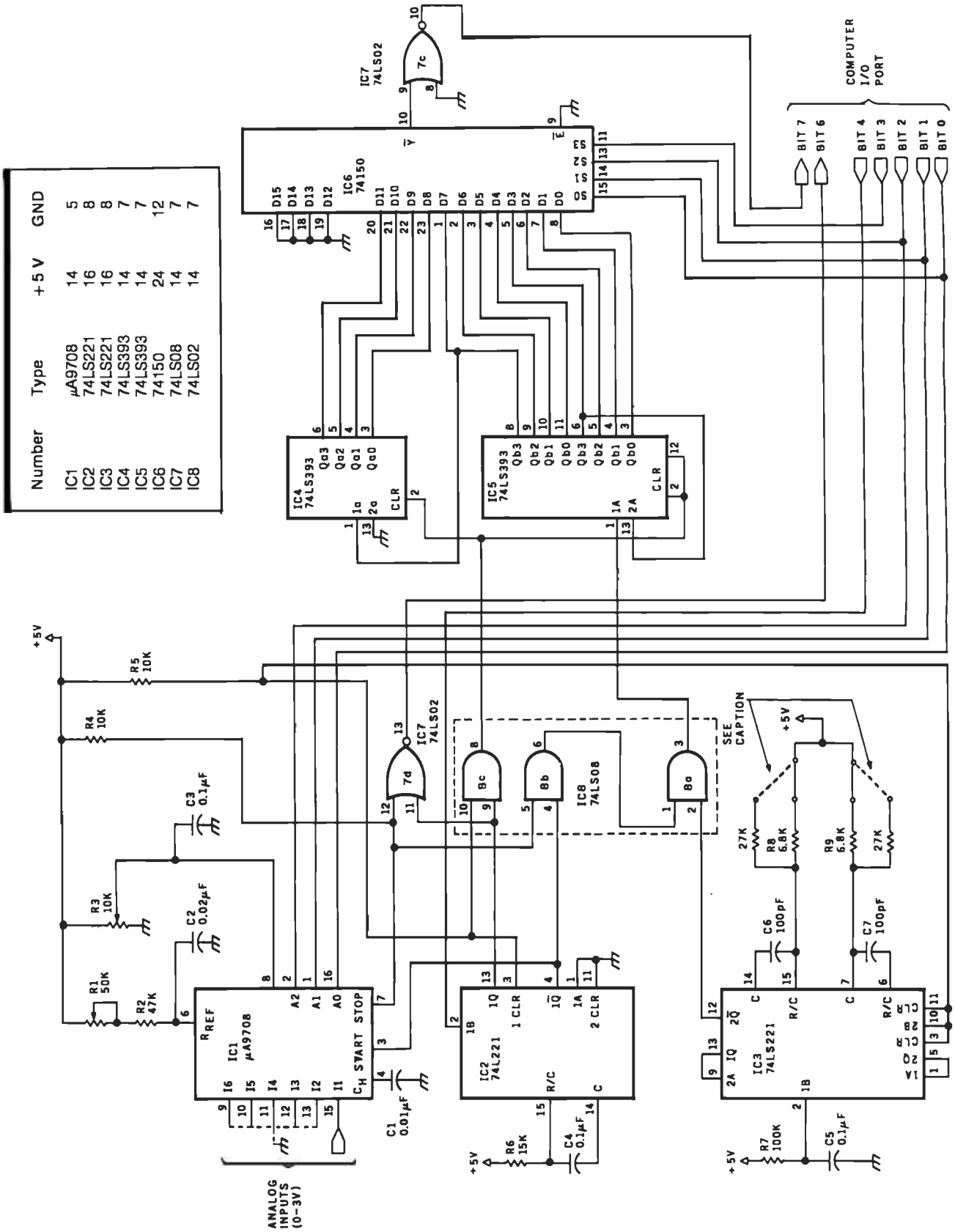


Figure 1: Schematic diagram of the A/D converter. Inputs I1 thru I6 of IC1 are the user's analog-input channels. The input voltage is converted to a binary number in the counter (IC4 and IC5), where it is retained until needed. The binary output is read in bit-serial fashion by the output multiplexer, IC6. Interface to the computer is through an 8-bit I/O port.

Easy selection of 8 or 10 bits of accuracy is accomplished by installing the clock timing components (C6, C7, R8, and R9) on a DIP header (see figure 2).

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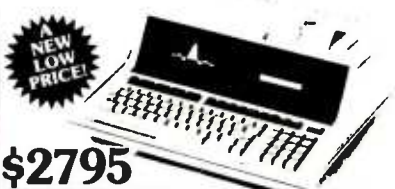


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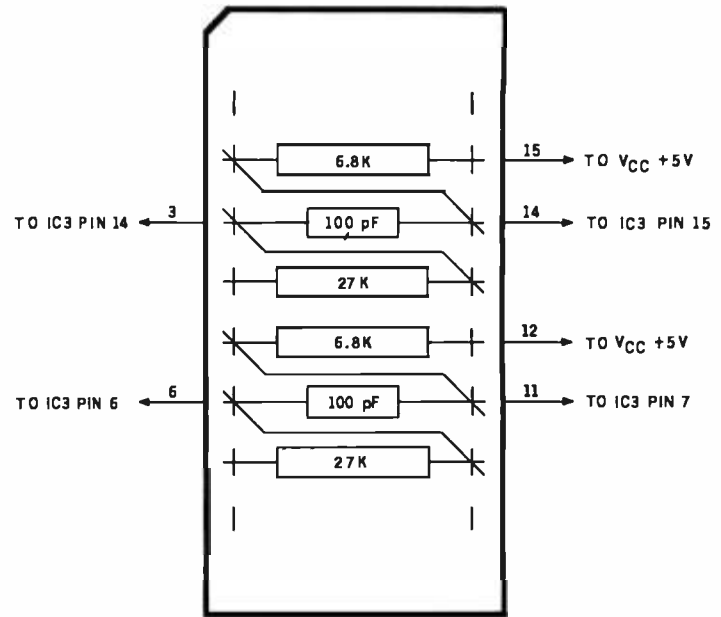


Figure 2: Wiring of the DIP header (top view). This optional feature may be installed for easy selection of 8 or 10 bits of accuracy. The clock timing components are mounted on the header in such a way that when it is reversed in its socket, the time constants of IC3 (a 74LS221 monostable multivibrator) are appropriately changed.

Listing 1: A program segment, written for the 6502 microprocessor, that illustrates use of the A/D converter. Hexadecimal 10 is added to the channel address, and this value is then written to the interfacing I/O port to start the conversion. Data from the counter is read when needed.

Address	Object Code	Label	Mnemonics	Comments
0250	A9 10		LDA H#10	;CHANNEL 0 ADDRESS
0252	8D 01 A8		STA DRA	;INITIATE A/D CONVERSION
0255	20 30 03		ISR RDADC	;READ CHANNEL 0 COUNT
0258	85 D0		STA D0	
025A	86 D1		STX D1	
025C	A9 17		LDA H#17	;CHANNEL 7 ADDRESS
025E	8D 01 A8		STA DRA	;INITIATE A/D CONVERSION
0261	20 30 03		ISR RDADC	;READ CHANNEL 7 COUNT
0264	85 C0		STA C0	
0266	86 C1		STX C1	
0268	A9 11		LDA H#11	;CHANNEL 1 ADDRESS
026A	8D 01 A8		STA DRA	;INITIATE A/D CONVERSION
026D	A9 02		LDA H#02	
026F	20 7C 05		ISR SUBM	;COUNT(REF) - COUNT(0)
0272	A5 C0		LDA C0	
0274	A6 C1		LDX C1	
0276	85 A0		STA A0	;SAVE CORRECTED REF COUNT
0278	86 A1		STX A1	
027A	20 30 03		ISR RDADC	;READ CHANNEL 1 COUNT
027D	85 C0		STA C0	
027F	86 C1		STX C1	
0281	A9 02		LDA H#02	
0283	20 89 05		ISR CMPM	;IS COUNT(1) < COUNT(0)?
0286	10 08		BPL SKIP	
0288	A5 D0		LDA D0	;SET COUNT(1)
028A	85 C0		STA C0	; TO
028C	A5 D1		LDA D1	; COUNT(0).
028E	85 C1		STA C1	;
0290	A9 02	SKIP:	LDA H#02	
0292	20 7C 05		ISR SUBM	;COUNT(1) - COUNT(0)

at the selected input. The ramp-start input is then set high. This disconnects the input voltage from the ramp capacitor, which now discharges linearly at a controlled rate through resistors R1 and R2. When the ramp capacitor is discharged, the ramp-stop output goes low. Since the capacitor's discharge time is directly proportional to the input voltage, a counter running during the interval from the conditions ramp-start-high to ramp-stop-low will, at the end, contain a count that is proportional to input voltage.

In this circuit, a low-to-high transition of peripheral-port bit 4 triggers IC2, a 74LS221 monostable multivibrator. Its Q output goes high to clear the counter, while the \bar{Q} output holds the ramp-start line low, allowing the μ A9708 (IC1) to acquire the voltage from the selected channel. Upon timing out, IC2's outputs change states, raising the ramp-start line to a high logic level and turning on the counter. When the ramp-stop line goes low, the counting stops, and peripheral-port bit 6 goes high to signal the computer that the conversion is complete. The counter value is the useful output of the converter, and is retained until it has been read and the next conversion cycle has begun.

The clock, IC3, is a multivibrator whose frequency is set to about 1 MHz by the 100 pF capacitors, C6 and C7, and 6.8 k-ohm resistors, R8 and R9, for a 10-bit count. An 8-bit count is selected by replacing R8 and R9 with 27 k-ohm resistors. If the frequency-determining components are installed symmetrically on a header, as shown in figure 2, the 8- or 10-bit counts can be selected by simply unplugging the header and reversing it.

A ripple counter and a 16-bit output multiplexer, controlled by address lines A0 thru A3, complete the circuit.

Before the circuit is used, all unused analog inputs should be grounded and the reference voltage and ramp slope should be set. The 10 k-ohm potentiometer, R3, is first adjusted until the reference voltage at pin 8 of IC1 is exactly 3 V, as in-

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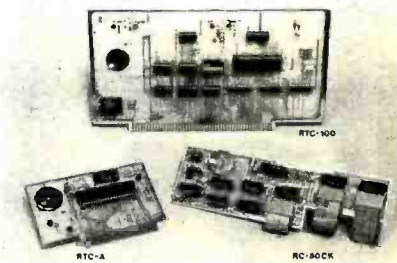
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indicated by an accurate voltmeter. Then the converter connected to the computer is run in a loop, repeatedly addressing and reading the reference voltage at address 7. The 50 k-ohm potentiometer, R1, is adjusted until the count is just under hexadecimal FF for an 8-bit count, or hexadecimal 3FF for a 10-bit count.

In normal use, the program must first configure the peripheral-port bits 0 thru 4 as outputs and bits 5 thru 7 as inputs, and it must clear bit 4. Voltage readings are taken by writing

the value of the channel address plus hexadecimal 10 to the peripheral port and then waiting until bit 6 goes high. The channel address should not be changed during this time. Reading of the counter data automatically clears peripheral port bit 4, enabling its low-to-high transition when the next address is written to the port. The counter is read a bit at a time by writing the address of the desired bit into the peripheral port, reading the port, and then left-shifting bit 7 (the counter data bit) into a register pair

Listing 2: RDADC, a 6502 subroutine to read data from the counter in the converter. The 16-bit counter value is returned in the accumulator and X register. Status bits reflect the condition of the high-order byte.

```

;          ***** READ A/D CONVERTER *****
;
;          THIS SUBROUTINE READS THE COUNTER OF THE A/D CONVERTER.
;          IT RETURNS THE HIGH-ORDER BYTE IN THE ACCUMULATOR
;          AND THE LOW-ORDER BYTE IN THE X REGISTER.
;
;          SCRATCH LOCATIONS USED: F0,F1
;
0330 A9 40      RDADC: LDA    H#40    ;LOAD MASK TO TEST BIT 6
0332 2C 01 A8   LPI:  BIT    DRA    ;IS A/D CONVERSION COMPLETED?
0335 50 FB      BVC    LP1      ;IF NOT, LOOP UNTIL DONE
0337 A2 0F      LDX    H#0F    ;LOAD INDEX REGISTER/COUNTER
0339 8E 01 A8   LP2:  STX    DRA    ;BIT ADDRESS
033C AD 01 A8   LDA    DRA    ;READ BIT
033F 2A        ROL    A        ;ROTATE ACCUMULATOR
0340 26 F1      ROL    F1      ;ROTATE MEMORY LOCATION F1
0342 26 F0      ROL    F0      ;ROTATE MEMORY LOCATION F0
0344 CA        DEX
0345 10 F2      BPL    LP2     ;BRANCH IF POSITIVE
0347 A6 F1      LDX    F1      ;LOAD LOW-ORDER BYTE
0349 A5 F0      LDA    F0      ;LOAD HIGH-ORDER BYTE
034B 60        RTS
    
```

Reference Designation	Part
IC1	μA9708, A/D converter
IC2,IC3	74LS221, monostable multivibrator
IC4,IC5	74LS393, dual 4-bit binary counter
IC6	74150, 1 of 16 data selectors
IC7	74LS02, quad 2-input NOR gate
IC8	74LS08, quad 2-input AND gate
C1	0.01 μF, polyester
C2	0.02 μF, ceramic
C3,C4,C5	0.1 μF, ceramic
C6,C7	100 pF, ceramic
R1	50 k-ohm, 10-turn potentiometer
R2	47 k-ohm, ¼ W, 5% tolerance
R3	10 k-ohm, 10-turn potentiometer
R4,R5	10 k-ohm, ¼ W, 10%
R6	15 k-ohm, ¼ W, 5%
R7	100 k-ohm, ¼ W, 10%
R8,R9	6.8 k-ohm or 2.7 k-ohm, ¼ W, 5%

Table 1: Parts list for circuit of figure 1. Capacitor C1 should be a low-leakage type. No precision tolerances are required.

or 2 bytes of memory that will contain the 16-bit count. The sequence is repeated for each bit, starting with the most-significant bit at hexadecimal address 0F and ending with the least-significant bit at address 00.

The most efficient operation will result when the analog-to-digital conversion is initiated at a point in the program that occurs a number of instructions before the voltage reading is required. The computer is then free to execute the intervening instructions before having to wait for completion of the conversion. The hand-assembled program segment, shown in listing 1, illustrates the use of the converter and the RDADC subroutine (see listing 2). Note the instructions inserted between the initiation of the conversion at hexadecimal address 026A and the reading of the output at address 027A.

A nonzero count is always obtained, even when reading 0 V. This count must be subtracted from the reference voltage and channel counts. Thus, the computation for a linearized and scaled voltage reading becomes:

$$V(i) = \frac{\text{Count}(\text{Channel } i) - \text{Count}(0)}{\text{Count}(7) - \text{Count}(0)} \times V_{\text{REF}}$$

where V_{REF} is the reference voltage.

Long-term drift effects are minimized by reading the zero and reference voltages each time a channel is sampled. When reading very small input voltages, the possibility exists that a channel count may be smaller than the zero count. The apparent instability resulting from this condition is avoided by simply setting the channel count equal to the zero count.

The uses for such a converter are many and diverse. For example, if you are an energy-conscious homeowner, you may wish to monitor temperatures throughout your home. Or, if you are an amateur horticulturist, you may wish to monitor light intensity and temperatures of air and soil to optimize growing conditions for plants or cuttings. Whatever the application, I hope that this converter, with its 8 bits of accuracy for table subscripts or 10 bits of accuracy for better resolution, will serve you well. ■

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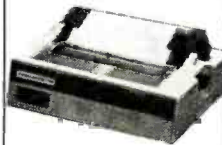
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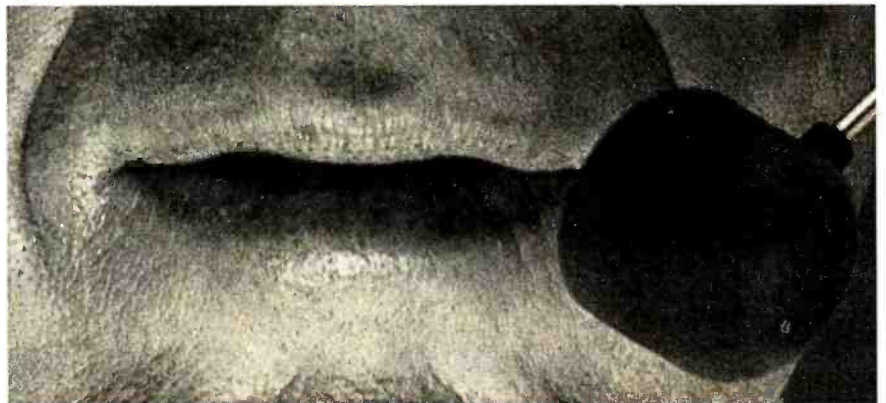
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A Votrax Vocabulary

Timothy A Gargagliano and Kathryn L Fons
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This vocabulary of 139 entries can be stored in as little as 770 bytes. The ASCII codes shown are for the TRS-80 voice synthesizer. Using Votrax symbology, however, this vocabulary is applicable to many other synthesizers, including the new SC01 phoneme speech chip.

(February 1981 BYTE, page 164), in which they presented an overview of the physiology of speech and a look at how Votrax voice synthesizers are programmed. Since that article contained only general guidelines for programming voice synthesizers, they decided to provide us with more specific information in the form of this list of common computer terms and how they would be programmed....SM]

[In February, Kathryn Fons and Tim Gargagliano coauthored an article entitled "Articulate Automata"

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F	.EH1	EH2	F	Votrax			
	3	4	F	ASCII			
J	.J	E1	AY	Y	Votrax		
	J	E	*	&	ASCII		
H	.A1	AY	Y	T	CH		
	@	*	&	T	C		
					ASCII		
X	.AH1	EH3	I3	Y	Votrax		
	;	5	#	&	ASCII		
J	.D	J	EH3	A1	AY	Y	Votrax
	D	J	5	@	*	&	ASCII
K	.K	EH3	A1	AY	Y	Votrax	
	K	5	@	*	&	ASCII	
L	.EH1	EH3	UH3	L	Votrax		
	3	5	8	L	ASCII		
M	.EH1	EH2	M	Votrax			
	3	4	M	ASCII			
N	.EH1	EH3	N	Votrax			
	3	5	N	ASCII			

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Vocabulary continued:

BREAKB B	R R	A1 @	AY x	K K	Votrax ASCII					
BUSB B	UH1 6	UH3 8	S S	Votrax ASCII						
CABLE . . . . .	.K K	A1 @	Y &	B B	UH3 8	L L	Votrax ASCII			
CHARACTER . . . . .	.K K	EH1 3	R R	EH1 3	K K	T T	ER /	Votrax ASCII		
CLEAR . . . . .	.K K	L L	AY x	I3 #	R R	Votrax ASCII				
CLOSE . . . . .	.K K	L L	01 0	U1 U	Z Z	Votrax ASCII				
CONTINUEK K	UH1 6	N N	T T	I1 I	I3 #	N N	Y1 Y	IU (U1 U	Votrax ASCII
COSINE . . . . .	.K K	01 0	U1 U	S S	AH1 ;	EH3 S	Y &	N N	Votrax ASCII	
DATA . . . . .	.D D	AE1 9	EH3 S	T T	UH2 7	UH3 8	Votrax ASCII			
DESK . . . . .	.D D	EH1 3	EH3 S	S S	K K	Votrax ASCII				
DEVICE . . . . .	.D D	EH1 3	EH3 S	V V	UH3 8	AH2 A	Y &	S S	Votrax ASCII	
DISK . . . . .	.D D	I1 I	I3 #	S S	K K	Votrax ASCII				
DISPLAY . . . . .	.D D	I1 I	S S	P P	L L	A1 @	I3 #	Y &	Votrax ASCII	
DRIVE . . . . .	.D D	R R	AH1 ;	EH3 S	Y &	V V	Votrax ASCII			
EDIT . . . . .	.EH1 3	D D	I1 I	T T	Votrax ASCII					
ELSE . . . . .	.EH1 3	EH3 S	L L	S S	Votrax ASCII					
ENABLE . . . . .	.EH1 3	N N	A1 @	Y &	B B	UH3 8	L L	Votrax ASCII		

END . . . . .	.EH1	EH3	N	D	Votrax															
	3	S	N	D	ASCII															
ENTER . . . . .	.EH1	EH3	N	T	ER	Votrax														
	3	S	N	T	/	ASCII														
ERASE . . . . .	.AY	I1	R	A1	AY	Y	S	Votrax												
	*	I	R	@	*	&	S	ASCII												
ERROR . . . . .	.EH1	ER	O1	R	Votrax															
	3	/	O	R	ASCII															
ESCAPE . . . . .	.EH1	EH3	S	K	A1	Y	P	Votrax												
	3	S	S	K	@	&	P	ASCII												
EXECUTE . . . . .	.EH1	K	PA0	S	EH1	K	Y1	IU	U1	T	Votrax									
	3	K	0	S	3	K	Y	(	U	T	ASCII									
EXPONENT . . . . .	.EH1	EH3	K	PA0	S	P	O1	U1	N	EH1	N	T								
	3	S	K	0	S	P	O	U	N	3	N	T								
FEED . . . . .	.F	E1	Y	D	Votrax															Votrax
	F	E	&	D	ASCII															ASCII
FIELD . . . . .	.F	E1	Y	L	D	Votrax														
	F	E	&	L	D	ASCII														
FIX . . . . .	.F	I1	I3	K	PA0	S	Votrax													
	F	I	#	K	0	S	ASCII													
FLOPPY . . . . .	.F	L	AH1	UH3	P	Y	Votrax													
	F	L	;	8	P	&	ASCII													
FOR . . . . .	.F	O2	O2	R	Votrax															
	F	[	[	R	ASCII															
FORMAT . . . . .	.F	O2	O2	R	M	AE1	EH3	T	Votrax											
	F	[	[	R	M	9	S	T	ASCII											
FORWARD . . . . .	.F	O2	O2	R	W	ER	D	Votrax												
	F	[	[	R	W	/	D	ASCII												
FRAME . . . . .	.F	R	A1	AY	Y	M	Votrax													
	F	R	@	*	&	M	ASCII													
FREE . . . . .	.F	R	E1	Y	Votrax															
	F	R	E	&	ASCII															
GET . . . . .	.G	EH1	EH3	T	Votrax															
	G	3	S	T	ASCII															
GLITCH . . . . .	.G	L	I1	I3	T	CH	Votrax													
	G	L	I	#	T	C	ASCII													

Technical Forum

Vocabulary continued:

GOSUB . . . . .	.G	01	U1	S	UH1	UH3	E	Votrax			
	G	0	U	S	6	8	E	ASCII				
GOTO . . . . .	.G	01	U1	T	IU	U1	Votrax				
	G	0	U	T	(	U	ASCII				
HUNDRED . . . . .	.H	UH1	UH3	N	D	R	EH3	D	Votrax		
	H	6	8	N	D	R	5	D	ASCII			
IF . . . . .	.I1	I3	F	Votrax							
	I	#	F	ASCII								
INKEY . . . . .	.I1	I3	N	K	AY	Y	Votrax				
	I	#	N	K	*	&	ASCII					
INPUT . . . . .	.I1	I3	N	P	00	T	Votrax				
	I	#	N	P	\$	T	ASCII					
INSTRINGI1	I3	N	S	T	R	I1	I3	NG	Votrax		
	I	#	N	S	T	R	I	#	+	ASCII		
INSTRUCTION	.I1	I3	N	S	T	R	UH1	K	SH	UH1	N	Votrax
	I	#	N	S	T	R	6	K	>	6	N	ASCII
KEYBOARDK	AY	Y	E	01	02	R	D	Votrax			
	K	*	&	E	0	L	R	D	ASCII			
KILLK	I1	I3	L	Votrax							
	K	I	#	L	ASCII							
LEFT . . . . .	.L	EH1	EH3	F	T	Votrax					
	L	3	5	F	T	ASCII						
LENL	EH1	EH3	N	Votrax							
	L	3	5	N	ASCII							
LENGTH . . . . .	.L	EH1	EH3	N	TH	Votrax					
	L	3	5	N	=	ASCII						
LEVELL	EH1	EH3	V	UH3	L	Votrax					
	L	3	5	V	8	L	ASCII					
LINEL	AH1	Y	N	Votrax							
	L	;	&	N	ASCII							
LIST . . . . .	.L	I1	I3	S	T	Votrax					
	L	I	#	S	T	ASCII						
LOADL	01	U1	D	Votrax							
	L	0	U	D	ASCII							
LOCKL	AH1	UH3	K	Votrax							
	L	;	8	K	ASCII							

LOG . . . . .	.L	AW2	AW2	G	Votrax				
	L	2	2	G	ASCII				
MANUAL . . . . .	.M	AE1	EH3	N	Y1	U1	UH3	L	Votrax
	M	9	5	N	Y	U	8	L	ASCII
MEMORY . . . . .	.M	EH1	EH3	M	O2	O2	R	Y	Votrax
	M	3	5	M	E	E	R	&	ASCII
MERGE . . . . .	.M	ER	D	J	Votrax				
	M	/	D	J	ASCII				
MID . . . . .	.M	I1	I3	D	Votrax				
	M	I	#	D	ASCII				
MODEL . . . . .	.M	AH1	UH3	D	UH3	L	Votrax		
	M	;	8	D	8	L	ASCII		
MICRO . . . . .	.M	UH3	AH2	AY	K	R	O1	U1	Votrax
	M	8	A	*	K	R	O	U	ASCII
MILLION . . . . .	.M	I1	I3	L	Y	UH3	N	Votrax	
	M	I	#	L	&	8	N	ASCII	
NAME . . . . .	.N	A1	AY	Y	M	Votrax			
	N	@	*	&	M	ASCII			
NEXT . . . . .	.N	EH1	EH3	K	PA0	S	T	Votrax	
	N	3	5	K	0	S	T	ASCII	
NEW . . . . .	.N	IU	U1	U1	Votrax				
	N	(	U	U	ASCII				
NOT . . . . .	.N	AH1	UH3	T	Votrax				
	N	;	8	T	ASCII				
ON . . . . .	.AH1	UH3	N	Votrax					
	;	8	N	ASCII					
OPEN . . . . .	.O1	P	I1	N	Votrax				
	O	P	I	N	ASCII				
OR . . . . .	.O1	O2	R	Votrax					
	O	E	R	ASCII					
OUT . . . . .	.UH3	AH2	U1	T	Votrax				
	8	A	U	T	ASCII				
PEEK . . . . .	.P	E1	Y	K	Votrax				
	P	E	&	K	ASCII				
PHASEF	A1	AY	Y	Z	Votrax			
	F	@	*	&	Z	ASCII			

Vocabulary continued on page 390

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Vocabulary continued:

POINTP	O1	I3	AY	N	T	Votrax
	P	O	#	*	N	T	ASCII
POKEP	O1	U1	K			Votrax
	P	O	U	K			ASCII
POSITION . . . .	.P	UH1	UH3	Z	I1	SH	UH3 N
	P	6	8	Z	I	>	8 N
							ASCII
POWER . . . . .	.P	AH1	UH3	W	ER		Votrax
	P	;	8	W	/		ASCII
PRINT . . . . .	.P	R	I1	I3	N	T	Votrax
	P	R	I	#	N	T	ASCII
PUT . . . . .	.P	001	001	T			Votrax
	P	X	X	T			ASCII
RANDOM . . . . .	.R	AE1	EH3	N	D	UH1	M
	R	9	S	N	D	6	M
							ASCII
READ . . . . .	.R	E1	Y	D			Votrax
	R	E	&	D			ASCII
REMARK . . . . .	.R	E1	M	AH1	R	K	Votrax
	R	E	M	;	R	K	ASCII
REPEAT . . . . .	.R	E1	P	E1	AY	T	Votrax
	R	E	P	E	*	T	ASCII
RESET . . . . .	.R	E1	S	EH1	EH3	T	Votrax
	R	E	S	3	S	T	ASCII
RESTORE . . . . .	.R	E1	S	T	O2	O2	R
	R	E	S	T	[	[	R
							ASCII
RESUME . . . . .	.R	E1	Z	IU	U1	U1	M
	R	E	Z	(	U	U	M
							ASCII
RETURN . . . . .	.R	E1	T	ER	R	N	Votrax
	R	E	T	/	R	N	ASCII
REWIND . . . . .	.R	E1	W	AH1	AY	Y	N
	R	E	W	;	*	&	N
							D
							ASCII
RIGHT . . . . .	.R	UH3	AH2	Y	T		Votrax
	R	8	A	&	T		ASCII
SAVE . . . . .	.S	A1	AY	Y	V		Votrax
	S	@	*	&	V		ASCII
SELECT . . . . .	.S	EH2	L	EH1	K	PA0	T
	S	4	L	3	K	0	T
							ASCII
							Votrax

SET . . . . .	.S S	EH1 3	EH3 5	T T	Votrax ASCII			
SHIFT . . . . .	.SH >	I1 I	I3 #	F F	T T	Votrax ASCII		
SINE . . . . .	.S S	AH1 ;	EH3 5	Y &	N N	Votrax ASCII		
STEP . . . . .	.S S	T T	EH1 3	EH3 5	F F	Votrax ASCII		
STOP . . . . .	.S S	T T	AH1 ;	UH3 8	F F	Votrax ASCII		
STRING . . . . .	.S S	T T	R R	I1 I	I3 #	NG +	Votrax ASCII	
SUPPLY . . . . .	.S S	UH1 6	F F	L L	AH1 ;	EH3 5	Y & Votrax ASCII	
SYSTEM . . . . .	.S S	I1 I	S S	T T	EH1 3	M M	Votrax ASCII	
TAB . . . . .	.T T	AE1 9	EH3 5	B B	Votrax ASCII			
TANGENTT T	AE1 9	EH3 5	N N	D D	J J	EH1 3	N N T T	Votrax ASCII
THEN . . . . .	.THV <	EH1 3	EH3 5	N N	Votrax ASCII			
TIME . . . . .	.T T	AH1 ;	EH3 5	Y &	M M	Votrax ASCII		
TRACET T	R R	A1 @	AY *	Y &	S S	Votrax ASCII		
THOUSANDTH =	AH1 ;	UH3 8	U1 U	Z Z	EH3 5	N N	D D	Votrax ASCII
USERY1 Y	IU (U1 U	U1 U	Z Z	ER /	Votrax ASCII		
USINGY1 Y	IU (U1 U	U1 U	Z Z	I1 I	I3 #	NG +	Votrax ASCII
VALUEV V	AE1 9	EH3 5	L L	Y1 Y	IU (U1 U	Votrax ASCII	
ZAPPEDZ Z	AE1 9	EH3 5	P P	FA0 0	T T	Votrax ASCII		

The Impossible Dream:

Computing e to 116,000 Places with a Personal Computer

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The 1960s were a decade of unrest, turbulence, and accomplishment. Man walked on the moon, *Star Trek* was launched, and the first million digits of π were determined by a computer. Today, as we face the early 1980s, Robert Truax, a backyard hobbyist, is constructing a private spacecraft, *Star Trek* has been revived as a movie, and personal computers are a reality. As a people, passion drives us to explore the unknown reaches of our universe. It is pleasing to note that this exploration is no longer the exclusive domain of governments and large institutions.

The purpose of this article is to share my experiences in computing the mathematical constant e to 116,000 digits of precision on an Apple II computer. Although this computation has little intrinsic value or use, the experience was stimulating and educational. The problems I was forced to overcome gave me insights that greatly contributed to new floating-point routines. These routines were, in some cases, two to three times as fast as those currently implemented in some of our languages at Apple. Because I wanted to develop my own solutions to the problem, I did not research existing techniques for computing e to great precision. Therefore, my approaches are quite possibly not state-of-the-art.

I first calculated e to 47 K bytes of precision in January 1978. The program ran for 4.5 days, and the binary result was saved on cassette tape. Because I had no way of

detecting lost-bit errors on the Apple (16 K-byte dynamic memory circuits were new items back then), a second result, matching the first, was required. Only then would I have enough confidence in the binary result to print it in decimal.

Before I could rerun the 4.5 day program successfully, other projects at Apple, principally the floppy-disk controller, forced me to deposit the project in the bottom drawer. This article, already begun, was postponed along with it. Two years later, in March 1980, I pulled the e project out of the drawer and reran it, obtaining the same results. As usual (for some of us), writing the magazine article consumed more time than that spent meeting the technical challenges.

Little Things Add Up

To compute the value of e , a method or formula must be found or derived. The *CRC Standard Mathematical Tables* handbook (see references) provides the well-known formula:

$$e = 1 + 1/1! + 1/2! + 1/3! + \dots$$

We know that e is approximately 2.71828. For the sake of simplicity, we will deal with the fractional part only (.71828, etc) and abbreviate it *efrac*.

$$efrac = 1/2! + 1/3! + 1/4! + \dots$$

Because each term is less than one-half the prior term, this series converges with the property that the sum of all terms beyond a specified n th term is less than that n th term. Thus, if the series is truncated after n terms, the maximum error in the computation is less than $(1/n!)$. This property relates the number of terms used, n , to the precision obtained in the computation. Because this series contains a factorial in the denominator of the terms, it is said to converge rapidly. This means that great precision can be obtained with relatively few terms. For example,

Just before this issue went to press, Steve Wozniak told me that he had redesigned the theoretical "e-machine" that uses dedicated hardware for calculating e . The machine, which costs under \$10,000, would use disk storage on a hard disk to replace large amounts of programmable memory. Steve estimates that a calculation of e to 100,000,000 places (ten times as many places as the current calculation of e) could be made in three months of calculation time....GW

the *CRC Standard Mathematical Tables* handbook lists $100!$ as 9.3326×10^{157} , signifying that 100 terms will yield almost 158 digits of precision. The rate of convergence is sufficient that, for the problem at hand, neither algebraic manipulation of the series for faster convergence nor selection of a different formula is necessary.

Divide and Conquer

The following algorithm accomplishes the evaluation of the series for e . Of course, all critical routines should be implemented in highly optimized machine (assembly) language for speed. An extra hour spent optimizing the innermost loops could save days of computation time. Even self-modifying code should be used to save a critical microsecond! Binary arithmetic should be used to obtain maximal precision and the fastest possible computation time. Later, the result can be converted to decimal as it is printed.

The algorithm is as follows (also see figure 1):

1. Divide available memory equally into two arrays, TERM and E. The TERM array will contain successive terms ($1/i!$) and is initialized to 0.5 ($1/2!$). The E array will contain the running total of the terms and is also initialized to 0.5 . Both arrays can be thought of as long bit streams of the fractional parts of the numbers they represent.
2. Set the variable DIVISOR to an initial value of 3.
3. Divide TERM by DIVISOR, forming $1/(DIVISOR!)$. Multiprecision division techniques will be discussed later.
4. Add TERM to E, keeping the assumed decimal points aligned. This sum will always be purely fractional (ie: it will never equal or exceed 1).
5. Increment the DIVISOR variable.
6. Repeat steps 3, 4, and 5 until TERM is reduced to all zeros or until a predetermined maximum divisor is reached.

This basic computation algorithm utilizes only 50% of available memory for the result. By rearranging the series for e , we can arrive at an approach that utilizes 100% of the memory.

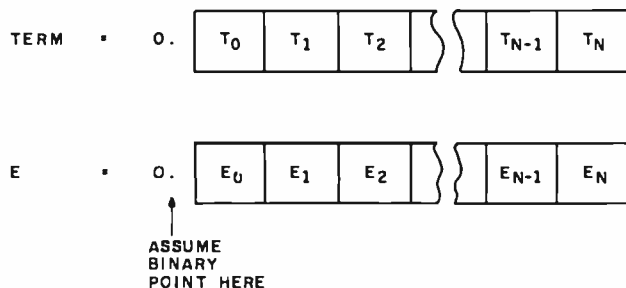


Figure 1: Memory usage in the first algorithm to calculate e . Equal amounts of memory are devoted to a sequence of bytes representing the value of the current term being calculated (TERM) and the sum of all terms calculated thus far (E). Both numbers are seen as binary fractions (ie: the leftmost bit represents $1/2$, the next bit represents $1/4$, etc).

We begin by reversing the order of terms in e frac:

$$efrac = 1/2! + 1/3! + \dots + 1/(n-1)! + 1/n! \quad (n \text{ terms})$$

$$= 1/n! + 1/(n-1)! + \dots + 1/3! + 1/2!$$

We then develop the following identity:

$$\frac{1}{i!} + \frac{1}{(i-1)!} = \frac{1}{i(i-1)!} + \frac{1}{(i-1)!}$$

$$= \frac{\frac{1}{i} + 1}{(i-1)!}$$

By repeatedly applying this identity to the formula, we get:

$$efrac = \frac{\frac{\frac{1}{n} + 1}{(n-1)} + 1}{3} + 1$$

$$\frac{2}{2}$$

On inspection, the second series is equivalent to the first for n terms. A notable property of the new series is that the computation begins with the n th (greatest) divisor and ends with 2 (the smallest). The algorithm for computing e with this series is as follows:

1. Allocate all available memory to the E array (which stores the value of e frac, the fractional part of e). Initialize it to zero.
2. Set the initial value of DIVISOR to n , the precalculated maximum term (where $n!$ is greater than the precision of the result to be computed).
3. Add 1 to E and divide by the current DIVISOR. The addition may simply imply setting the carry before dividing.
4. Decrement the DIVISOR.
5. Repeat steps 3 and 4 until the divisor equals 1.

Divisor	E (after step 3)
5	$1/5$
4	$1/4 + 1/(4 \times 5)$
3	$1/3 + 1/(3 \times 4) + 1/(3 \times 4 \times 5)$
2	$1/2 + 1/(2 \times 3) + 1/(2 \times 3 \times 4) + 1/(2 \times 3 \times 4 \times 5)$ $(1/2! + 1/3! + 1/4! + 1/5!)$

Table 1: Example of the calculation of e by the first algorithm.

An example of this algorithm for $n=5$ is given in table 1.

How Large Is It?

An associate of mine once discovered that integrated circuit layouts could be conveniently specified in nano-acres! In the computation of e , it is more meaningful to specify the precision of the result in decimal digits rather than in the number of bytes allocated. The following formula performs the conversion:

$$\log_{10}(x) = \log_{256}(x) \times \log_{10}(256)$$

$$(\text{number of digits}) = (\text{number of bytes}) \times (2.40824)$$

For example, assume that 14 K bytes of memory are allocated to the fraction of e . The number of digits of accuracy this represents is given by the following:

$$\begin{aligned} \text{number of digits} &= 14 \times 1024 \times 2.40824 \\ &= 34524.5 \text{ digits} \end{aligned}$$

The process of calculating the number of terms needed to compute e to this precision is less straightforward. What must be determined is the minimum value of n , where $n!$ is greater than the precision corresponding to available memory. For the above example, this is the minimum n such that $n!$ is greater than 10^{34524} . The *CRC Standard Mathematical Tables* handbook lists Stirling's Formula, an equation useful for calculating the

magnitude of $n!$ for reasonably large n :

$$\lim_{n \rightarrow \infty} \frac{n! \exp(n)}{n^{(n+0.5)}} = \sqrt{2\pi}$$

Taking the natural logarithms of both sides, we get:

$$\lim_{n \rightarrow \infty} \ln(n!) = \frac{\ln(2\pi)}{2} + [\ln(n)] [n+0.5] - n$$

Dividing by $\ln(10)$ to obtain the result in common (base-10) logarithms, we see the following:

$$\lim_{n \rightarrow \infty} \log_{10}(n!) = \frac{\log_{10}(2\pi)}{2} + [\log_{10}(n)] [n+0.5] - \frac{n}{\ln(10)}$$

The integer portion of this result gives us one less than the number of digits in $(n!)$.

The HP-41C calculator program in listing 1 calculates $\log_{10}(n!)$ (the number of digits in $n!$), given n .

By trial and error, it is easy to zero in on the minimum n for which $\log_{10}(n!)$ is greater than 34,524, the number of digits of precision corresponding to 14 K bytes of memory. Table 2 shows a set of values for n in the order in which they were calculated to find the desired value.

The value 9716 is found to be the minimum suitable value of n . Because it is difficult to relate the precision of $n!$ to that of $1/n!$, a slightly higher value (perhaps 9720) should be used for n . This will also compensate for minor formula or calculation errors.

A Multiprecision Division Algorithm

The problem at hand calls for the division of a very large dividend (possibly several kilobytes) by a moderate divisor (2 bytes). The general approach is to shift the divisor relative to the dividend, from the most significant bits toward the least, performing the familiar subtract/replace and shift technique that we call long division.

A few general optimizations should be considered. First, the following algorithm assumes that the divisor is less than 32,768 (2^{15}). If the divisor were to exceed 32,768, it would have to be compared to a value that could exceed 16 bits (2 bytes). Because indexed operations on the 6502 microprocessor are slower than absolute, direct, zero-page, or register operations, a few "fast" memory locations are allocated to hold the temporary (ie: relating to the current byte) dividend/quotient, and remainder. These locations are designated A0 (dividend/quotient), and A1 and A2 (2-byte remainder), and they should be allocated to the most accessible memory locations (or registers). The high-order byte of

Listing 1: *The FACTLOG program for the Hewlett-Packard HP-41C calculator. This program calculates the approximate number of digits in the number (n!).*

```
LBL ALPHA FACTLOG ALPHA ENTER LOG LASTX .5 + *
x <> y LN / -
PI ENTER + LOG 2 / + RTN
```

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the fraction array E is assumed to be E(0), and the low-order byte is E(n). Remember that the 2-byte divisor, NH and NL, represents a whole number, and that the dividend represents a binary fraction with the binary point directly to the left of the MSB (most significant bit) of E(0).

In the algorithm that follows, the A0 byte represents the current byte, E(i), of the dividend at step 2. By step 6, however, all the digits of the dividend have been shifted out to the left (to the A1, A2 combination), and the digits of the new quotient have been shifted into A0 from the right. A0 is actually doing the work of two 8-bit registers.

Of course, all computation should be done in binary for maximum precision and speed. While targeted for 8-bit machines, these techniques are applicable to machines of longer word lengths.

The "add 1 and divide by n" algorithm (see figure 2) is as follows:

1. Initialize the remainder (locations A2 and A1) to 1, effectively adding 1.0 to the fractional dividend prior to dividing. (A2 is the most significant byte of the remainder.) This accommodates the algorithm developed for calculating *e*. An unmodified divide operation would call for initializing the remainder to zero. Initialize the index, *i*, to zero.
2. Move the next dividend byte, E(*i*), to location A0 to divide it by *n*. Shift A0 left 1 bit, moving the MSB into the carry bit.
3. Rotate the 16-bit remainder (A2 and A1) to the left by 1 bit, and rotate the carry bit from A0 into the LSB (least significant bit) of A1. This corresponds to the "shift" portion of the subtract-and-shift algorithm for division. No overflow can occur from this shift because the residual remainder must be less than twice the divisor, which in turn is less than $32,768 (2^{15})$.

n	log ₁₀ (n!) (number of digits in n!)
10000	35659.5
9000	31681.9
9700	34461.4
9800	34860.3
9730	34581.0
9720	34541.2
9710	34501.3
9715	34521.2
9716	34525.2

Table 2: Trial-and-error determination of the number of terms, *n*, needed to obtain 34,524 digits of precision in the calculation of *e*. In the algorithm used to calculate *e*, the smallest contribution to the final value is made by the term (1/*n*!). The number of digits in (*n*!) is determined by estimating the value of *n*! and taking the logarithm to the base 10. The desired value of *n* is the first integer value greater than 34,524.

4. Compare the remainder, A2 and A1, to the divisor locations NH and NL. If the remainder is greater, then replace it with the difference of the two and set the quotient bit to 1. Otherwise, clear the quotient bit.
5. Rotate the quotient bit into the LSB of A0, and rotate the MSB of A0 into the carry bit.
6. Perform steps 3, 4, and 5, a total of eight times. Then replace E(*i*) with the byte in A0 (which is now the quotient of the byte-wide division just finished). Increment the index, *i*, and continue at step 2 until the last byte, E(*n*), has been processed.

Special Optimizations

I drive a small car and have found that it is helpful to accelerate or decelerate slightly in advance of certain stretches of the road (especially hills and downgrades) to obtain an adequate performance. Similarly, it is

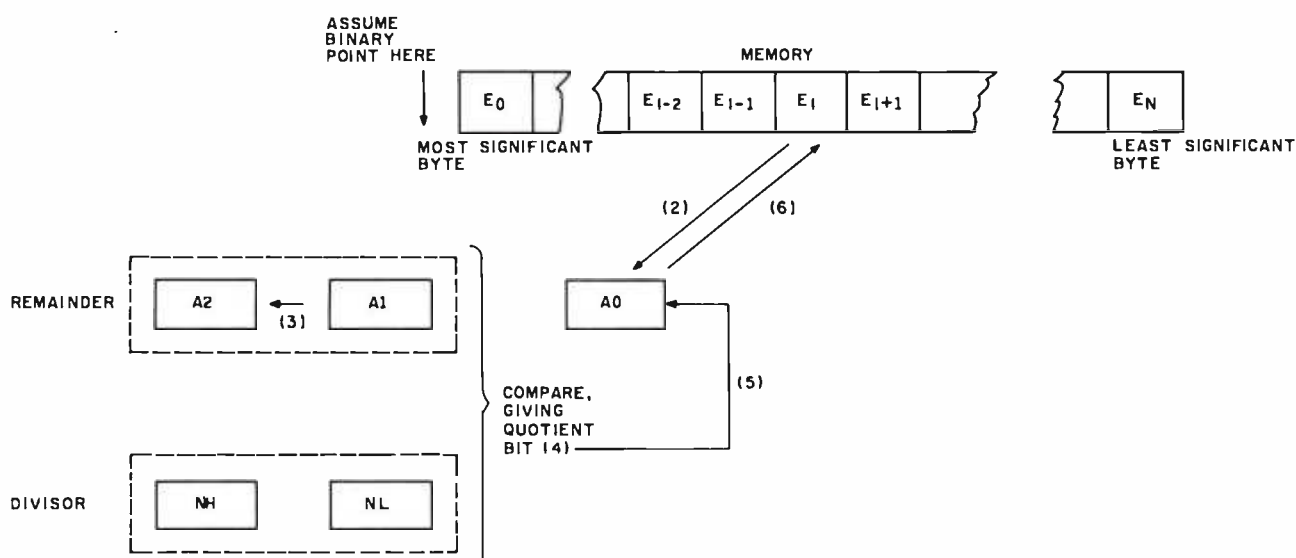


Figure 2: Memory usage in the multiple-byte "add 1 and divide by n" division algorithm. The second algorithm (given in the text) reduces memory usage by 50% by using one long string of bytes in the computation process. The E array is divided 1 byte at a time by the 2-byte divisor. The A0 byte is used to store both the dividend and the quotient at different points in the algorithm. The numbers in parentheses refer to numbered steps in the algorithm.



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sometimes necessary to compensate for the inherent deficiencies of microprocessors (eg: their size) by carefully implementing specific optimizations. For example, the comparison performed in step 4 (discussed above) would normally be done by subtracting the low, and then high bytes, and possibly preserving the difference for replacement of the remainder. Within certain processors, it may be faster to first compare the high bytes, since they frequently dictate the comparison result (255 out of 256 times for arbitrary contents). Also, the critical steps 3, 4, and 5 can be coded eight times in-line to avoid the overhead time of a loop. And because the divisor changes infrequently, it can be coded as fast immediate-mode data. After each full divide, the code, which resides in programmable memory, can be modified for the next divisor.

The 6502 assembly-language program in listing 2 calculates e in 14 K bytes of memory. In order to keep the listing brief for this article, the program is not fully optimized. The major operation (add 1, divide) is not coded in-line eight times but is instead implemented as a loop. Because the Y register is used as a loop counter, it is not available as an index to the e array, and time-consuming increment instructions must be performed on the instructions at EREF1 and EREF2. Also, it is slightly faster not to move the current dividend byte of e into a separate fast location (A0 in the algorithm).

The e array begins at hexadecimal location 800 (which is the most significant byte of the array). This secondary text-screen page of the Apple II allows you to view roughly the first 1 K bytes of e as they are calculated. Although the character representation is not readily useful, it is at least comforting to observe that the program is working on the correct section of memory. Do not execute this program until you read further and have a good idea of how long it runs before completion. Also, remember that although the result is in binary and somewhat meaningless, it will later be converted to decimal and printed.

Tomorrow Is a Long Time

The execution time of this program is proportional to the number of divisions performed (9719 for the above example), the number of bytes being divided (14 K bytes in this case), and the average divide time per byte.

The average divide time per byte is calculated as follows. In listing 2, the numbers in parentheses are the cycle times of all significant instructions of the divide routine. Careful analysis shows that when the high-order dividend (remainder) byte is less than the high-order divisor byte, 23 cycles are used. When the former is greater than or equal to the latter, 39 cycles are used, with approximately 13.5 additional cycles (on the average) if the two are equal. Statistically, the remainder will be less than the divisor half of the time and greater than or equal to the divisor half of the time. Analysis reveals that the 2 bytes will be equal approximately one out of every $2H$ comparisons, where H is the high-order divisor

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byte contents. In the example, H varies from 37 down to 0, so the average frequency of equality is 1 in 37. Using this "Judge factor," the average cycle time per 1-bit partial division is computed as follows:

$$\begin{aligned} \text{cycles per bit} &= 2^{1/2} + 2^{2/2} + 2^{3/2} \\ &= 31.3649 \text{ cycles} \end{aligned}$$

Every byte divided includes eight of the above itera-

tions plus an overhead of 21 cycles, giving the following average:

$$\begin{aligned} \text{cycles per byte} &= (\text{cycles per bit} \times 8 \text{ bits per byte}) \\ &\quad + 21 \\ &= 31.3649 \times 8 + 21 \\ &= 271.919 \text{ cycles} \end{aligned}$$

The average time per cycle on the Apple II is a function of the crystal frequency (14.31818 MHz) and the fre-

Text continued on page 399

Listing 2: A 6502 machine-language program for calculating e to 34,524 decimal digits. The result is in binary and must be converted to decimal by the programs shown in listings 3 and 4.

```
SOURCE FILE: BCALC1
0000:          1          LSTON
0000:          2          *****
0000:          3          *
0000:          4          *   CALCULATION OF E -- 14K   *
0000:          5          *
0000:          6          *   WOZ           20-APR-80   *
0000:          7          *
0000:          8          *   EXAMPLE PROGRAM   *
0000:          9          *
0000:         10          *****
0000:         11          *
0000:         12          * LOCATIONS $800-3FFF ARE USED *
0000:         13          * FOR THE (BINARY) FRACTION OF *
0000:         14          * E. LOCATION $800 IS THE MOST *
0000:         15          * SIGNIFICANT BYTE, $3FFF IS *
0000:         16          * THE LEAST SIGNIFICANT. THIS *
0000:         17          * CORRESPONDS TO APPROXIMATELY *
0000:         18          * 34524 DIGITS. *
0000:         19          *
0000:         20          *****
0000:         21          *
0000:         22          * THE FIRST DIVISOR IS 9720 *
0000:         23          * AND THE LAST IS 2. 9720 *
0000:         24          * FACTORIAL IS GREATER THAN *
0000:         25          * 10 ^ 34524. *
0000:         26          *
0000:         27          *****
0000:         28          *
0000:         29          * THE MAJOR OPERATION, IS AN *
0000:         30          * INCREMENT (+1) OF E FOLLOWED *
0000:         31          * BY A MULTI-PRECISION DIVIDE *
0000:         32          * BY THE CURRENT DIVISOR. *
0000:         33          * EACH SUCCESSIVELY LESS SIG- *
0000:         34          * NIFICANT BYTE OF E, TOGETHER *
0000:         35          * WITH THE RESIDUAL REMAINDER *
0000:         36          * A1 AND A2, IS DIVIDED BY THE *
0000:         37          * CURRENT 2-BYTE DIVISOR. THE *
0000:         38          * 8-BIT QUOTIENT IS LEFT IN E *
0000:         39          * AND THE RESIDUAL REMAINDER *
0000:         40          * IN A1 AND A2 (ACC HOLDS A2). *
0000:         41          *
0000:         42          *****
0000:         43          A1      EQU 0          (CURRENT BYTE OF E IS A0, ACC IS A2)
0000:         44          PCOUNT EQU 1      COUNTS RAM PAGES OF E ARRAY.
```

Listing 2 continued on page 398

Listing 2 continued-

0800:	45 E	EQU	\$800	E, BINARY FRACTION, TO \$3FFF.
0038:	46 NUMPAG	EQU	\$38	14K IS 56 RAM PAGES.
25F8:	47 N	EQU	9720	(N FACTORIAL IS > 34524 DIGITS)
25F8:	48 NL	EQU	N&\$FF	LO BYTE OF N.
0025:	49 NH	EQU	N/256	HI BYTE OF N.

```

----- NEXT OBJECT FILE NAME IS ECALC1.OBJO
0240:      51      ORG      $240
0240:A9 38      52 NXTDVR LDA #NMPAG  INIT RAM PAGE COUNTER
0242:85 01      53      STA PCOUNT  FOR 56 PAGES.
0244:A9 01      54      LDA #1
0246:85 00      55      STA A1      INIT RESIDUAL REMAINDER TO 1. (FOR +1)
0248:A9 08      56      LDA #E/256
024A:8D 5C 02   57      STA EREF1+2  MODIFY CODE SO THAT REFS
024D:8D 78 02   58      STA EREF2+2  TO E POINT TO FIRST BYTE.
0250:A9 00      59      LDA #0      (ACC IS ALSO A2 OF RESIDUAL REMAINDER)
0252:8D 5B 02   60      STA EREF1+1
0255:8D 77 02   61      STA EREF2+1
0258:A0 08      62 NXTBYTE LDY #8      (2) COUNTER--8 BITS PER BYTE.
025A:0E 00 08   63 EREF1  ASL E      (6) MSB OF DIVIDEND BYTE TO CARRY.
025D:26 00      64 NXTBIT  ROL A1     (5) SHIFT 3-BYTE DIVIDEND.
025F:2A         65      ROL A      (2) (ACC IS A2)
0260:C9 25      66 NHREF1  CMP #NH     (2) IF HI BYTE LESS THAN DIVISOR
0262:90 12      67      BCC EREF2     (3/2) THEN QUOTIENT BIT IS 0.
0264:D0 06      68      BNE REPLACE  (3/2) (TAKEN IF GREATER)
0266:A6 00      69      LDX A1     (3) COMPARE LOW BYTES IF HI BYTES EQUAL.
0268:E0 F8      70 NLREF1  CPX #NL     (2)
026A:90 0A      71      BCC EREF2     (3/2) IF LESS, QUOTIENT BIT IS 0.
026C:AA         72 REPLACE TAX      (2)
026D:A5 00      73      LDA A1     (3) REPLACE RESIDUAL REMAINDER A1 AND A2
026F:E9 F8      74 NLREF2  SBC #NL     (2) WITH RESIDUAL REMAINDER
0271:85 00      75      STA A1     (3) MINUS CURRENT DIVISOR.
0273:8A         76      TXA      (2) (HI BYTE OF RESIDUAL REMAINDER)
0274:E9 25      77 NHREF2  SBC #NH     (2) (GUARANTEED TO SET CARRY)
0276:2E 00 08   78 EREF2  ROL E      (6) QUOTIENT BIT INTO A0 LSB, MSB TO CARRY.
0279:88         79      DEY      (2) NEXT OF 8 BITS.
027A:D0 E1      80      BNE NXTBIT  (3/2) LOOP--NOTE: CARRY = QUOTIENT BIT.
027C:EE 5B 02   81      INC EREF1+1  (5)
027F:EE 77 02   82      INC EREF2+1  (5) MODIFY CODE REFS TO E ARRAY.
0282:D0 D4      83      BNE NXTBYTE  (3) (NO BYTE OVERFLOW)
0284:EE 5C 02   84      INC EREF1+2
0287:EE 78 02   85      INC EREF2+2  (MODIFY HI BYTE)
028A:C6 01      86      DEC PCOUNT
028C:D0 CA      87      BNE NXTBYTE  LOOP UNTIL DONE 56 RAM PAGES.
028E:AD 69 02   88      LDA NLREF1+1
0291:D0 06      89      BNE NXTDVR2
0293:CE 61 02   90      DEC NHREF1+1  DECR IMMEDIATE REFS TO
0296:CE 75 02   91      DEC NHREF2+1  CURRENT DIVISOR.
0299:CE 69 02   92 NXTDVR2 DEC NLREF1+1
029C:CE 70 02   93      DEC NLREF2+1
029F:AD 69 02   94      LDA NLREF1+1
02A2:4A         95      LSR A
02A3:0D 61 02   96      ORA NHREF1+1  LOOP IF DIVISOR > 1.
02A6:D0 98      97      BNE NXTDVR
02A8:60         98      RTS      (DONE)

```

*** SUCCESSFUL ASSEMBLY: NO ERRORS

Text continued from page 397:

quency-dividing circuitry that generates the microprocessor clock. Due to color-graphics considerations, a slight adjustment (to eliminate display jitter) is made, which introduces a constant multiplying the crystal period, and gives us the following time per machine cycle:

$$\begin{aligned}\text{time per cycle} &= 912 / ((65)(14.31818 \text{ MHz})) \\ &= 0.9799269 \mu\text{s}\end{aligned}$$

The division time per byte (in μs) and time per program execution can now be calculated:

$$\begin{aligned}\text{time per byte} &= \text{cycles per byte} \times \text{time per cycle} \\ &= 271.919 \text{ cycles} \times .9799269 \mu\text{s} \\ &\quad \text{per cycle} \\ &= 266.46 \mu\text{s} \\ \text{time per program} &= \text{time per byte} \times \text{number of} \\ &\quad \text{bytes} \times \text{number of divisions} \\ &= 266.46 \mu\text{s} \times (14)(1024) \times 9719 \\ &= 37.126 \text{ seconds} \\ &= 10.3 \text{ hours}\end{aligned}$$

Note that as you compute e to greater precision, both the number of divisors and the length of each division increase. Also, at some point, a 2-byte division no longer suffices and a 3-byte division must be used. This causes the execution time to vary with roughly the second power of the precision sought. For example, three times the precision takes ten times as long to calculate!

Running the Example Program

If you wish to try the example program before branching out on your own, a few suggestions should be heeded. First, it is a shame to run a program for 10 hours and then find out it contained a minor bug. By changing N (the maximum divisor) to 1000 and NUMPAG to 4 (for 1 K bytes of precision), a quick trial/practice version can be assembled. The practice run allows the user to get the obvious mistakes out of the way with minimum consequence and verify that the assembly is correct. The following commands will clear the memory locations used, run the program, and finish in about 4.5 minutes (273 seconds). Hexadecimal location 0800 should contain B7, and location 0BFF should contain 24 upon completion. As mentioned previously, you can watch the calculation proceed by displaying the secondary text screen on the Apple II. During the trial run, it should be constantly changing.

The following two lines (to be entered when the Apple II is in monitor mode) allow you to run the test program:

```
"800:0 N801 < 800.BFEM
"C055 240C C054
```

The first line clears the area of memory that will be used, and the second line switches the video display to text

page 2 (which will contain the value of e being computed), runs the program of listing 2, then returns to text page 1 when the program is complete.

The real (10-hour) example program should be run twice, and the results compared to verify that the program does not contain a minor bug and that the constants were properly determined. As discussed below, it is not necessary to initialize memory before running the program if the constant n has been properly selected. Therefore, it is recommended that the program be run first with initialized memory and later with random (uninitialized) memory. These results, when compared, should be identical. Once you have confidence in the binary result, save it on tape or floppy disk for printing in decimal.

Go Forth and Multiply

The computed binary fraction must next be converted to decimal and printed. The general method of converting a binary fraction to a decimal fraction is to repeatedly multiply it by decimal 10 (in binary). The carry from each multiplication (integer portion of product) is the next decimal digit. Because the most significant digits are generated first, the result can be printed as it is generated.

A higher-level language such as BASIC should be used to format the output, but unless you are planning a short vacation, highly optimized machine language should be used for the base conversion. The 6502 programs in listing 3 accomplish the conversion. Subroutine INIT is called once to generate a 256-entry, multiply-by-100 lookup table. Subroutine MULT scans the e array, from the least toward the most significant bytes, multiplying each byte by 100 via a fast table lookup. It also handles carries. The resultant carry is a 2-digit number between 0 and 99 that is returned to BASIC for printing. Note that multiplying by 100, instead of 10, generates 2 digits per pass.

Seeing Is Believing

The BASIC formatting program in listing 4 should produce an attractive printout. No single program will suffice, due to the fact that printers and people are so varied. The considerations include page headers (title, date, page number), lines per page, spacing between lines, digits per line, digit groupings (eg: groups separated by a space or two), and margins. For example, the poor horizontal registration of a Centronics 779 printer is painfully obvious with single-spaced printouts but almost undetectable with double-spaced ones. A little trial and error will insure that your printout is a perfect "10."

The program in listing 4 was used with an NEC (Nippon Electric Company) Spinwriter. It prints 60 digits per line (twelve groups of 5 digits, separated by single blanks) and 60 lines per page. The page heading is simply the letter e and the page number, carefully aligned with the left and right margins. The text " $e = 2.$ " precedes the first digit of the printout. The program ends after printing 34,500 digits, despite the fact that an additional 24 digits are re-

Text continued on page 402

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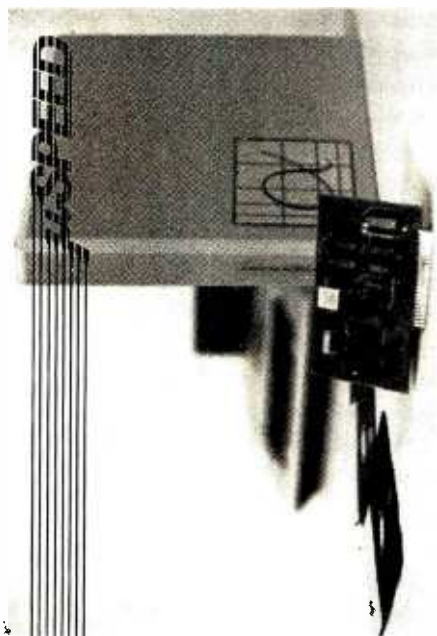
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Listing 3: A BASIC driver program to print e from binary to decimal form. The program uses the machine-language program EPRNT, shown in listing 4.

```

SOURCE FILE: EPRNT
0000:      1 *****
0000:      2 *
0000:      3 *      'E' PRINTOUT ROUTINES      *
0000:      4 *
0000:      5 *      14K VERSION                *
0000:      6 *
0000:      7 *      WOZ          20-APR-80      *
0000:      8 *
0000:      9 *****
0000:     10 *
0000:     11 * THESE SUBROUTINES PERFORM      *
0000:     12 * THE CRITICAL OPERATIONS      *
0000:     13 * FOR CONVERTING THE 14K        *
0000:     14 * BINARY VERSION OF 'E'      *
0000:     15 * TO DECIMAL FOR PRINTING.    *
0000:     16 * THEY ARE INTENDED TO BE      *
0000:     17 * CALLED FROM A BASIC PROGRAM  *
0000:     18 * WHICH DOES THE ACTUAL        *
0000:     19 * PRINTING.                    *
0000:     20 *
0000:     21 *****
0000:     22 *
0000:     23 * THE BINARY REPRESENTATION      *
0000:     24 * OF THE FRACTIONAL PART OF    *
0000:     25 * E (OR ANY OTHER NUMBER      *
0000:     26 * TO BE CONVERTED TO DECIMAL) *
0000:     27 * IS STORED IN LOCATIONS $800  *
0000:     28 * (MOST SIGNIFICANT) TO $3FFF  *
0000:     29 * (LEAST). THE SUBROUTINES      *
0000:     30 * INIT AND MULT RESIDE IN THE    *
0000:     31 * $4000 PAGE OF MEMORY AND     *
0000:     32 * USE TABLES PRODLO AND        *
0000:     33 * PRODHI IN THE $4100 AND        *
0000:     34 * $4200 PAGES RESPECTIVELY.   *
0000:     35 * LOMEM MUST BE SET TO $4300  *
0000:     36 * (17152 DECIMAL) OR GREATER   *
0000:     37 * FROM BASIC.                  *
0000:     38 *
0000:     39 *****
0000:     40 *
0000:     41 * SUBROUTINE INIT MUST BE        *
0000:     42 * CALLED ONCE TO GENERATE        *
0000:     43 * 'MULTIPLY BY 100' TABLES      *
0000:     44 * PRODLO AND PRODHI. INIT      *
0000:     45 * MUST BE CALLED BEFORE MULT.   *
0000:     46 *
0000:     47 * SUBROUTINE MULT PERFORMS      *
0000:     48 * A 'MULTIPLY BY 100' ON THE    *
0000:     49 * NUMBER 'E'. IT RETURNS        *
0000:     50 * THE NEXT TWO DIGITS OF THE     *
0000:     51 * DECIMAL EQUIVALENT AS A

```

```

0000:      52 * NUMBER BETWEEN 0 AND 99 IN *
0000:      53 * LOCATION 1 (WHERE BASIC *
0000:      54 * CAN PEEK IT FOR PRINTING). *
0000:      55 * *
0000:      56 *****

0000:      58 XSAV EQU 0 X-REG SAVE LOCATION.
0001:      59 RESULT EQU 1 RESULT BYTE FROM MULTIPLY.
0002:      60 PCOUNT EQU 2 COUNTS NUMBER OF RAM PAGES OF E.
4100:      61 PRODLO EQU $4100 LOW BYTE TABLE (100 * IDX).
4200:      62 PRODHI EQU $4200 HI BYTE TABLE (100 * IDX).
0800:      63 E EQU $800 E, BINARY FRACTION, TO $3FFF.
0038:      64 NUMPAG EQU 56 56 PAGES IN 14K
003F:      65 LASTPAG EQU $3F LAST (LEAST SIGNIFICANT) PAGE OF E.
0000:      66 *
0000:      67 *****
0000:      68 *

----- NEXT OBJECT FILE NAME IS EPRNT.OBJO
4000:      69 ORG $4000
4000:86 00 70 INIT STX XSAV PRESERVE X-REG FOR INT BASIC.
4002:A9 00 71 LDA #0 STARTING PRODUCT LO BYTE.
4004:AA 72 TAX STARTING PRODUCT HI BYTE.
4005:A8 73 TAY STARTING INDEX TO PRODUCT TABLES.
4006:99 00 41 74 PRODCEN STA PRODLO,Y STORE LOW BYTE OF 100 * Y.
4009:48 75 PHA PRESERVE A-REG
400A:8A 76 TXA HI BYTE OF CURRENT PRODUCT.
400B:99 00 42 77 STA PRODHI,Y STORE HI BYTE OF 100 * Y.
400E:68 78 PLA RESTORE A-REG (PRODUCT LOW BYTE).
400F:18 79 CLC
4010:69 64 80 ADC #100 ADD 100 FOR NEXT PRODUCT.
4012:90 01 81 BCC NXTPROD
4014:E8 82 INX
4015:C8 83 NXTPROD INY NEXT OF 256 PRODUCTS.
4016:D0 EE 84 BNE PRODCEN
4018:A6 00 85 LDX XSAV RESTORE X-REG FOR INT BASIC.
401A:60 86 RTS (RETURN)
401B: 87 *
401B: 88 *****
401B: 89 *
401B:A9 38 90 MULT LDA #NUMPAG
401D:85 02 91 STA PCOUNT 56 PAGES IN 14K.
401F:A9 3F 92 LDA #LASTPAG
4021:8D 32 40 93 STA MULT1+2 INIT E REFS FOR LEAST
4024:8D 38 40 94 STA MULT2+2 SIGNIFICANT RAM PAGE.
4027:A0 00 95 LDY #0 INIT INDEX TO E (WILL DECR TO $FF FIRST TIME)
4029:A2 00 96 LDX #0 TRICK TO CLEAR RESIDUAL CARRY.
402B:18 97 CLC
402C:BD 00 42 98 MULBYT LDA PRODHI,X (4) HI PROD BYTE IS RESIDUAL CARRY.
402F:88 99 DEY (2) NEXT MORE SIGNIFICANT BYTE OF E.
4030:BE 00 08 100 MULT1 LDX E,Y (4) (GET IT)
4033:7D 00 41 101 ADC PRODLO,X (4) TIMES 100, PLUS RESIDUAL CARRY.
4036:99 00 08 102 MULT2 STA E,Y (5) RESTORE PRODUCT BYTE.
4039:98 103 TYA (2) LAST BYTE THIS PAGE?
403A:D0 F0 104 BNE MULBYT (3/2) NO, CONTINUE.
403C:CE 32 40 105 DEC MULT1+2 (6)

```

Listing 3 continued:

```
403F:CE 38 40 106      DEC  MULT2+2    (6) NEXT MORE SIGNIFICANT PAGE.
4042:C6 02 107      DEC  PCOUNT     (5) DONE 56 PAGES?
4044:DO E6 108      BNE  MULBYT    (3) NO, CONTINUE.
4046:7D 00 42 109    ADC  PRODHI,X  RETRIEVE FINAL CARRY.
4049:85 01 110      STA  RESULT    SAVE AS TWO-DIGIT RETURNED VALUE.
404B:A6 00 111      LDX  XSAV      RESTORE X-REG FOR INT BASIC.
404D:60 112      RTS           (RETURN)
```

*** SUCCESSFUL ASSEMBLY: NO ERRORS

Listing 4: EPRNT, a machine-language program that converts a binary number for printing as a decimal number.

FORMATTER PROGRAM - APPLE INTEGER BASIC

FILE E1 IS 'E' FROM \$800 TO \$3FFF

FILE EPRNT.OBJO IS INIT AND MULT SUBRS

CAUTION: MUST SET LOMEM TO 17152!

```
10 D$="": PRINT D$;"NOMON C,I,0": PRINT D$;"BLOAD E1,A$800": PRINT D$;
   "BLOAD EPRNT.OBJO,A$4000": PRINT D$;"PR#2"
20 INIT=16384;MULT=16411: CALL INIT:ODDEVEN=0
30 FOR PAGE=1 TO 10: PRINT : PRINT "      E";: FOR I=1 TO 63: PRINT " "
   ;: NEXT I: PRINT "PAGE ";PAGE/10;PAGE MOD 10: PRINT
40 FOR LINE=1 TO 60: IF PAGE>1 OR LINE>1 THEN 50: PRINT " E=2.";: GOTO
   60
50 PRINT "      ";
60 FOR GROUP=1 TO 12
70 FOR DIG=1 TO 5: GOSUB 200: NEXT DIG
80 PRINT " ";: NEXT GROUP
90 PRINT : IF PAGE=10 AND LINE=35 THEN 110: NEXT LINE: REM QUIT AFTER 34500
   DIGITS
100 PRINT : PRINT : PRINT : NEXT PAGE
110 PRINT D$;"PR#0": END : REM TURN PRINTER OFF
190 REM
192 REM SUBROUTINE 200 PRINTS NEXT DIG
194 REM
200 IF ODDEVEN=1 THEN 220: CALL MULT
210 PRINT PEEK (1)/10;: GOTO 230
220 PRINT PEEK (1) MOD 10;
230 ODDEVEN=1-ODDEVEN: RETURN
```

Text continued from page 399:

quired in order to be correct. The final page and line number were precalculated to detect this stopping point. Lines 200 thru 230 make up a digit-printing subroutine that calls the assembly-language multiply-by-100 routine (MULT) every other digit.

Analysis of the Algorithm

The specified algorithm has the property that the contents of e at a given stage of computation will yet be divided by $(i!)$, where i is the current divisor. The first im-

plication of this property is that the allocated memory need not be initialized, since it will all be reduced to insignificance when divided by $n!$ (because n , the starting divisor, was specifically chosen such that $n!$ is greater than the significance corresponding to that much memory).

An interesting aspect of this implication is that the result is perfect to the last calculated bit, despite the fact that terms beyond the n th have been omitted. Additional terms (before the n th) would simply cause the allocated

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In order to help those people applying for these guaranteed and direct loans fill out their loan applications the “right way,” ICC Business Research, through its diligent compilation and research efforts, has successfully assembled and published a comprehensive, easy-to-follow seminar manual: *The Money Raiser's Guaranteed and Direct Loans Manual*, that will quickly show you practically everything you'll need to know to prepare a loan application to get federally Guaranteed and Direct Loans.

Here are just some of the many important benefits the Money Raiser's Guaranteed and Direct Loans Manual provides you with:

- a completely filled in sample set of actual SBA loan application forms, all properly filled in for you to easily follow—aid's you in quickly preparing your own loan application the right way. Each line on the sample application forms is explained and illustrated in easy-to-understand language.

- fast application preparation procedures for getting loans for both new start up business ventures and established firms.
- advises you on how to properly answer key questions necessary for loan approval and in order to help avoid having your application turned down—gives you advice on what you should not do under any circumstances.
- what simple steps you take to guarantee eligibility—no matter if you do not presently qualify.
- where you can file your application for fastest processing.

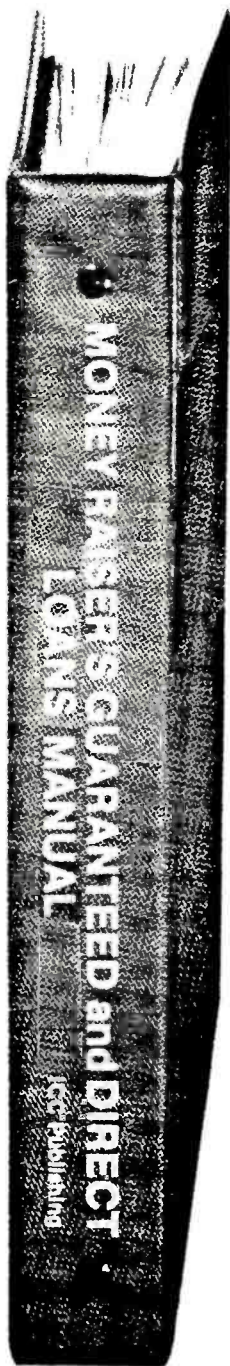
At this point the most important question you want answered is: Just where is all this loan money coming from? Incredible as it may sound—these Guaranteed Loans, Direct Loans, and Immediate Loans are indeed available right now — from the best, and yet, the most overlooked and frequently the most ignored and sometimes outright ridiculed...“made-fun-of” source of ready money...fast capital, in America — THE UNITED STATES GOVERNMENT.

Of course, there are those who upon hearing the words “UNITED STATES GOVERNMENT” will instantly freeze up and frown and say:

“...only minorities can get small business loan money from the government!”

Yet, on the other hand (and most puzzling) others will rant on and on and on that:

“...don't even try, it's just impossible — all those Business Loans Programs are strictly for the Chryslers, the Lockheeds, the big corporations...not for the little guy or small companies.” etc.



Still there are those who declare:

“...I need money right now...and small business government loans take too darn long. It's impossible to qualify. No one ever gets one of those loans.”

Or you may hear these comments:

“...My accountant's junior assistant says he thinks it might be a waste of my time!” “Heck, there's too much worrisome paperwork and red tape to wade through!”

Frankly — such rantings and ravings are just a lot of “bull” without any real basis — and only serve to clearly show that lack of knowledge...misinformation...and and not quite fully understanding the UNITED STATES GOVERNMENT'S Small Business Administration's (SBA) Programs have unfortunately caused a lot of people to ignore what is without a doubt — not only the most important and generous source of financing for new business start ups and existing business expansions in this country — but of the entire world!

Now that you've heard the “bull” about the United States Government's SBA Loan Program — take a few more moments and read the following facts:

- Only 9.6% of approved loans were actually made to minorities last year
- What SBA recognizes as a “small business” actually applies to 97% of all the companies in the nation
- Red tape comes about only when the loan application is sent back due to applicant not providing the requested information...or providing the wrong information
- The SBA is required by Congress to provide a minimum dollar amount in business loans each fiscal year in order to lawfully comply with strict quotas. (Almost 5 billion this year)

Yet, despite the millions who miss out — there are still literally thousands of ambitious men and women nationwide who are properly applying — being approved — and obtaining sufficient funds to either start a new business, a franchise, or buy out or expand an existing one. Mostly, they are all just typical Americans with no fancy titles, who used essentially the same effective know-how to fill out their applications that you'll find in the Money Raiser's Guaranteed and Direct Loans Manual.

So don't you dare be shy about applying for and accepting these guaranteed and direct government loans. Curiously enough, the government is actually very much

GUARANTEE #1
Simply — look over this most effective money raising loan preparation assistance manual for 15 days — and, then, if you are not convinced that it can actually help you obtain the Business Loan you need right away — just return it for a full and prompt refund.

interested in helping you start a business that will make a lot of money. It's to their advantage — the more money you make the more they stand to collect in taxes. In fiscal 1981, our nation's good old generous “uncle” will either lend directly or guarantee billions of dollars in loan requests, along with technical assistance and even sales procurement assistance. Remember, if you don't apply for these available SBA funds somebody else certainly will.

Don't lose out — now is the best time to place your order for this comprehensive manual. It is not sold in stores. Available only by mail through this ad, directly from ICC Business Research, the exclusive publisher, at just a small fraction of what it would cost for the services of a private loan advisor or to attend a seminar.

For example:
Initially, this amazing Guaranteed and Direct Loans Manual was specially designed to be the basis of a Small Business Loan Seminar — where each registrant would pay an admission fee of \$450. But our company felt that since the manual's quality instructions were so exceptionally crystal-clear that anyone who could read, could successfully use its techniques without having to attend a seminar or pay for costly private loan advisory assistance services.

Therefore, for those purchasing the manual by mail, no 3 day class, no course and accommodations are required. And rather than \$450 we could slash the price all the way down to just a mere \$35 — a small portion of a typical seminar attendance fee — providing you promptly fill in and mail coupon below with fee while this special “seminar-in-print” manual offer is still available by mail at this relatively low price!

Remember, this most unique manual quickly provides you with actual sample copies of SBA Loan application and all other required forms—already properly filled in for you to easily use as reliably accurate step-by-step guides—thus offering you complete assurance that your application will be properly prepared, and thereby immediately putting you on the right road to obtaining fast, no red-tape loan approval.

GUARANTEE #2
Even after 15 days — here's how you are still strongly protected — if you decide to keep the manual — and you apply for an SBA Loan anytime within 1 year...your loan must be approved and you must actually receive the funds or your money will be refunded in full.

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memory to have different contents (ie: be initialized arbitrarily) when the n th term is reached. Since division proceeds from high toward low significant bits, arbitrary data beyond a specified least significant byte can never affect the contents of that byte or any more significant byte. There can be no accumulated truncation errors such as those encountered with summation-of-terms approaches.

The second implication is that, at a given stage of calculation, only the most significant bytes of e (ie: those that will not subsequently be divided to insignificance) need to be divided! The first divisions can be very short, only a few bytes or so, while the last ones must encompass all of e . For a given divisor, i , the number of (least significant) bytes of e which need *not* be divided is $\log_{256}(i!)$, which may be calculated by the HP-41C program in listing 5. Note that it calls the previously written program FACTLOG, which calculates the number of digits of $(i!)$. The algorithm used is:

number of bytes of $i!$ = number of digits of $i!/\log_{10}(256)$

It is unfeasible to precalculate the number of bytes to leave undivided (or the number to divide) for each divisor and to save it in a table because the table would consume a great deal of memory. As an alternative, the divisors can be broken into blocks of, say, 1 K bytes each, and for each block a fixed number of bytes (of e)

can be divided. The number of bytes to divide for a given block is calculated as the total number of bytes in the e array minus the number of insignificant bytes (calculated as above) corresponding to the minimum divisor of the block, plus a "guard" byte or two to cover slight calculation errors.

In a later program that calculated e to 116,000 digits, I used 47 K bytes (188 pages of 256 bytes each) of memory, and the maximum divisor was 28,800. The divisors were grouped into fifteen blocks of 2 K-byte divisors each, and the number of memory pages not to be divided were precalculated for each block (see table 3). This version of the program used a lookup table to determine how many pages to divide (188 minus the number *not* to divide) for each divisor. This technique proved extremely beneficial because it reduced the computation time from four days to two.

The 47 K-byte version used virtually all the memory in a 48 K-byte Apple. The e array occupied hexadecimal locations 400 thru BFFF. A starting divisor of 28,800

Listing 5: *The FACTBYT program for the Hewlett-Packard HP-41C calculator. This program calculates the precision to which the multibyte division has to be carried out for a given divisor. See table 3 for details.*

LBL ALPHA FACTBYT ALPHA XEQ ALPHA FACTLOG ALPHA 256 LOG / RTN

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Range of Divisors in Same Group	Number of Insignificant Bytes	Number of Pages That Can Be Left Uncalculated
2 to 2047	0	0
2048 to 4905	2448	9.6
4096 to 6143	5406	21.1
6144 to 8191	8558	33.4
8192 to 10239	11836	46.2
10240 to 12287	15206	59.4
12288 to 14335	18652	72.9
14336 to 16383	22158	86.6
16384 to 18431	25718	100.5
18432 to 20479	29325	114.5
20480 to 22527	32972	128.8
22528 to 24575	36656	143.2
24576 to 26623	40374	157.7
26624 to 28671	44123	172.4
28672 to 30719	47900	187.1

Table 3: Table of truncated multibyte divisions that can be made during the second algorithm. Due to the nature of the second algorithm, most divisors need not carry the division out the entire length of the multibyte dividend. By grouping divisors and not calculating the bytes that are unimportant to that particular group, calculation time can be significantly decreased.

resulted in 115,925 digits of precision. Because the result occupied screen memory, it had to be written to cassette tape by the calculation program before returning to the Apple II monitor. Because there was no memory available for a BASIC program, the output formatting program was coded in assembly language and resided in parts of pages 0 and 1. Pages 2 and 3 were used for the multiply-by-100 tables.

On the Horizon

As with any limitless search, there remains the challenge to compute e to even greater precision. Unfortunately, the computation time of the specified algorithm is exponentially related to the precision sought. Divide operations on high-speed computers (approximately 12 μ s per 32 bits) are two orders of magnitude faster than the 6502 routines. The ultimate approach is to construct a custom "divide machine." Current technologies and low programmable memory prices make it feasible to construct such a machine with a thousand-fold performance improvement over the 6502 microprocessor. With such a machine, e could be computed to 100,000,000 digits within a couple of years (one year constructing and testing, one year computing). Such a machine would require power supply backup and error-correcting memory. The memory should be purchased at the latest possible date due to decreasing prices.

Once a few simple concepts are understood, the computation that I have described is as easy as π (see listing 6). Why do people spend time computing these numbers to such absurd precision? Because they're there, I suppose. Who knows what great discoveries will be made by personal computer owners in the coming years? Rest assured that a guaranteed place in the mathematics Hall of Fame awaits the discoverer of the next greatest prime number. ■

Listing 6: A partial printout of the value of e . The first line agrees with the fifty-place value for e that is given in the CRC Standard Mathematical Tables.

E

PAGE 01

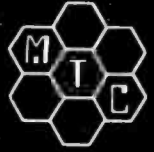
E=2.71828 18284 59045 23536 02874 71352 66249 77572 47093 69995 95749 66967
 62772 40766 30353 54759 45713 82178 52516 64274 27466 39193 20030 59921
 81741 35966 29043 57290 03342 95260 59563 07381 32328 62794 34907 63233
 82988 07531 95251 01901 15738 34187 93070 21540 89149 93488 41675 09244
 76146 06680 82264 80016 84774 11853 74234 54424 37107 53907 77449 92069
 55170 27618 38606 26133 13845 83000 75204 49338 26560 29760 67371 13200
 70932 87091 27443 74704 72306 96977 20931 01416 92836 81902 55151 08657
 46377 21112 52389 78442 50569 53696 77078 54499 69967 94686 44549 05987
 93163 68892 30098 79312 77361 78215 42499 92295 76351 48220 82698 95193
 66803 31825 28869 39849 64651 05820 93923 98294 88793 32036 25094 43117
 30123 81970 68416 14039 70198 37679 32068 32823 76464 80429 53118 02328
 78250 98194 55815 30175 67173 61332 06981 12509 96181 88159 30416 90351
 59888 85193 45807 27386 67385 89422 87922 84998 92086 80582 57492 79610
 48419 84443 63463 24496 84875 60233 62482 70419 78623 20900 21609 90235
 30436 99418 49146 31409 34317 38143 64054 62531 52096 18369 08887 07016
 76839 64243 78140 59271 45635 49061 30310 72085 10383 75051 01157 47704
 17189 86106 87396 96552 12671 54688 95703 50354 02123 40784 98193 34321
 06817 01210 05627 88023 51930 33224 74501 58539 04730 41995 77770 93503
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 13419 51246 65201 03059 21236 67719 43252 78675 39855 89448 96970 96409
 75459 18569 56380 23637 01621 12047 74272 28364 89613 42251 64450 78182
 44235 29486 36372 14174 02388 93441 24796 35743 70263 75529 44483 37998
 01612 54922 78509 25778 25620 92622 64832 62779 33386 56648 16277 25164
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 69829 46959 30801 91529 87211 72556 34754 63964 47910 14590 40905 86298
 115125 81589 55664 00700 37088 40705 00444 70875 66622 00000 00000 00000
 E

PAGE 10

92105 78191 37103 01889 79206 40888 39747 67667 14472 73142 54467 92350
 05246 18849 23745 53075 75734 90270 73424 96298 87999 69420 94595 96100
 87025 01329 45332 53580 45689 28570 72412 07965 91980 92255 50560 06197
 12835 41270 20207 25839 94171 17552 09208 20151 09650 95266 85113 89757
 71508 10849 44350 82854 58749 91294 38575 63115 66832 45668 27992 99186
 15390 09255 87171 68404 95663 99195 91540 34218 36453 72120 23678 60865
 53647 45175 65487 93189 25644 08527 44891 90918 19341 16675 83563 43975
 88860 46349 41311 18752 41038 42546 79379 99203 54691 04119 35443 11321
 91360 68129 65756 85836 11774 56465 46748 61061 98859 14148 05799 31872
 53675 31243 47033 54826 37527 08135 31055 70818 04964 24985 84646 14797
 34675 99315 94651 47870 25065 27108 35087 82350 65653 23317 97738 65666
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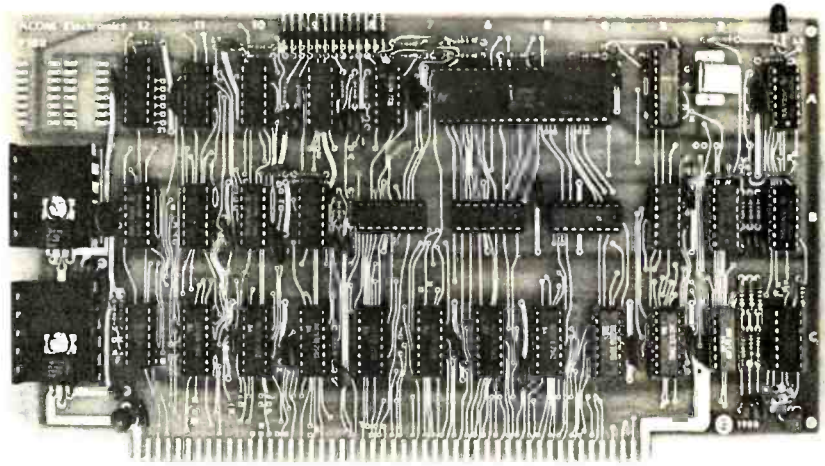
Microcomputer Systems

A new line of S-100 Z80-based microcomputer systems from California Computer Systems provides real-time hardware-vector interrupt and interrupt-nesting capabilities. Multiprocessing with interleaved data-transfer rates of up to 2 megabytes per second can be achieved using direct memory access. The main board has two programmable real-time clocks, two 8-bit parallel interface channels, and two programmable RS-232C serial I/O (input/output) channels, one of which may be used for synchronous communication. The chassis contains a nineteen-slot motherboard and a power supply.

The CCS OASIS multitasking operating system features re-entrant and relocatable program capabilities, and employs an ISAM (indexed-sequential access method) file structure. Task-to-task communication, file protection, timekeeping, spooling, overlay, and device-independent I/O are accomplished through software. The operating system is supported with debug, editing, relocatable-linkage, and file-sort utilities. CP/M and MP/M can be used with the system. A BASIC interpreter and compiler, FORTRAN, COBOL, and Pascal compilers are also available.

Optional boards include printer and terminal interfaces, 16 K-, 32 K-, and 64 K-byte memory boards, floppy-disk subsystems and expansions, and Winchester-type disk subsystems and expansions. Prices for the CCS systems range up to \$9100. Contact California Computer Systems, Marketing Department, 250 Caribbean Dr, Sunnyvale CA 94086, (408) 734-5811.

Circle 524 on inquiry card.



Acom's 8088 Board

The P188 is an S-100 bus 8088 microprocessor board that will run as a stand-alone processor or as a slave. Jumpers allow configuring the card to run in different operating modes, as well as with static or dynamic memory. The 8088 microprocessor has 16-bit internal architecture, addresses 1 megabyte of mem-

ory, and features 8- and 16-bit signed and unsigned arithmetic in binary or decimal, including multiply and divide.

The P188 costs \$345 assembled and tested, and \$275 in kit form. For more information, contact Acom Electronics, 4151 Middlefield Rd, Palo Alto CA 94303, (415) 494-7499.

Circle 525 on inquiry card.

Single-Board 6800 Computer

The ACS 12-PRO requires a power supply and terminal to operate. The 6800-based system provides two programmable 16-bit timers, an RS-232C serial port, two 8-bit parallel ports with handshake control, and up to 4 K bytes of programmable memory and 6 K bytes of PROM (programmable read-only memory).

The ACS 12-PRO is supplied with Datricon's 4 K D-FORTH operating system. With 1 K bytes of programmable memory, D-FORTH, and a manual, the ACS 12-PRO sells for \$495. For additional details, contact Datricon Corporation, 7911 NE 33rd Dr, Suite 200, Portland OR 97211, (503) 284-8277.

Circle 526 on inquiry card.

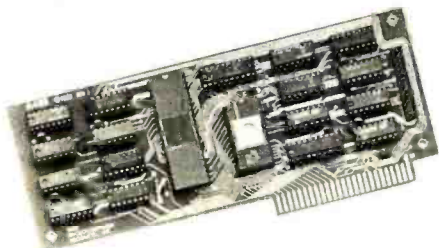
Where Do New Products Items Come From?

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?

PERIPHERALS

Apple IEEE-488 Interface



The A488 interface card permits the Apple II and the Apple II Plus to operate as IEEE-488 bus controllers. The A488 uses an MC68488 LSI 488-controller integrated circuit that decreases the number of circuits required. The board has 2 K bytes of firmware in EPROM (erasable programmable read-only memory). For special-purpose firmware development, the EPROM can be replaced by programmable memory. The A488 allows bus and

system control with character-string instrument commands for set-up, measure, clear, local, trigger, serial-poll, and respond functions. Any equipment on the bus can be designated by a name of up to sixteen characters. Up to fifteen pieces of equipment can be connected to the A488 across a distance of up to 20 meters (66 feet) from the Apple. The card's driver firmware is linked to string routines within Applesoft; floating-point processing of numeric data is easily done. Error checking is included, and software timing loops are not needed.

The A488 is priced at \$475 from SSM Microcomputer Products Inc, 2190 Paragon Dr, San Jose CA 95131, (408) 946-7400.

Circle 527 on inquiry card.

Printer for Under \$1000

The Model 445 Paper Tiger printer features a seven-wire ballistic-type print head and tractor-feed motor drives. The 445 can print at speeds up to 198 cps (characters per second). Functions include bold text and the ability to print 80 columns at 10 pitch and 132 columns at 16.7 pitch. Other features include the 96-character upper- and lower-case ASCII (American Standard Code for Information Interchange) character set, six or eight lines-per-inch vertical spacing, multiline buffering, and RS-232C- and Centronics-compatible parallel interfaces. Transmission rates from 110 to 1200 bps (bits per second) are selectable. Variable form length, perforation skipping, and the ability to handle six-part forms and roll paper are other features.

Integral Data Systems' DotPlot graphics capability is offered as an option. DotPlot enables printing the full range of graphics characters. The Paper Tiger Model 445 costs \$795 and the DotPlot package is \$99. Contact Integral Data Systems Inc, Milford NH 03055, (603) 673-9100.

Circle 529 on inquiry card.



Turn IBM Typewriters Into RS-232Cs

California Micro Computer's 5060 and 5061 modules enable the IBM Model 50, 60, and 75 electronic typewriters to perform as RS-232C-compatible computer I/O (input/output) devices. The modules can be installed and removed easily without requiring modifications to the typewriter. The model 5061 is a print-only

version, while the 5060 allows the typewriter to perform full terminal functions. Both units offer ASCII coding with full buffering. The 5061 costs \$497 and the 5060 is \$860.

For further information, contact California Micro Computer, 9323 Warbler Ave, Fountain Valley CA 92708, (714) 968-0890.

Circle 528 on inquiry card.

Extend the TRS-80 Color Computer Bus

The Color Connection is a device that extends the TRS-80 Color Computer system bus as a System-50 bus (SS-50). Using the Color Connection, floppy-disk drives and video terminals can be added, and the Color Computer's 16 K-byte internal memory can be expanded. The Color Connection sells for \$99.95 from Percom Data Company, 211 N Kirby, Garland TX 75042, (800) 527-1592; in Texas, (214) 272-3421. Circle 530 on inquiry card.

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What's New?

PERIPHERALS

Low-Cost Color-Graphics Terminal



RCA's VP-3301 is a microprocessor-controlled terminal with color graphics, reverse video, programmable and resident character sets, selectable data rates and formats, a flexible-membrane keyboard, and audio feedback. The VP-3301 can be connected to modems for communication with most timesharing and data-base computer networks. The software-selectable character-display

format can produce either 40 characters by 24 lines or 20 characters by 12 lines. Characters and background can be displayed in one of eight colors or gray scales. The communications interface is RS-232C or 20 mA current-loop. Configuration control includes line/local, uppercase only, full- and half-duplex, data-word formatting, plus two control-code options. The video output can be directly connected to monitors or, with an RF (radio frequency) modulator, to a television set. The suggested price for the VP-3301 is \$369 from RCA Microcomputer Products, New Holland Ave, Lancaster PA 17604, (717) 397-7661.

Circle 531 on inquiry card.

8-Inch Floppy-Disk Drives

Matchless Systems, 18444 S Broadway, Gardena CA 90248, (213) 327-1010, has announced the MS-800 8-inch floppy-disk drive. The drive is compatible with the TRS-80 Models I and II, the Apple II, and S-100 systems. The MS-800 has a capacity of 256 K bytes of storage. The data transfer rate is 256 k bps (bits per second) and the track-to-track access time is 10 ms. The prices range from \$995 to \$1595, which includes all hardware (such as the controller), software, and documentation. Circle 532 on inquiry card.

S-100 I/O Board

The MFIO is an I/O (input/output) board designed for S-100 bus systems. It features four serial RS-232C ports with independent data rates of 50 to 19.2 k bps. It also includes 24 bits of parallel I/O configurable for four ports, five timer/counters, sixteen levels of vectored-interrupt control, and an optional battery-powered real-time clock/calendar. The MFIO costs \$595. For more information, contact Digicomp Research, Terrace Hill, Ithaca NY 14850, (607) 273-5900.

Circle 533 on inquiry card.

Series 47-TR Plotter

The Series 47-TR Strip Chart/Plotter is a curve tracer with alphanumeric capabilities. Its plotting area is 25 cm (10 inches) wide. The plotter features an RS-232C- or IEEE-488-compatible port and bidirectional paper drive. It requires two 8-bit words formatted to provide analog pen position. Pen speed is 75 cm per

second with a position accuracy of $\pm 0.15\%$, full scale. Paper can be incremented up to 2 cm per second at 0.0127 cm per step. The 47-TR is priced at \$945. For details, contact Pedersen Instruments, 2772 Camino Diablo, Walnut Creek CA 94596, (415) 937-3630.

Circle 534 on inquiry card.

Graphics Terminal for the North Star

The Sigma 1042S high-resolution, memory-mapped graphics terminal is designed for the North Star microcomputer. The display provides a 640 by 800 dot matrix backed by a 64 K-byte display memory. The display memory is divided into sixteen 4 K-byte blocks, which are individually selectable for mapping onto a main-memory window of only 4 K bytes. The 1042S terminal can also be used as a word-processing work station. In this application mode, it includes variable spacing, multiple fonts, and scientific-character capabilities. Reverse video, blinking, and intensification are offered as hardware features. The terminal can be used as a system console under CP/M. The 1042S costs \$4000.

For more information, contact Sigma Information Systems USA Inc, 556 Trapelo Rd, Belmont MA 02178, (617) 484-2063.

Circle 535 on inquiry card.

Cash Register Scans Bar Code

The CE-1000 bar-code-scanning cash register can keep track of your entire inventory. It is designed for use with the Commodore CBM microcomputer and includes software, firmware, and hardware. The unit can read UPC (Universal Product Code) bar codes found on most products for point-of-sale operations, making it useful for convenience, liquor, food, record stores, and other small businesses.

The CE-1000 bar-code scanner costs \$1350. For more information, contact Creative Equipment, 50 NW 68 Ave, Miami FL 33126, (305) 261-7866.

Circle 536 on inquiry card.

What's New?

PUBLICATIONS

The Sizzle Sheet

The Sizzle Sheet is a marketing-communications guide for those who market computers, communications and information products, systems, and services. Featured are reviews and reports, editorials on the news, business and trade press, plus special issues.

For details, contact The Sizzle Sheet, POB 801, 150 Speen St, Framingham MA 01701, (617) 875-0013.

Circle 537 on inquiry card.

Symbol Manipulation Using LISP

This is a manual for the LISP programming language. The book introduces the basics of LISP programming and demonstrates how it is used in practice. It also discusses how artificial intelligence systems are built. Case studies and problems in pattern matching, natural-language understanding, and problem solving are included. An appendix offers a sample terminal session, lists basic LISP functions, and explains differences between MACLISP and INTERLISP.

Symbol Manipulation Using LISP costs \$13.95, and is published by Addison-Wesley, Reading MA 01867, (617) 944-3700.

Circle 538 on inquiry card.

Printronic Printers Described in Brochure

A color brochure describing Printronix dot-matrix printers is available from Printronix Inc. The brochure discusses the Printronix hammer-bank printing mechanism and includes examples of graphics, bar codes, labels, and alphanumeric forms. For your free copy, contact Printronix Inc, 17421 Derian Ave, POB 19559, Irvine CA 92713, (714) 549-7700.

Circle 539 on inquiry card.

Magazine for TI 99/4 Users

99'er Magazine is a bimonthly magazine with news about the TI 99/4 and other TMS9900-based personal-computer systems. It features tutorial articles, software, book and product reviews, opinions and news items, and a question-and-answer technical forum.

Each issue is divided into sections for education, games and simulations, home activities, and business, scientific, or professional applications. Regular features include columns on the Logo language, CAI (computer-aided instruction), speech-synthesis usage, interfacing with peripherals, computer chess, The Source and TEXNET, news from user groups, and lessons in programming techniques. Advertisements from suppliers of software, peripherals, and other related products and services are also included. A bulletin-board page for noncommercial messages is provided for its readers.

The subscription rate is \$15 for one year. Contact 99'er Magazine, Emerald Valley Publishing Company, 2715 Terrace View Dr, Eugene OR 97405, (503) 485-8796. Circle 540 on inquiry card.

GamesMaster Catalog

The GamesMaster Catalog has listings of board, computer, electronic, hand-held, fantasy, and other kinds of games. One section is exclusively devoted to Dungeons and Dragons-type games. Nearly 1000 games are described in full detail, including landscape sets and miniature pieces.

For a copy of the catalog, contact Boynton & Associates Inc, Clifton House, Clifton VA 22024, (703) 830-1000.

Circle 541 on inquiry card.

Computer Crimes Books

The Computer/Law Journal has published a two-volume set on computer crimes. This first volume contains an introduction by Senator Abraham Ribicoff, author of the Federal Computer Crimes Protection Act. There are articles by well-known scholars like Donn Parker, Susan Nycum, John Taber, Rob Kling, and Jay Becker.

Volume two has a history of the Stanley Mark Rifkin case and a compilation and analysis of all federal and state statues and bills addressing computer crimes, as well as a case digest, bibliography, and book reviews. Both issues are available for \$16 each, plus \$1 per issue postage. Contact the Center for Computer/Law, 530 W 6th St, 10th floor, Los Angeles CA 90014.

Circle 542 on inquiry card.

Computer Books from Entelek

This catalog of computer books from Entelek features books on programming languages, microcomputers, robots, calculators, and educational uses of computers. The catalog is free from Entelek, Ward-Whidden House/The Hill, POB 1303, Portsmouth NH 03801.

Circle 543 on inquiry card.

1981 Computer-Science and Engineering Books

A catalog of MIT Press books in the computer-science and engineering fields is available. This catalog describes over fifty books. Most of the books are offered at a 20% discount through December 1981. Copies of the catalog can be obtained from The MIT Press, Promotion Department, 28 Carleton St, Cambridge MA 02142, (617) 253-5642.

Circle 544 on inquiry card.

What's New?

SOFTWARE

Merge Your 737 Printer and Scripsit

Until Apparat Inc introduced Flextext, TRS-80 Model I users could not use all of the features of the Centronics 737 printer (Radio Shack Line Printer IV) with Scripsit, Radio Shack's word-processing program. Flextext is a utility for Scripsit and the 737 printer that supports proportional or compressed character sets in normal and extended modes, right-justified formatting using the proportional or compressed character sets, underlining in any of the Scripsit-selectable formats and Flextext-selectable character sets, super- or subscripts, and the intermixing and combining of the 737's features anywhere in a document. Flextext requires at least one disk drive and a TRSDOS-type operating system. The program costs \$29.95 from Apparat Inc, 4401 S Tamarac, Denver CO 80237.

Circle 545 on inquiry card.

Chinese Lessons Program

Chinese greetings, times, seasons, numbers, foods, and other commonly used terms are contained in eleven computer-instruction lessons. Color, graphics, and sound are used in each lesson. Memory aids, meanings, and pronunciations are presented with the Chinese characters. The proper stroke sequence for each character is shown and can be repeated at the user's pace.

The Chinese lesson program is available for \$29.95 on a double-sided 5-inch floppy disk for the Apple II with 48 K bytes of programmable memory and a single disk drive. For details, contact Computer Translation Inc, Department BPI, POB 7004 University Sta, Provo UT 84602, (801) 224-1169. Circle 546 on inquiry card.

Utilities for the TRS-80 Color Computer

Mint Software's utilities for the Color Computer require 16 K bytes of memory. There are three cassette-based programming utilities available: Renumber, which provides the capability to load a program, renumber and save it; Squeeze, which will compress BASIC code to utilize minimum memory; and Merge, which allows two separate programs on cassette to be merged and saved. Other aids for cross-referencing line numbers and variables are available. The programs cost \$19.95. A 16 K-byte memory expansion is also available for \$70. Contact Mint Software, 6422 Peggy St, Baton Rouge LA 70808, (504) 766-2318.

Circle 547 on inquiry card.

DMADOS for 8080/Z80 Systems

DMADOS is a single-user, CP/M-compatible 8080 and Z80 disk operating system. It maintains up to sixteen user-defined passwords, allows files to be declared write-protected or invisible to the directory, and can function as a batched console processor. Using DMADOS, up to six print files can be sent to a background print task for printing. User-oriented prompting and error messages are provided.

DMADOS offers support for floppy- and hard-disk files of up to 4.2 megabytes. It is supplied with several utilities and a manual. DMADOS is available on 8-inch floppy disks or North Star double/quad-density formats. For more information on this \$200 operating system, contact John D Owens Associates Inc, 12 Schubert St, Staten Island NY 10305, (212) 448-6283.

Circle 548 on inquiry card.

Electronics Designers Program

Wiremaster is for small electronics companies with printed-circuit layout and wrapped-wire prototyping production problems. Connection data is derived from the schematic diagram and fed to Wiremaster in a CP/M text file. Outputs include a network map showing all pins and wires, a wire list sorted by lengths and levels, a parts list, and checklists that detect all wiring errors. The resulting information can then be used for printed-circuit-board layout, error checking, wiring, component stuffing, and system debugging.

Wiremaster comes on a single-density 8-inch CP/M floppy disk with a manual for \$150. It runs on Z80 and TRS-80 Model II CP/M systems with 48 K bytes of memory. Contact Afterthought Engineering, 7266 Courtney Dr, San Diego CA 92111, (714) 277-7863.

Circle 549 on inquiry card.

Dragonquest

In a race against the sun, you search for Smaegor, Monarch of Dragonfolk, who has kidnapped the Princess of the Realm and holds her in an unknown place. You must search the land, seeking the tools needed for the ultimate battle. On the river Delta and in the Temple of Baathteski, clues abound. But where is the Princess? This is the scenario of Dragonquest, an adventure game from The Programmer's Guild, POB 66, Peterborough NH 03458, (603) 924-6065. It runs on TRS-80 Model I microcomputers, and costs \$15.95 on cassette or \$21.95 on a floppy disk.

Circle 550 on inquiry card.

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C. ITOH Starwriter, 45 cps, daisy wheel **\$1849**

EPSON MX-80, 80 cps, 9x9 dot matrix **\$545**

ANADEX 9500/9501, up to 200 cps, high resolution dot **\$1349**

OKIDATA Microline 80, 80 cps, 9x7 dot matrix **\$525**

Microline **82**, bidirectional, friction/pin feed **\$625**

Microline **83**, bidirectional, 120 cps, uses 15" paper **\$995**

T1-810, 150 cps, Basic **\$1695**

Package-Compressed print, vertical form control **\$1830**

CENTRONICS 704-9,180 cps, 9x9 dot matrix, 132 col, RS-232 **\$1595**

704-11,180 cps, 9x9 dot matrix, 132 col, parallel **\$1695**

730,100 cps, 7x7 dot matrix, same as R.S. LPII **\$660**

737,80 cps, nx9 dot matrix, same as R.S. LPIV **\$849**

proportional spacing

DEC LA-34 **\$1085**

S-100 SPECIALTIES



These high quality, reliable products have made CCS defacto industry standard for S-100 products Assembled and tested:

2200 H.D. Mainframe, 20 a. P.S., 12 slot MB **\$434** **\$399**

2065C 64K dynamic RAM/Bank Select **\$720** **\$580**

2810A Z-80 CPU, serial port, ROM monitor **\$310** **\$259**

2422A Floppy Cont, CP/M 2.2, ROM monitor **\$425** **\$345**



CB2 Z-80 CPU **\$344** **\$295**

2P + 2S I/O interface **\$290** **\$249**

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TELEVIDEO 912 C **\$950** **\$725**

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Discus 2 + 2 + CP/M® **\$963**

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CAMEO cartridge drive controller **\$1500** **\$1275**

controller, **CDC Hawk Drive** (5 fix, 5 rem) **\$6995** **\$5995**

controller, **Western Dynex** (5 fix, 5 rem) **\$5995** **\$5099**

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CCS 400-1A w/10MB hard disc, 2 serial, 2 parallel ports **\$6999**

Optional CP/M for **CCS 300, 400** (OASIS available) **\$150**

NNC 80 w/1MB floppy drives, 2 serial, 3 parallel ports **\$3799**

NNC 80W w/.5MB floppy, 8.4MB hard disc, (OASIS optional) **\$6693**

ALTOS single and multi-user systems **\$call**

MORROW Decision 1, MICROSOFT basic, UNIX **\$call**

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APF Imagination Machine, basic, color, sound, tape, etc. **\$399**

ATARI 400 **\$512**

800 with 16K RAM **\$895**

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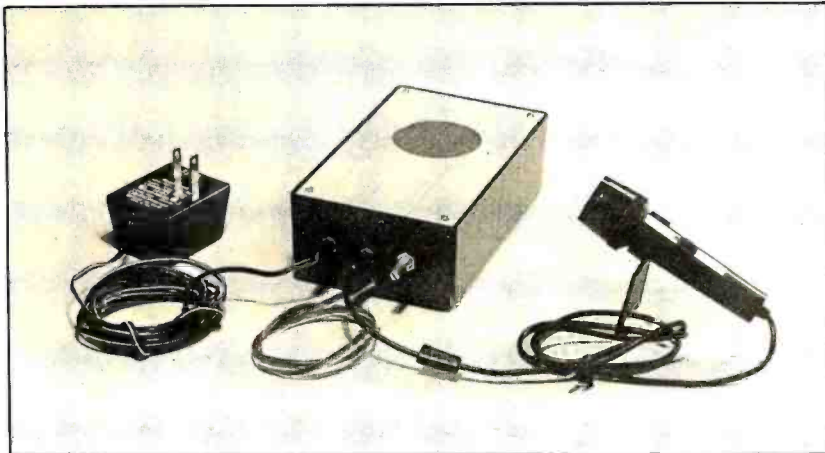
For fast delivery, send certified checks, money order or call to arrange direct bank wire transfers. Personal or company checks require two to three weeks to clear. All prices are mail order only. Prices subject to change without notice; call for latest prices. Prices include 2% cash discount. N.Y. residents add sales tax.

Radio Shack® is a trademark of the Tandy Corp. CP/M® is a trademark of Digital Research



What's New?

MISCELLANEOUS



Voice Recognition for Z80 Systems

The Cognivox Model VIO-232 voice peripheral is designed for microcomputers using the Z80 microprocessor with a minimum-size programmable memory of 16 K bytes. The VIO-232 can be programmed to recognize words or short phrases from up to 32 entries, and it can answer with up to 32 words or short phrases. The

recognition and voice response vocabularies can be different, allowing a dialogue with the computer. Vocabularies larger than 32 words are possible. The Cognivox VIO-232 includes a microphone, power supply, amplifier, speaker, and manual. The price is \$149 from Voicetek, POB 388, Goleta CA 93116.

Circle 551 on inquiry card.

RS-232C-to-Current-Loop Adapter

The ADA400 is a bidirectional RS-232C-to-current-loop adapter, ideal for use with KIM-1 microcomputers. It allows the utilization of an RS-232C-interface terminal instead of a current-loop-interface teletypewriter. The ADA400 does not alter the data-transfer rate. It uses standard power supplies with low current requirements. The adapter can be modified to become an RS-232C-to-TTL (transistor-transistor logic) and TTL-to-RS-232C adapter. The ADA400 retails for \$24.50. More information can be obtained from Connecticut microComputer Inc, 34 Del Mar Dr, Brookfield CT 06804, (203) 775-4595.

Circle 552 on inquiry card.

Record-Retrieval System for PL/I-80

BT-80 is a single-user record-retrieval system based on the B-tree index-organization technique. BT-80 is useful in PL/I-80 applications where single- or multi-keyed access to data records is required. Its facilities can be accessed from PL/I-80 or assembly-language application programs. The system includes utilities that provide access to command-level functions.

BT-80 runs under the CP/M 2.0, MP/M, and CP/NET operating systems. To operate, BT-80 requires the PL/I-80 runtime library and LINK-80 linkage editor. For complete details, contact Digital Research, POB 579, 801 Lighthouse Ave, Pacific Grove CA 93950, (408) 649-3896. Circle 553 on inquiry card.

Battery Backup for the PET

Backpack is a battery backup system for the Commodore PET. It is designed for installation within the computer case. Backpack provides 6 to 10 minutes of full-power emergency backup to the computer (video display included) during power failures. The batteries are recharged from the computer's power supply. No special wiring is needed to install the device. Backpack comes assembled for \$225.

For more information, contact ETC Corporation, POB G, Apex NC 27502, (919) 362-4200.

Circle 554 on inquiry card.

Datapro Rates Word-Processing Systems

Thirteen word-processing systems have been named to the 1980 Datapro Honor Roll. Selection of these systems was based on results of a mail survey, which is contained in a thirty-page report, Word Processing Systems User Ratings. This report also contains general information about word-processing systems. The report is available for \$15 from Datapro Research Corporation, 1805 Underwood Blvd, Delran NJ 08075, (609) 764-0100.

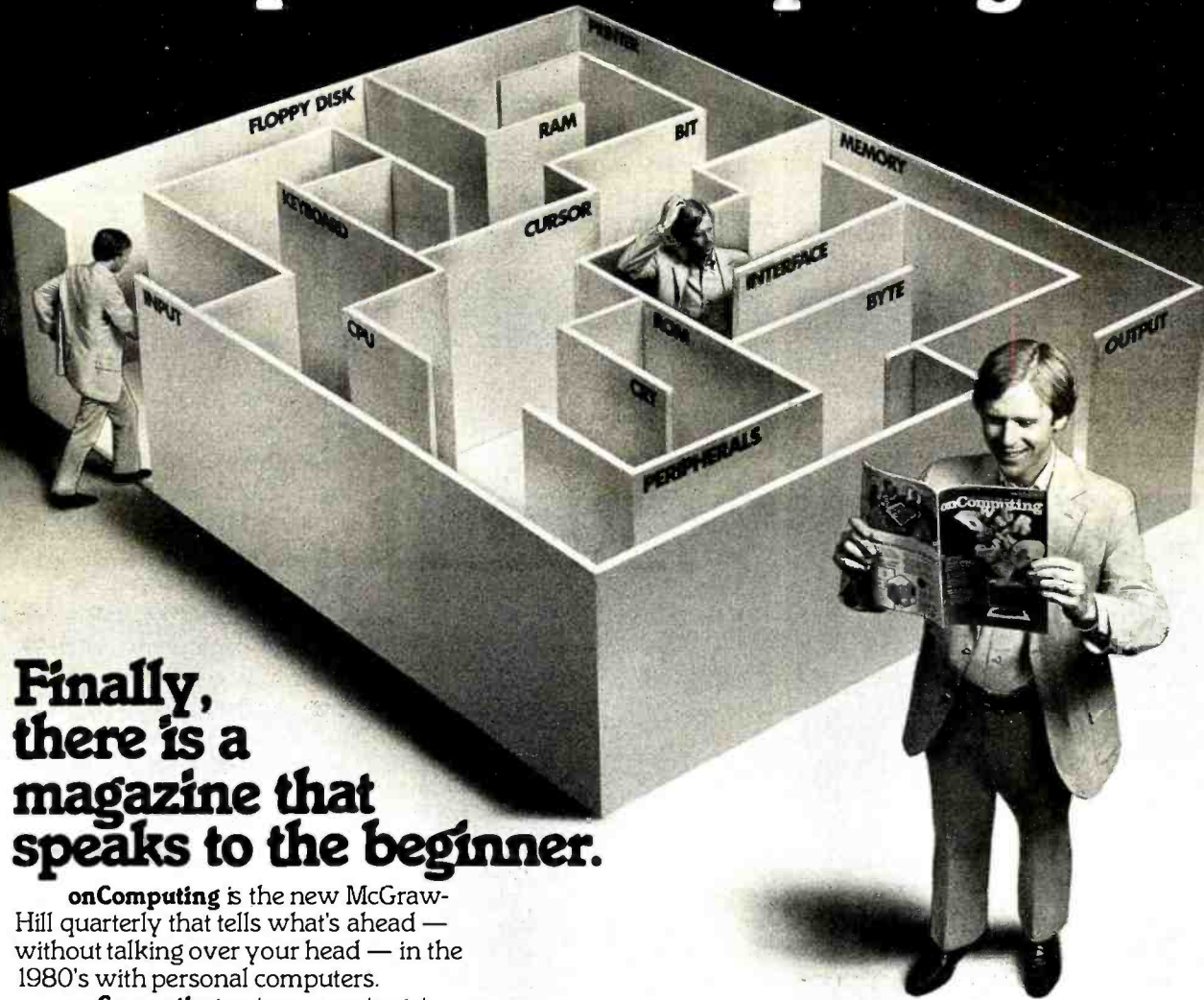
Circle 555 on inquiry card.

Floppy-Disk Carrier Case

The En Route case carries up to fifty 8- and 5-inch floppy disks during travel. It is small enough to fit under an airplane seat. The case has a polyethylene inner lining to prevent dust buildup. A key lock is included. The En Route case costs \$65 from Inmac, 2465 Augustine Dr, POB 4780, Santa Clara CA 95051, (408) 727-1970.

Circle 556 on inquiry card.

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What's New?

MISCELLANEOUS

Universal Development System

The UDS-1000 universal development system is a floppy-disk-based system that uses the Z80 microprocessor. Various cross-assemblers for software development are supplied from a selection including the Texas Instruments TMS1000 and the TMS-1400 series; Rockwell R6500/1, MM75, -76, -77, and -78 series; Motorola 6800; Mostek 3870; Intel 8748, 8048; RCA 1802; NSC COP 420; OKI OLMS42; and other microprocessors. In addition to the cross-

assembler, a ROM (read-only memory) emulation board for prototype testing and an EPROM (erasable programmable ROM) programmer are included. The price of the system, including 64 K bytes of programmable memory, a 24-line by 80-character video terminal, an 80 cps (characters per second) printer, ROM emulation, and the EPROM programmer board, is \$8750. For information, contact Multitech Electronics Inc, 10322A N Stelling Rd, Cupertino CA 95014, (408) 252-4212.

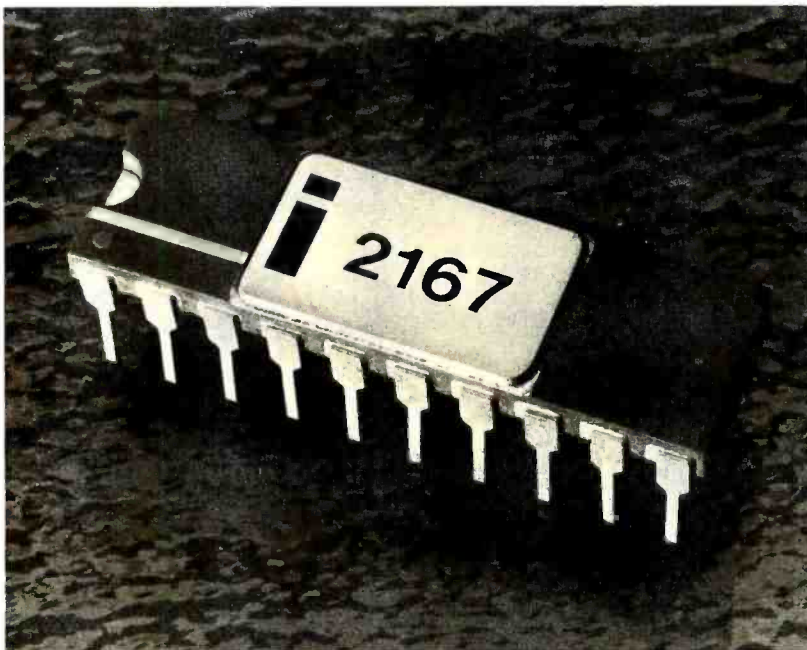
Circle 557 on inquiry card.

Spelling Error Detection/Correction Package

Proof/it is a set of programs that scans the words in a text file and compares them with those in one or more dictionaries. Words that are not found are flagged as possible errors. Correctly spelled words can be added automatically to the dictionary. Corrections can be directly substituted for incorrectly spelled words in the text file. A package including manual and software on a floppy disk with over 10,000 words in the dictionary is \$125. Software on a 5-megabyte hard-disk pack with over 30,000 words in the dictionary is \$100 more. The manual can be purchased separately for \$10.

Proof/it runs on Alpha Micro AM-100 computers with 32 K bytes of memory. For information, contact Datalab Inc, 617 E University, Suite 250, Ann Arbor MI 48104, (313) 995-0663.

Circle 559 on inquiry card.



16 K by 1-Bit Static Memory

The 2167 is a 16 K by 1-bit programmable static memory device from Intel. The 2167 can replace Intel's 2147 and 2141 static circuits. Compared to these devices, the 2167 has a greater density and lower power consumption. It also has a 55 ns access speed. The HMOS (high-performance metal-oxide semiconductor) device does not require clocking or

timing strobes. The 2167's inputs and outputs are TTL-compatible and are unlatched. Address setup and hold timings are not required.

Prices for the 2167 are \$68.55 per unit, in quantities of 100. For further details, contact Intel Corporation, 3585 SW 198th Ave, Aloha OR 97005, (503) 642-6344.

Circle 558 on inquiry card.

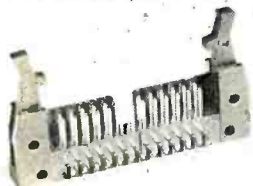
Daisy-Wheel Printer

The Starwriter letter-quality daisy-wheel printer runs at 25 cps. The Starwriter comes with a Centronics-compatible parallel interface, and uses Diablo ribbons and print wheels. The Starwriter has graphics capabilities and is code-compatible with Oume and Diablo printers. The printer accommodates paper widths of up to 38 cm (15 inches), and can make three copies. The Starwriter is available for \$1779 from Computer Textile Inc, 10960 Wilshire Blvd, Suite 1504, Los Angeles CA 90024, (213) 477-2196.

Circle 560 on inquiry card.

INSULATION DISPLACEMENT SOCKETS

RIGHT ANGLE HEADERS



Pins	PC Mounting	Wire Wrap
10	IDH10SR .80	IDH10WR 1.75
20	IDH20SR 1.25	IDH20WR 2.75
26	IDH26SR 1.85	IDH26WR 3.60
34	IDS34SR 2.15	IDH34WR 4.15
40	IDH40SR 2.50	IDH40WR 4.90
50	IDH50SR 3.15	IDH50WR 6.15

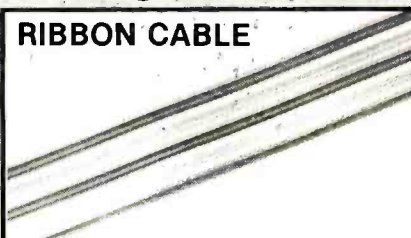
EJECTOR EARS .25 EACH

CARD EDGE CONNECTORS



Pins	Part No.	Price
10	IDE10	3.25
20	IDE20	3.50
26	IDE26	4.05
34	IDE34	4.85
40	IDE40	5.65
50	IDE50	5.90

RIBBON CABLE



	Conductors: Solid Color		Color Coded	
	10 ft.	100 ft.	10 ft.	100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00

25 PIN "D" CONNECTORS



Style	Part #	Price
SOLDER STYLE		
Male	DB25P	.2.25
Female	DB25S	3.00
Hood	DB25C	1.10
INSULATION DISPLACEMENT		
Male	IDC25P	4.95
Female	IDC25S	5.25
Hood	IDC25C	1.35

SOCKETS



Pins	Part No.	Price	Stain Relief
10	IDS10	1.25	.25
20	IDS20	2.02	.25
26	IDS26	2.65	.25
34	IDS34	3.50	.25
40	IDS40	4.05	.25
50	IDS50	5.06	.25

CABLE PLUGS



Pins	Part No.	Price
14	IDP14	1.25
16	IDP16	1.40
24	IDP24	2.25
40	IDP40	3.65

WIRE WRAP WIRE

WIRE KITS

Length	100/Bag	500/Bag	1K/Bag	Length	100/Bag	500/Bag	1K/Bag	Kit No. 1	\$9.95	Kit No. 3	\$32.95
2.5"	\$1.25	\$3.58	\$ 6.19	6.5"	\$1.92	\$6.44	\$11.81	250 3"	100 4 1/2"	500 2 1/2"	500 4 1/2"
3.0"	1.30	3.86	6.78	7.0"	1.99	6.76	12.44	250 3 1/2"	100 5"	500 3"	500 5"
3.5"	1.37	4.15	7.37	7.5"	2.08	7.07	13.09	100 4"	100 6"	500 3 1/2"	500 5 1/2"
4.0"	1.42	4.44	7.94	8.0"	2.14	7.38	13.73			500 4"	500 6"
4.5"	1.48	4.74	8.54	8.5"	2.18	7.69	14.36	Kit No. 2 \$24.95 Kit No. 4 \$59.95			
5.0"	1.54	5.04	9.13	9.0"	2.24	8.11	15.01	250 2 1/2"	250 5"	1000 2 1/2"	1000 4 1/2"
5.5"	1.58	5.38	9.72	9.5"	2.30	8.32	15.65	500 3"	100 5 1/2"	1000 3"	1000 5"
6.0"	1.65	5.66	10.31	10.0"	2.39	8.71	16.28	500 3 1/2"	250 6"	1000 3 1/2"	1000 5"
								500 4"	100 6 1/2"	1000 4"	1000 6"
								250 4 1/2"	100 7"		

Kynar precut wire. All lengths are overall, including 1" strip on each end. Colors and lengths cannot be mixed for quantity pricing. Choose from colors Red, Blue, Black, Yellow, White, Green, Orange, and Violet.

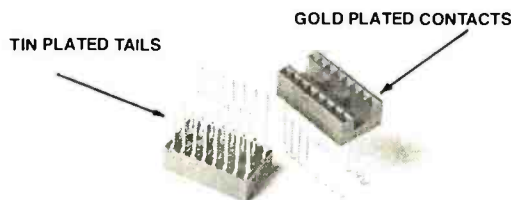
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20	21	.87	18.27
22	19	.94	17.86
24	17	.96	16.32
28	15	1.25	18.75
40	10	1.70	17.00

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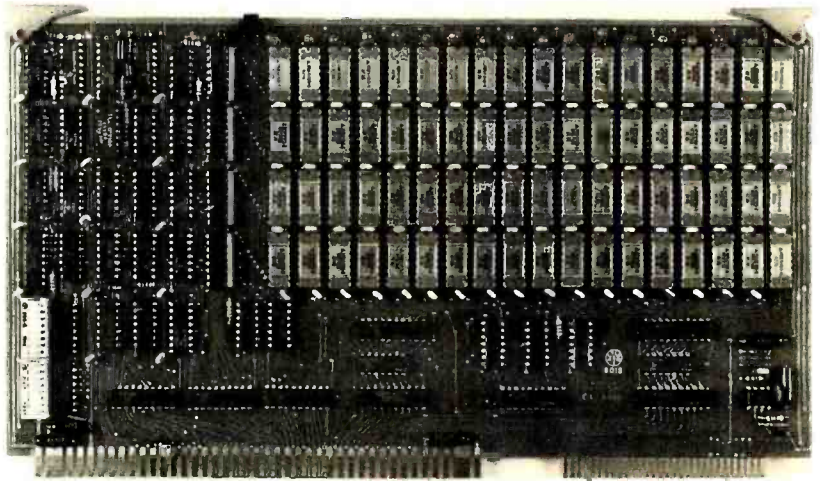
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What's New?

MISCELLANEOUS

Memory Board for the SBC 86/12A

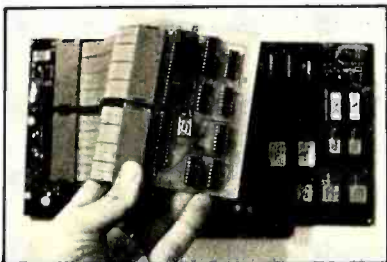
The CI-8086 memory board is designed for Intel's Intellec SBC 86/12A microcomputer. Available with 32 K to 512 K bytes on a single board (depending on what memory components are used), the module is compatible with 8- and 16-bit Multibus-based systems. The CI-8086 generates and checks even parity with selectable interrupt on parity error. It features a 250 ns data-access time and a 375 ns cycle time. The memory is addressable in 16 K-byte increments up to a total of 16 megabytes of memory. Power consumption is under 8 W. The price is \$1500 for the 128 K-byte



board and \$4700 for the 512 K-byte module. The CI-8086 is available from Chrislin Industries Inc, 31352 Via Colinas, #102,

Westlake Village CA 91361, (213) 991-2254.

Circle 561 on inquiry card.



Replace an 8080 with an 8085

A 50 to 250% throughput increase can be achieved with the Series II Microprocessor Enhancement Modules. These modules perform 8080A in-circuit emulation using a code-compatible 8085A-2 microprocessor. Installation requires less than five minutes, involving only the replacement of the system 8080A processor and status latch with connectors. The modules are offered for most 8080A products at \$350 in OEM (original equipment manufacturer) quantities. An Evaluation Design Pack is available for \$500. Contact Paragon Systems Inc, POB 2050, Corvallis OR 97330, (503) 758-1029. Circle 562 on inquiry card.

12-Bit CMOS Converters

The DAC1218 and the DAC1219 are 12-bit CMOS (complementary metal-oxide semiconductor), 4-quadrant, multiplying, D/A (digital-to-analog) converters. The devices offer 12-bit monotonicity, maximum differential linearity error of ± 0.5 LSB (least significant bit), and feature a design technique resulting in TTL (transistor-transistor logic) compatibility. Power-supply voltages can range from +5 to +15 V; typical power consumption is 20 mW. The DAC1218 has a maximum linearity error specification of 0.012%, and the DAC1219 is rated at 0.024%.

In OEM quantities of 100, the DAC1218 sells for \$10.75 each, and the DAC1219 is priced at \$9.75 each. For additional information, contact National Semiconductor Corporation, 2900 Semiconductor Dr, Santa Clara CA 95051, (408) 737-5000.

Circle 563 on inquiry card.

Expand Atari's Memory

The RAMCRAM memory modules can expand the Atari 400's memory to 32 K bytes and the Atari 800's to 48 K. RAMCRAM plugs into the Atari internal memory-module slot, replacing the Atari's module. Each RAMCRAM module contains 32 K bytes of programmable memory. The suggested retail price is \$320.

An 8-slot bus-expansion board for the Atari and Apple microcomputers, with power supply, controller, and software, is available for further memory expansion. This memory-board bus can hold up to eight RAMCRAMs, offering 256 K bytes of programmable memory. Its suggested retail price is \$850.

For further details on both of these devices, contact Axlon Inc, 170 N Wolf Rd, Sunnyvale CA 94086, (408) 730-0216.

Circle 564 on inquiry card.

New Commodore VIC 20 Computer

Now Available

Introducing the first full-featured, expandable color computer priced under \$300!

Now, a new computer — the VIC 20 — offers a full range of special features and expansion capabilities which rival the features of existing microcomputers selling for 4 or 5 times as much!

The new VIC (Video Interface Computer) connects to any television set or monitor and provides 5K bytes of memory.

Check these outstanding features:

- **Color:** 8 character colors, 8 border colors, 16 screen colors
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- **Memory:** 5K RAM (Random Access Memory) expandable externally to 32K RAM
- **Keyboard:** Full typewriter keyboard with special screen editing keys & PET graphics
- **Graphics:** Full PET keystroke graphics
- **Language:** PETBASIC
- **Programmable Function Keys:** 4 programmable function keys (8 separate functions)



- **Plug-In Program & Memory Expansion Cartridges:** (programs plug directly into the back of the computer...each program can be up to 27K)
- **Full Computer Accessories:** disk drive, printer, tape cassette, game controls & more
- **Connects to any TV set/monitor:** (Built-in RF Modulator)

Expansion Features & Peripherals

The VIC 20 is designed so a first time user can begin using it immediately with plug-in program cartridges, and build his system gradually as his needs (or budget) allow.

VIC system peripherals will include a tape cassette unit, single floppy disk drive, printer — and a broad range of add-on accessories which tailor the system to a variety of applications.

FREE with purchase the VIC 20 Personal Computer Manual. This User Manual is very unique as it is the most comprehensive manual ever written for a personal computer. The key ingredient is that no previous knowledge of programming or even typewriting is required. The manual is designed for the first-time owner along with extensive appendices for both the more experienced computerists and the beginners.

A "User Friendly" Computer

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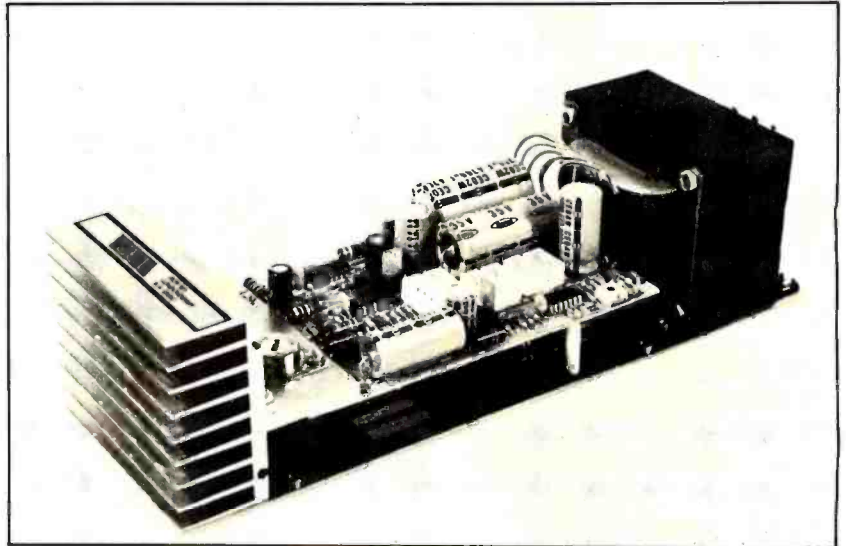
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What's New?

MISCELLANEOUS

Eight Amp Power Supply for OEMs

The CEI Model FD503 is an 8 A power supply that provides outputs of +5 VDC at 8 A, +12 VDC at 2.5 A, -5 VDC at 1 A, -12 VDC at 0.5 A, and +24 VDC at 1.5 A continuous, 4 A surge. Floppy-disk drives can plug into the output connectors of the supply. The FD503 regulates positive outputs to 0.1% and negative outputs to 1%. Options include 100, 115, or 230 VAC power use; AC step-down for 115 V Shugart motors; and interconnecting cables. The CEI FD503 is priced at \$139 each in lots of 100. Contact CEI Corporation, POB 501, Grenier Industrial Park, Londonderry NH 03053, (603) 623-8888.



Circle 565 on inquiry card.

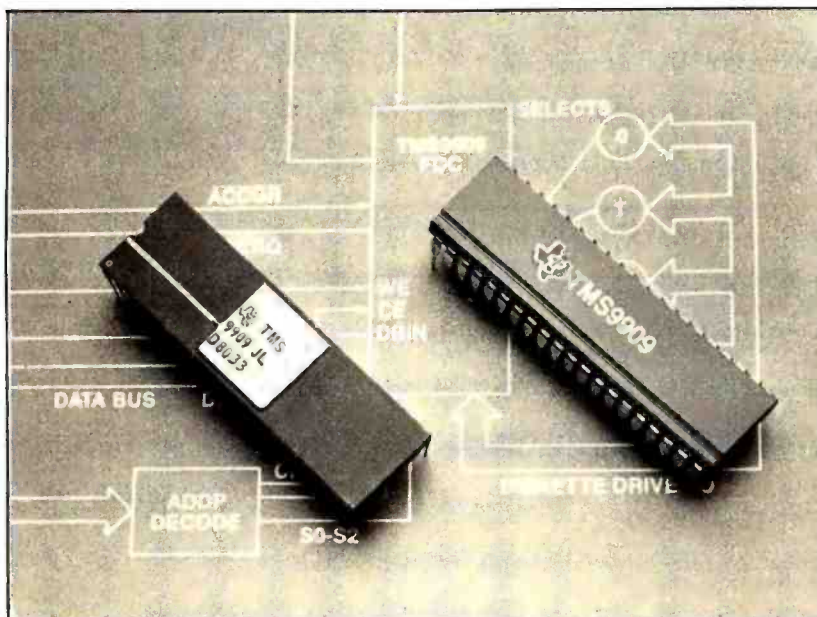
Universal Floppy-Disk-Controller Circuit

The TMS9909 floppy-disk-controller integrated circuit can control any floppy-disk drive while interfacing with any 8- or 16-bit microprocessor. It can read

from and write onto partial sectors, read from or write onto single or multiple sectors of hard- and soft-sectored disks, as well as simultaneously control 5- and 8-inch drives. The TMS9909 provides CRC (cyclic redundancy

check); data transfer rates of 125, 250, and 500 k bytes per second with one crystal; hard and soft formatting for 5- and 8-inch disks; and side selection for double-sided disks. Users can program the device for all major track parameters and various track-stepping, settling, and head-loading times. The TMS9909 supports single- and double-density formats on up to four drives. The TMS9909 has a memory-mapped microprocessor interface that supports an external DMA (direct memory access) interface. This allows designers to build only one interface for all floppy-disk formats.

For further details, contact Texas Instruments, Inquiry Answering Service, POB 25012, MS 308, Dallas TX 75265, attn: TMS9909.



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Dysan Diskettes (Box of 5)	22
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Verbatim Diskette Boxes (Holds 50 Disks)	18
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Basic Interactive Terminal Software (BITS)	29
Data Capture	29
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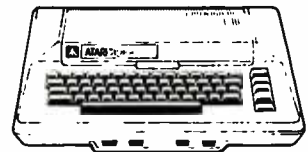


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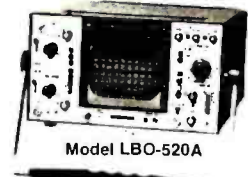
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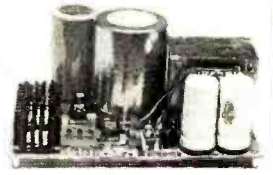
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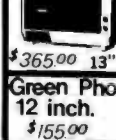


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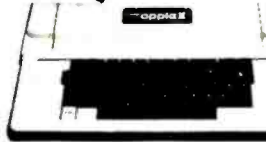
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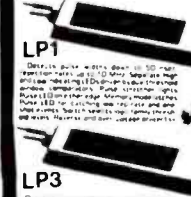
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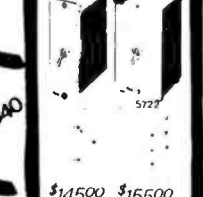
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20	10/280
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IC SOCKETS

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LP1 \$40 LP3 \$60

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IC SOCKETS

8 PIN	10/120
14	10/140
16	10/160
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20	10/280
22	10/280
24	10/280
28	10/380
40	10/475

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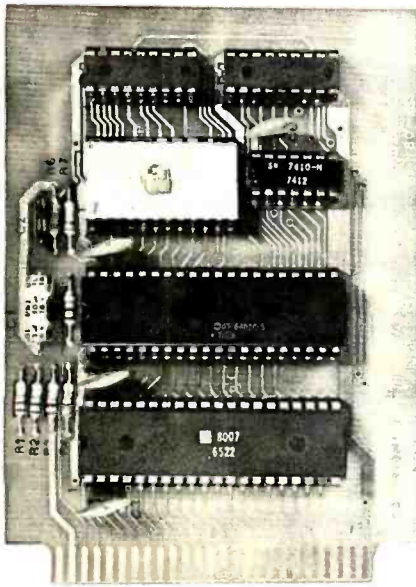


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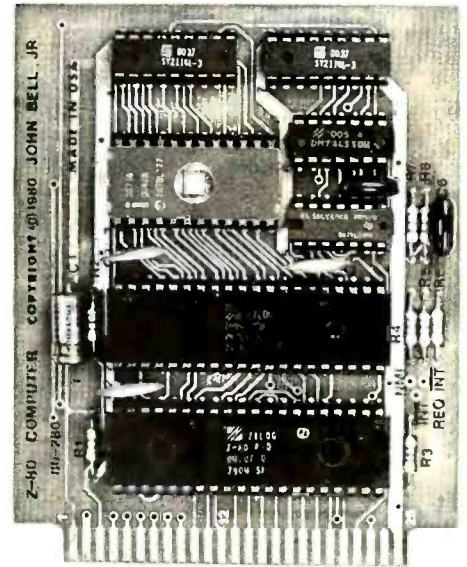
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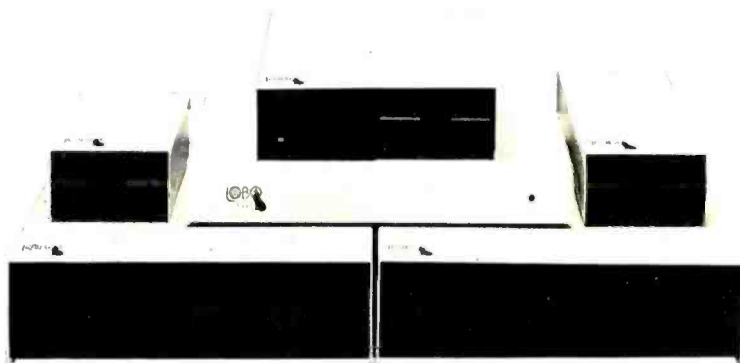
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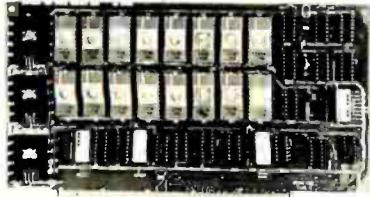
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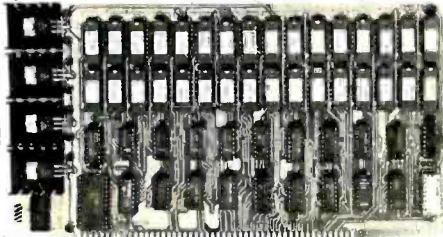
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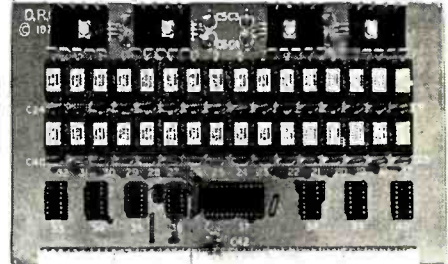
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74121N	34	LM393	1.60	CD4050	3.5	MM5334	1.90	4 MHz	4.25		
74123N	34	LM393	1.60	CD4051	3.5	MM5335	1.90	8 MHz	4.25		
74124N	34	LM393	1.60	CD4052	3.5	MM5336	1.90	16 MHz	4.25		
74125N	34	LM393	1.60	CD4053	3.5	MM5337	1.90	32 MHz	4.25		
74126N	34	LM393	1.60	CD4054	3.5	MM5338	1.90	64 MHz	4.25		
74127N	34	LM393	1.60	CD4055	3.5	MM5339	1.90	128 MHz	4.25		
74128N	34	LM393	1.60	CD4056	3.5	MM5340	1.90	256 MHz	4.25		
74129N	34	LM393	1.60	CD4057	3.5	MM5341	1.90	512 MHz	4.25		
74130N	34	LM393	1.60	CD4058	3.5	MM5342	1.90	1024 MHz	4.25		
74131N	34	LM393	1.60	CD4059	3.5	MM5343	1.90	2048 MHz	4.25		
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74133N	34	LM393	1.60	CD4061	3.5	MM5345	1.90	8192 MHz	4.25		
74134N	34	LM393	1.60	CD4062	3.5	MM5346	1.90	16384 MHz	4.25		
74135N	34	LM393	1.60	CD4063	3.5	MM5347	1.90	32768 MHz	4.25		
74136N	34	LM393	1.60	CD4064	3.5	MM5348	1.90	65536 MHz	4.25		
74137N	34	LM393	1.60	CD4065	3.5	MM5349	1.90	131072 MHz	4.25		
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74139N	34	LM393	1.60	CD4067	3.5	MM5351	1.90	524288 MHz	4.25		
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74146N	34	LM393	1.60	CD4074	3.5	MM5358	1.90	67108864 MHz	4.50		
74147N	34	LM393	1.60	CD4075	3.5	MM5359	1.90	134217728 MHz	4.50		
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74160N	34	LM393	1.60	CD4088	3.5	MM5372	1.90	1099511627776 MHz	4.50		
74161N	34	LM393	1.60	CD4089	3.5	MM5373	1.90	2199023255552 MHz	4.50		
74162N	34	LM393	1.60	CD4090	3.5	MM5374	1.90	4398046511104 MHz	4.50		
74163N	34	LM393	1.60	CD4091	3.5	MM5375	1.90	8796093022208 MHz	4.50		
74164N	34	LM393	1.60	CD4092	3.5	MM5376	1.90	17592186444416 MHz	4.50		
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74176N	34	LM393	1.60	CD4104	3.5	MM5388	1.90	7205759565023936 MHz	4.50		
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74199N	34	LM393	1.60	CD4127	3.5	MM5411	1.90	6044629211595692933184 MHz	4.50		
74200N	34	LM393	1.60	CD4128	3.5	MM5412	1.90	12089258423913385866592 MHz	4.50		
74201N	34	LM393	1.60	CD4129	3.5	MM5413	1.90	24178516847826771733184 MHz	4.50		
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They're always buggin' us about something or other.
CAN YOU THINK OF A SPECIFIC EXAMPLE?
Well, my boyfriend made me come here.
YOUR BOYFRIEND MADE YOU COME HERE. - THAT'S INTERESTING.
I need some help, that much is certain.
WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP?
Perhaps I could learn to get along with my mother.
TELL ME MORE ABOUT YOUR FAMILY.
You see, like my father, in some ways,
WHAT RESEMBLANCE DO YOU SEE?
You are afraid of me.
DOES IT PLEASE YOU TO BELIEVE I AM AFRAID OF YOU?
My father is afraid of everybody.
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Bullies.
DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT
YOUR BOYFRIEND MADE YOU COME HERE?

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1.000 A	5.7143	9.9860	22.1184	37.9529	42.9258	47.8509
1.8432	5.565	10.000	22.5758	38.3768	42.9578	48.000
1.8437	5.562	10.2458	28.3556	38.4448	43.0008	48.3005
2.000 A	6.000	10.4968	28.5008	38.6258	43.0378	48.6568
2.2871 A	6.144	10.7355	28.7378	38.8258	43.0748	48.7005
2.4576 A	6.3000	10.8755	27.000	39.3128	43.1858	48.8758
2.500 A	6.2970	10.8366	27.0005	39.5058	43.2588	48.7005
2.6657	6.400	11.1360	27.5508	39.6668	43.3358	49.7258
2.9500	6.5336	11.155	29.4008	39.7538	43.3708	49.8728
3.000 A	6.72538	11.2185	28.5278	39.8758	43.4078	50.2558
3.067	6.75840	11.2880	28.7588	39.9258	43.4378	51.0558
3.200	6.9003	11.4776	29.8758	40.4448	43.4448	51.3128
3.2758	7.0063	11.5566	29.3378	40.5928	43.5568	51.7718
3.500	7.0336	11.6816	30.0648	40.8128	43.6798	51.8568
3.5718	7.2015	12.442	30.8258	41.8338	43.6658	52.8128
4.000	7.1835	14.3182	30.8258	40.8758	43.7778	56.7505
4.843	7.2586	14.4308	30.8768	40.8888	43.8128	60.6005
4.3426	8.000	15.000	31.4378	40.9258	43.8148	60.7505
4.803	8.0556	15.4408	31.7538	41.0008	43.8518	66.7505
4.9103	8.1415	15.5056	31.9008	41.1658	43.8868	70.4005
4.9503	8.1818	15.000	32.000	41.3768	43.9258	75.0005
4.8303	8.3300	15.3848	33.2005	41.9278	44.0008	80.8338
4.9152	8.4998	17.2248	33.6258	42.0008	44.0378	93.6668
5.000	8.5766	17.2422	34.5558	42.5838	44.3768	100.6668
5.0668	8.6556	18.000	34.7538	42.6258	44.7778	101.6668
5.1703	8.9628	18.4328	34.9718	42.7005	45.1258	103.6668
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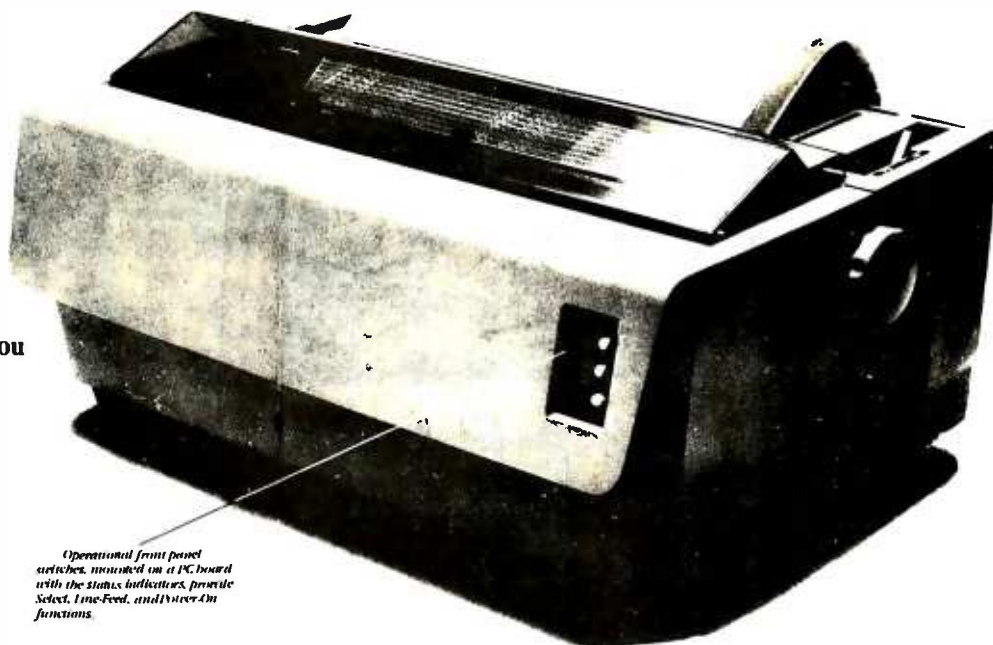
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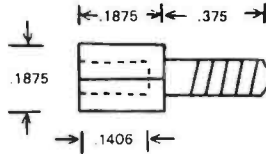
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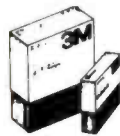
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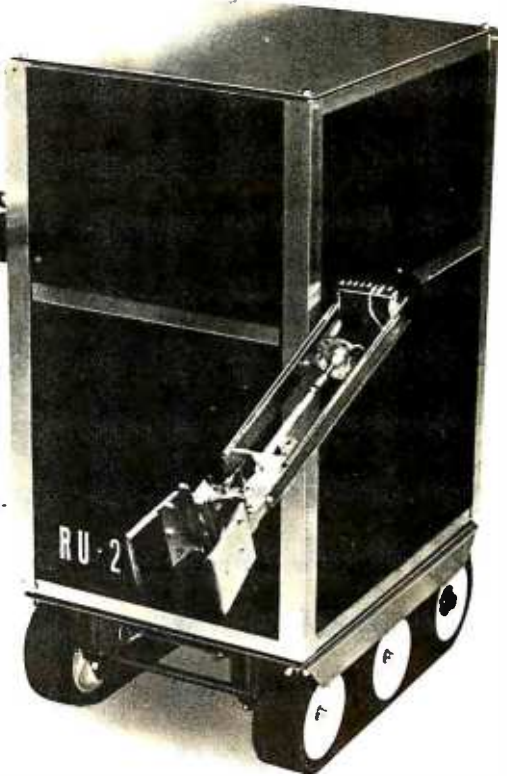
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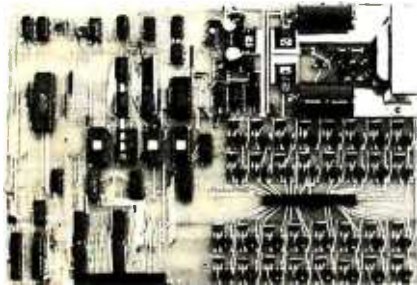


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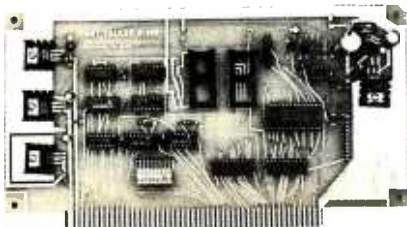
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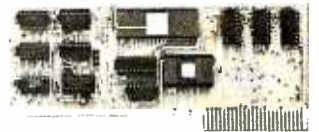
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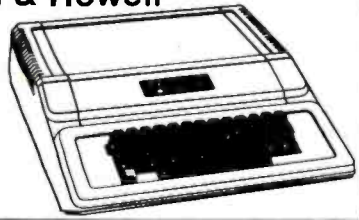
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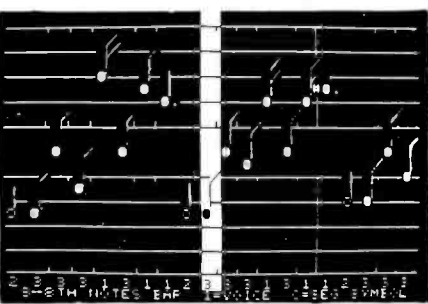
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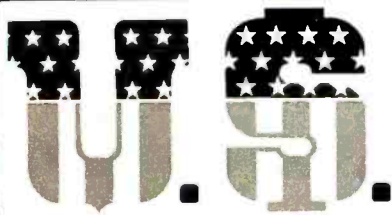
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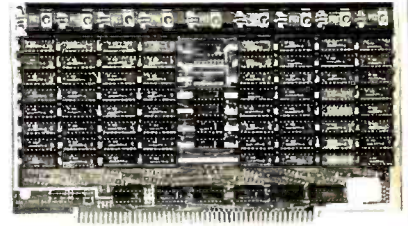
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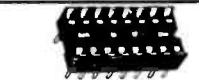
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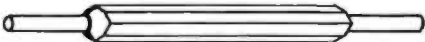
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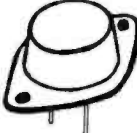
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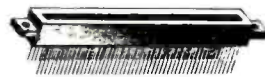


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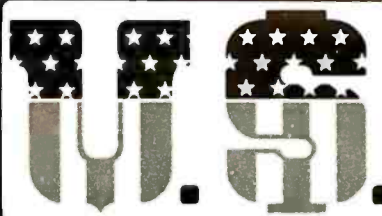
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74LS10	.29	74LS132	.79	74LS251	1.79
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74LS83	.95	74LS191	1.95	74LS390	1.95
74LS85	1.49	74LS192	1.95	74LS393	1.95
74LS86	.95	74LS193	1.95	74LS395	1.95
74LS90	.75	74LS194	1.49	74LS490	4.95
74LS92	.75	74LS195	.95	74LS668	1.69
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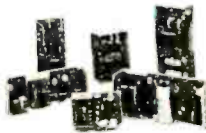
11 EDISON DRIVE ★ NEW LENOX ★ ILLINOIS 60451
CALL TOLL FREE: 1-800-435-9357 ★ MONDAY thru SATURDAY
(ILLINOIS RESIDENTS CALL: 815-485-4002) ★ 8:00 a.m. to 6:30 p.m.

TERMS: Prepayment - C.O.D. up to \$100.00 - M/C Visa
\$5.00 Processing and Handling added to each order PLUS
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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.

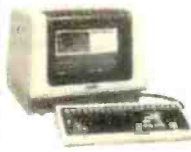


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+5V @ 9A	-5V @ 8A	+24V @ 7A	US-384 89.00
SHUGART - SIEMANS - MPI 5 1/2"			
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Televideo 950 - \$950.00
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Also have 920C, SOROC, HAZELTINE, etc. What we don't have is room on this page. Call Toll Free 800 number for prices.



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(Gold Contacts)

As long as there is a price war, we will fight your battle. Compare at your local Dept. store and buy U\$ MICRO.



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5 1/4"	SOFT	\$2.65 ea.
5 1/4"	HARD 10	2.65 ea.
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Complete S-100 12 Slot Computer. Ample system power with regulated power for drives. Excellent for Subsystem or Hobby use. 4 hours to build. 16 conn. incl., less fans)

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\$195.00 w/no Drives

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!



2 SHUGART 801R POWER SUPPLY

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5" \$550.00 - 8" \$980.00

Attractive, convenient and compact Two Drive Mass Storage includes Power Supply, Drives, Cabinets and Cables. Double Sided, Double Track available too! \$145.00 Kit (Less Cable)



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★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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Double Density 8" and 5" Disk Controller designed for S-100 IEEE standards. Uses Western Digital 1795, 1691 2143 Chip Set.



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3-1/8"

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SPECIALS OF THE MONTH

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Expansion 16K Dynamic RAMs for Apple, TRS-80 S-100 systems. T.I., Mostek Intel, Call for manufacturer.

200 NS

INTEL

8251 \$4.95

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VERY POPULAR I.O. CHIPS BY LEADING MANUFACTURER

2114s

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200 NS

TMS-4044

\$4.25

MM-5257

INTEL 2147

250 NS

CMOS Version \$4.50!

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2716s

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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.

8" 851R \$585.00

SIEMANS DRIVE

8" 100-8

\$375.00

Very Special Price on these BRAND NEW current production units Add \$10.00 for Extended 1 Year Warrantee!

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SN7400N	19	SN74123N	59
SN7401N	22	SN74125N	39
SN7402N	22	SN74126N	44
SN7403N	23	SN74127N	45
SN7404N	22	SN74132N	65
SN7405N	23	SN74136N	95
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	69
SN7408N	26	SN74142N	295
SN7409N	23	SN74143N	235
SN7410N	22	SN74144N	295
SN7411N	29	SN74145N	62
SN7412N	29	SN74147N	195
SN7413N	29	SN74148N	120
SN7414N	59	SN74150N	29
SN7415N	29	SN74151N	67
SN7417N	29	SN74152N	67
SN7420N	22	SN74153N	61
SN7421N	35	SN74154N	119
SN7422N	29	SN74155N	82
SN7423N	29	SN74156N	89
SN7425N	29	SN74157N	69
SN7426N	29	SN74158N	165
SN7427N	29	SN74160N	95
SN7428N	45	SN74161N	95
SN7430N	22	SN74162N	89
SN7432N	29	SN74163N	87
SN7437N	29	SN74164N	97
SN7438N	29	SN74165N	97
SN7439N	29	SN74166N	120
SN7440N	24	SN74167N	135
SN7441N	19	SN74170N	159
SN7442N	27	SN74172N	95
SN7443N	79	SN74173N	79
SN7444N	79	SN74174N	89
SN7445N	79	SN74175N	85
SN7446N	79	SN74176N	85
SN7447N	79	SN74177N	85
SN7448N	79	SN74179N	160
SN7450N	23	SN74180N	75
SN7451N	23	SN74181N	175
SN7453N	23	SN74182N	175
SN7454N	23	SN74183N	195
SN7455N	29	SN74185N	195
SN7460N	23	SN74186N	95
SN7470N	39	SN74188N	30
SN7472N	39	SN74189N	15
SN7473N	39	SN74191N	115
SN7474N	36	SN74192N	85
SN7475N	36	SN74193N	85
SN7476N	36	SN74194N	85
SN7479N	460	SN74195N	85
SN7480N	59	SN74196N	85
SN7481N	110	SN74197N	85
SN7482N	110	SN74198N	39
SN7483N	55	SN74199N	139
SN7485N	65	SN74221N	139
SN7486N	39	SN74251N	95
SN7488N	19	SN74252N	95
SN7490N	39	SN74279N	89
SN7491N	65	SN74283N	215
SN7492N	52	SN74284N	30
SN7493N	49	SN74285N	390
SN7494N	49	SN74290N	195
SN7495N	65	SN74298N	95
SN7496N	62	SN74365N	68
SN7497N	310	SN74366N	68
SN74100N	99	SN74376N	79
SN74107N	32	SN74366N	79
SN74109N	32	SN74393N	190
SN74116N	195	SN74393N	190
SN74121N	29	SN74490N	190
SN74122N	39		

74LS00

74LS00N	35	74LS164N	119
74LS01N	28	74LS165N	89
74LS02N	28	74LS166N	246
74LS03N	28	74LS168N	89
74LS04N	39	74LS169N	189
74LS05N	28	74LS170N	199
74LS06N	39	74LS173N	89
74LS08N	39	74LS174N	99
74LS10N	28	74LS175N	99
74LS11N	39	74LS181N	220
74LS12N	28	74LS190N	115
74LS13N	47	74LS191N	115
74LS14N	125	74LS192N	98
74LS15N	39	74LS193N	98
74LS20N	39	74LS194N	115
74LS21N	38	74LS195N	95
74LS22N	38	74LS196N	89
74LS26N	39	74LS197N	89
74LS27N	39	74LS221N	149
74LS28N	39	74LS240N	195
74LS29N	39	74LS241N	195
74LS32N	39	74LS242N	195
74LS37N	79	74LS243N	195
74LS38N	39	74LS244N	195
74LS50N	26	74LS245N	495
74LS52N	79	74LS246N	110
74LS53N	79	74LS248N	110
74LS54N	79	74LS249N	169
74LS51N	26	74LS251N	179
74LS55N	35	74LS252N	98
74LS56N	35	74LS253N	98
74LS57N	35	74LS257N	98
74LS58N	35	74LS258N	98
74LS59N	59	74LS259N	295
74LS60N	68	74LS260N	69
74LS62N	45	74LS261N	249
74LS63N	45	74LS262N	59
74LS64N	69	74LS273N	175
74LS65N	119	74LS275N	440
74LS66N	45	74LS279N	59
74LS67N	75	74LS283N	110
74LS68N	129	74LS290N	129
74LS69N	75	74LS293N	195
74LS70N	110	74LS294N	110
74LS71N	98	74LS298N	129
74LS72N	45	74LS324N	175
74LS73N	45	74LS347N	195
74LS74N	195	74LS348N	195
74LS75N	195	74LS349N	195
74LS114N	65	74LS353N	165
74LS122N	65	74LS363N	149
74LS123N	119	74LS365N	99
74LS124N	135	74LS366N	99
74LS125N	89	74LS367N	73
74LS126N	89	74LS368N	73
74LS132N	79	74LS373N	275
74LS136N	79	74LS374N	275
74LS138N	89	74LS375N	69
74LS139N	89	74LS377N	195
74LS140N	125	74LS385N	195
74LS148N	149	74LS386N	65
74LS151N	79	74LS390N	195
74LS152N	79	74LS393N	195
74LS154N	249	74LS395N	170
74LS159N	236	74LS399N	236
74LS162N	99	74LS424N	99
74LS167N	99	74LS566N	175
74LS168N	99	74LS567N	229
74LS169N	81	74LS595N	199
74LS171N	115	74LS596N	199
74LS172N	115	74LS597N	199
74LS163N	99	74LS598N	199

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DIGITAL MULTIMETER

The U.S. Model TouchTest 20 is a 2 1/2 digit multi-meter with 1000 readings of measuring 10 parameters including 10 current ranges and 44 ranges Features touch test and annunciator lamp indication of control settings which include function range and on-off control

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BECKMAN Digital Multimeters

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Choice of Models - The ECH 310 has all the features 7 functions 29 ranges plus 2.5% vdc accuracy

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MODEL 150

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The DIGITALKER is a speech synthesis system consisting of multiple integrated MOS integrated circuits. It contains a speech synthesizer chip (SPC) and speech ROM and when used with external filter, amplifier, and speaker, produces a speech signal which is intelligible, smooth, and clear. It includes the major functions and emphasis of a natural speech. Also, female and child's voices can be synthesized.

- Completely independent system, not requiring a decoder chip.
- Designed to be easily interfaced to most microprocessors.
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- Naturalization and emphasis analog speech.
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- TTL compatible.
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DIGITALKER™ DT1000. Self contained board that - with just a speaker and a power supply - can retrofit any desired combination of 144 words. **\$485.00**

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ATARI 800 \$825.00 ATARI 400 \$449.00

ATARI 800 Includes: Computer Console, BASIC Lang. Cartridge, BASIC Language Programming Manual, 800 Operator's Manual w/Notebook, 16K RAM Module, Power Supply, TV Switch Box.

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SYMA-1	6502	239.00	Add 39.95	AIM-65	6502	375.00	Add 49.95
Cymatic	280	409.00	N/A	ENCL-65	1802	199.00	Add 49.95

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Now! Special TV. Adapter lets you use your existing T.V. set as a computer display. **\$499.00** Console only.

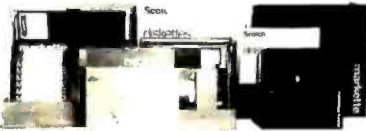
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\$24.95
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Ten boxes \$22.75 One hundred boxes \$21.50

Memorex 3401	10x	10 boxes	Scotch 7410(10)0110	10x	10 boxes
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8 1/2" INCH	Scotch	box	10 bx.	Dyan box	10 bx.	MKN box	10 bx.
Single side/40 den.	740-0	33.	32.	3740/1	549.	547.	3060 9. 3. 3.
Single side/double den.	741-0	45.	43.	3740/1d	75.	73.	3090 37. 38.
Single side/32 sector	740-32	35.	33.		na.	na.	
Double side/double D.	743-0	65.	59.		na.	3115 19. 18.	

SCOTCH brand head elevating kit. \$24.95 MNA-CMSK08 please specify 5 1/4" 8" Prices available on request for: tape, cartridges, diskpacks, volum diskettes.

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TRS-80 \$25
APPLE II \$25

16k memory (8) 4116's

Factory prime. Unconditionally guaranteed for one full year. Add \$3.00 for TRS-80 jumpers and instructions.



DYNAMIC

	ea.	32+	100+	1K+
4116-200ns	3.25	3.00	2.75	2.50
4116-150ns	3.75	3.50	3.25	3.00
4164 64K	49.50	45.00		

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21L02 450ns.	1.19	1.05	.99	
21L02 250ns	1.49	1.45	1.39	
2114L4 450ns	3.95	2.95	2.75	2.50
2114L3 300ns	4.25	3.75	3.00	2.75
4044-4 450ns	4.95	4.50	4.25	4.00
4044-2 250ns	5.50	4.95	4.50	4.35
5257-3 300ns	4.47	4.25	4.05	3.75

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2708 450ns	4.95	4.50	3.75	3.25
2716 5V.	7.95	6.50	5.00	4.50
2716 tri-volt	9.95	9.00	8.25	7.50
2732 bitel	19.00	17.50	16.00	
2532 TI	21.50	19.00		
2764	*			



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Direct connect modems eliminate loss of information due to the carbon compression associated with acoustic modems. Choose either of these two great units.

The Universal Data Systems 103LP is switch selectable between answer and originate modes. Fully Bell 103 compatible. Directly connects to the new modular telephone bank. 100% power from the telephone line. No need to locate modem in proximity to C.Tower receptacle. MOD-103LP 2 years.

Navigation "B" Cat connectors to host the new "Bell" modular handsets. Ideal for multiple line office telephony. Requires external A.C. power. MOD-BGAT 2 Yrs.

UDS 103J/LP AUTO ANSWER \$219



26 Megabyte Hard Disk Drive from **GEORGE MORROW'S Thinker Toys** \$3950

Other Morrow Products	Price	Basic Jackson 23 computer	\$2150
Additional hard disk	23650	disk Jackson 23 Controller	1050
Linexa 23 1 drive	238	AT23 hard disk Controller	524
Busca 23 2 drives	1827	Serial/parallel Interface	310
Busca 23 1 1/2" drive	1850	"Bus" Keyboard	272
Busca 24 2 drives	2257	8110 Gen 35-Megabyte hard	2500

HEWLETT PACKARD \$2650



The Hewlett Packard HP-85 is a complete, low cost portable computer system. This self contained package includes CPU, keyboard, printer, CRT display and cassette tape drive. SYS-10185 30 lbs.



The new BSR timer runs your home just like a clockwork. Runs at 100ms and operates while your away from home. Completely compatible with your existing System X-10 devices.

BSR Timer eight channel	\$65.00	Appliance Module 500 W.	\$12.85
Master control console	\$4.05	120V/100V/200V Switch	\$3.95
Ultrasonic Controller	19.95	240V full control wall switch	14.50

S-100 Mother Board \$35

Quiet Buss



8803-18 18 slot IMSAI

SWITCHES



HP SWITCHES	PK.	THORNTON	ea.	100+
4	1.88	.75	.59	
7	1.29	.63	.70	
8	1.05	.91	.87	
12	1.10	.99	.91	

CONNECTORS



GOLD EDGE CONNECTORS	each	10+	100+
5-100 125" centers	\$2.95	\$25.00	
Insol solder 125" row	\$2.95	\$25.00	
Insol wire wrap (27")	3.95	4.50	
Sullins HI-Hel. 125"	4.50	4.50	
Sullins HI-Hel. WAV	5.15	4.50	
Sullins (Althal. 140")	4.95	4.50	

INTEGRATED CIRCUIT SOCKETS	each	200+	each	1000+
8 pin 4-10 4-20	3.45	3.45	3.45	
14 pin 10-20	4.15	4.15	4.15	
16 pin 12-11	5.00	4.15	4.15	
18 pin 12-11	4.80	4.15	4.15	
24 pin 12-11	5.80	4.15	4.15	
40 pin 12-11	1.60	1.47	1.47	

SPECIAL \$295 SHUGART SA800/1

Your Choice 115V. 60Hz or 230V. 50Hz.

These Shugart eight inch disk drives were originally purchased by major computer manufacturers. Upon failing incoming inspection the drives were sent back to Shugart for realignment.

California Digital has negotiated an extremely attractive agreement to purchase the entire inventory of the SA800's. We are offering the drives on a first come basis at only \$295. (Subject to remaining inventory on hand.) Installation manual \$10 additional. Warranty 30 days from date of receipt. NOTE: The SA800/1 is standard mount and not the "R" suffix rack mount unit. SPC-800/115 or SPC-800/230 16 lbs.

Shugart Associates



\$395 801/R Disk Drive 15 lbs.

Shugart 801/R with CP 200 power supply, muffin exhaust fan, complete in dual enclosure with all the necessary connecting cables. Documentation included. 36 pounds. MSD-1001 \$795 Same as above but with two Shugart 801/R disk drives. \$1195

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 contaminants. Requires only DC voltage. Dual California Digital 5 1/4" enclosure. \$1500 ST506 drive and power supply.

Shugart Associates SA400 removable media disk drive for above package. add: \$300 S-100 & Apple controller scheduled for spring release.

DATA INPUT TERMINAL

This keystation terminal was recently perfected from the CMC division of the Perdec Corporation. The unit was originally designed for inputting data directly onto magnetic tape.

The system is comprised of a premium cast aluminum and fiberglass enclosure, along with a Honeywell 1500 series full effect keyboard. Thirty display lamps indicate the operator of the system status. Your inch long speaker acknowledges acceptance of data and alerts the operator of pending problems. The most of all this "UNIX" terminal with a 10th-Imagination, can be retrofitted to make the perfect home for an S-100 computer and video display or other modifications will accept the Honeywell A81-85 microcomputer.

Five volt regulated power supply is available for an additional \$70. (See June Byte) All units are in excellent condition. Original acquisition over \$700. 22 lbs.

Regulated Power Supply 5 VOLT 5AMP \$1195

This 12801 surplus power supply was removed from working equipment. Pass transistor regulation outputs five volts at a maximum ripple free output. Suitable for TTL logic applications. SPC-101 6 pounds.

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Circle 46 on inquiry card.

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MEMOREX
8" DISKETTES
\$25 WITH FREE LIBRARY CASE

Recently the Memorex Corporation had a concession on a contract for a truck load of eight inch diskettes. California Digital was fortunate to be offered this load of prime magnetic media. These diskettes are "UNBRANDABLE" but are guaranteed first quality Memorex Brand. (\$2500 single den.) Like all diskettes and by California Digital, a library case is supplied free with the purchase of over 500. This offer is subject to remaining inventory on hand.

World's Best Selling Printer

EPSON
MX80

Immediate Delivery

Only \$475

Correspondence quality printing. A lot of printers costing a lot more can't touch the MX-80's performance. It gives you a choice of 40, 80, 166 or 132 columns of printing in as many as four distinct printing density modes, a total of twelve different combinations which can accommodate nearly any printing requirement.

Bi-directional printing. Logical seeking of shortest lines. 80 CPS. 64 graphics characters. Forms handling. The list of standard features goes on and on. The fact is that there are few printers that can compete with the MX-80 at ANY price. And none - ZERO - in its extraordinarily affordable price range.

ACDEFGHIJLMMNOPRSTUVWXYZACDEFGHIJ
.....

SUPER BUY



NEW
from INTEGRAL DATA
460
Paper Tiger
with GRAPHICS \$1150

The 460 Paper Tiger uses a dot matrix character formation technique in which the placement of the dots overlap both horizontally and vertically to achieve a correspondence quality print. The printer's nine-wire print head uses staggered needle rows to create vertically overlapping dots. The head is driven bi-directionally under microprocessor control by a stepper motor driven mechanism. "Two K" buffer allows the printer to accept the entire content of a 1.520 character CRT screen. With graphics suggested retail price \$1,395. 27 lbs. PRG-460C

NEC Spinwriter
5510P/S
\$2795



The word processing quality Spinwriter prints at speed up to 45 characters per second. The Model 5510P/S is supplied with both parallel and RS-232 serial interfaces. Also included is the tractor and mechanism, along with print ribbon. P/N: 5510P/S. 70 lbs. Keyboard (USR) Model 5520P/S available \$2995. P/N: 5520P/S. 75 lbs.



TEC V-300
Word Processing
Daisy Wheel Printer
\$1595

Finally a reasonably priced letter quality printer... Bi-directional printing at 25 characters per second. Full 136 print positions wide. Proportional spacing 1/12" horizontal, 1/8" vertical. Uses standard Diablo brand interchangeable daisy print wheels. Intel 8085 CPU microprocessor controlled. Interfaces via Centronics parallel connector. Shipping 58 lbs. P/N: V-300.

TELETYPE MODEL 43

- 4320 KEYBOARD MODELS
- TTL serial output AAA \$ 995
 - RS232 serial AAK 1050
 - Friction 80 column AAE 1100
 - Friction 80 RS232 AAL 1195
 - Bell 103 Modem AAB 1495



ULTRA-VIOLET PRODUCTS UVSTTE
UV EPROM ERASER

\$65

CENTRONICS

730 \$595
737 \$750



Both the Centronics 730 and the 737 are capable of accepting standard office letterhead or pin feed continuous forms. For higher resolution the 737 implements a nine wire dot matrix print head. Parallel interface. Add \$65 for RS232. PRC-730P (S). PRC-737P (S) 17 lbs.

IBM 3101
Display Terminal

IBM Direct Price \$1295
California Digital

discount price \$1195



New from the Amplex Corporation. The Dialogue 80 features removable keyboard, displayable two pages (four optional) dual program keys, half intensity protected fields and status line. Transmits data either block, line or character mode. Excellent value. VDT-D80 shipping 47 lbs.

AMPEX
DIALOGUE 80
CRT TERMINAL
\$995

VIDEO TERMINALS

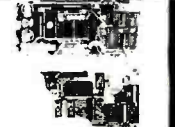
- ADDS Regent 25 numeric cluster VDT-R25 \$850
- ADDS Regent 30 25th status line VDT-R30 950
- ADDS Regent 40 limited graphics VDT-R40 1195
- ADDS Regent 60 Block mode VDT-R60 1495
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- Digital Equipment VT-100 VDT-V100 1595
- Digital Equipment VT-132 VDT-V132 1895
- Direct VP-800A emulator VDT-P800 call
- Hazeltine 1410 VDT-H1410 750
- Hazeltine 1420 VDT-H1420 795
- Hazeltine 1500 VDT-H1500 850
- Hazeltine 1510 VDT-H1510 1025
- Hazeltine 1520 VDT-H1520 1225
- Hewlett Packard 2621A VDT-HP21A
- Hewlett Packard 2621P VDT-HP21P
- IBM 3101-10 character mode green VDT-3101 1195
- IBM 3101-20 block mode VDT-31012 1395
- Lear Siegler 3A upper case only VDT-L3A 850
- Lear Siegler ADM5 VDT-L5 945
- Lear Siegler ADM31 VDT-L31 1385
- Lear Siegler ADM42 VDT-L42 1995
- Soroc IQ 120 VDT-Q120 675
- Soroc IQ 135 NEW VDT-Q135 850
- Soroc IQ 140 detachable keyboard VDT-Q140 1150
- Televideo 912C VDT-T912 665
- Televideo 920C VDT-T920 745
- Televideo 950C detachable keybd. VDT-T950 985
- Zenith Z-19 VDT-Z-19 735

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- BMC KG12C 18MHz P-31 grn phosphor \$259
- Leedex/Ardek 12" 100 129
- Leedex 100 green 169
- Leedex 100-80 197
- Hitachi color 13" 389
- Zenith color 13" 379
- NEC green phosphor Panasonic color 10" 219
- Sanyo 9" BW 149
- Sanyo 12" green phos. 235
- Sanyo 15" BW 259
- Sanyo 13" color 419

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APPLE COMPUTER

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Clock/Timer, Bat. back-up 742-4 89
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Programmable Timer 7740A 99
Analog/Digital converter 7470A 99
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Apple II-40 CPU card 378
D. C. HAYES PRODUCTS
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Intro X-10 system for BSR \$239
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Superlaser SD200 245
ROM Plus with filter 165
ROM Writer/Programmer 119
APPLE BRAND PRODUCTS
Apple Language card 450
Floppy disk with controller 580
Floppy disk without controller 495
Apple parallel interface 175
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Dual serial parallel interface A10 390
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8" floppy controller (Pascal) 360

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Assembled • Tested • Burned-in

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Godout 5085/5088 dual 16 bit processor B1/C-C2B 375
Measurement Systems Z-80 3 serial 2 parallel serial time clock, 8 vector B1/C-C2B 285
SD Systems S10C-280 Z-80 with serial A parallel I/O ports B1/C-C2B 385
Teletek TPC-1 single board CPU & floppy disk controller plus I/O B1/C-C2B 695
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TEL 12 slot table ENJ-T12 485
TEL 22 slot table ENJ-T22 650
Godout mainframe ENJ-GM1
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Calif. Computer 2065A 61K dynamic memory B1/C-C2065 \$329
Calif. Computer 2016 18K static memory B1/C-C2016 250
Calif. Computer 2032 32K static memory B1/C-C2032 385
Godout Ram 17 64K static memory 16 bit B1/C-G17 1025
SD Systems Kaxandorum II 16K dynamic B1/C-K216 295
61K dynamic I/O-M-K264 375
Measurement Systems M18B-100 for Alpha Micro B1/C-M18B-100 685
- FLOPPY DISK CONTROLLER
Calif. Computer 2422A with 2 x CPU B1/C-C2422 329
Godout Disk Controller features the NEC 765 controller, DMA arbitration B1/C-G13 395
Measurement Systems 765 comp. simple & double density, Error recovery B1-M1 110
SD Systems Versafloppy II double density B1-V1-2 119
Turbell D/II B1/T-172 119
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Calif. Computer 2718 I/O type board B1/C-C2718 199
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CIT Computer real time clock/calendar B1/C-C13 135
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D.C. Hayes 5-100 Micro-modem B1/C-M100 310
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Rotron Muffin Fan

\$14.77 \$12.00 @ 100
10.50 @ 1000



115 VAC, 7 Watts WR2A1
Factory fresh Muffin fans
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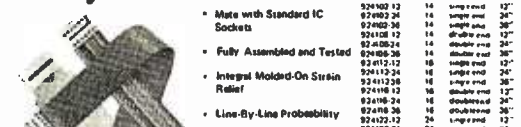
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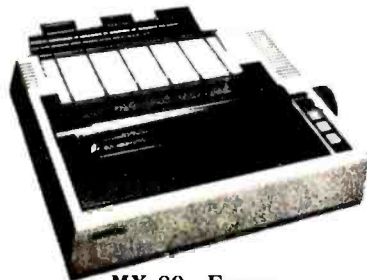
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SN7412N .25	SN7484N .35	SN74172N 1.39
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SN7414N .69	SN7486N .89	SN74174N .79
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SN7425N .29	SN7497N 1.00	SN74185N 2.49
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74LS04 .25	74LS94 .75	74LS196 1.15
74LS05 .25	74LS95 .75	74LS197 1.15
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74LS10 .25	74LS100 .75	74LS202 1.15
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74LS43 .25	74LS133 .75	74LS235 1.15
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74LS46 .25	74LS136 .75	74LS238 1.15
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74LS48 .25	74LS138 .75	74LS240 1.15
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74LS56 .25	74LS146 .75	74LS248 1.15
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74LS67 .25	74LS157 .75	74LS259 1.15
74LS68 .25	74LS158 .75	74LS260 1.15
74LS69 .25	74LS159 .75	74LS261 1.15
74LS70 .25	74LS160 .75	74LS262 1.15
74LS71 .25	74LS161 .75	74LS263 1.15
74LS72 .25	74LS162 .75	74LS264 1.15
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74LS74 .25	74LS164 .75	74LS266 1.15
74LS75 .25	74LS165 .75	74LS267 1.15
74LS76 .25	74LS166 .75	74LS268 1.15
74LS77 .25	74LS167 .75	74LS269 1.15
74LS78 .25	74LS168 .75	74LS270 1.15
74LS79 .25	74LS169 .75	74LS271 1.15
74LS80 .25	74LS170 .75	74LS272 1.15
74LS81 .25	74LS171 .75	74LS273 1.15
74LS82 .25	74LS172 .75	74LS274 1.15
74LS83 .25	74LS173 .75	74LS275 1.15
74LS84 .25	74LS174 .75	74LS276 1.15
74LS85 .25	74LS175 .75	74LS277 1.15
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74LS87 .25	74LS177 .75	74LS279 1.15
74LS88 .25	74LS178 .75	74LS280 1.15
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74LS95 .25	74LS185 .75	74LS287 1.15
74LS96 .25	74LS186 .75	74LS288 1.15
74LS97 .25	74LS187 .75	74LS289 1.15
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74LS100 .25	74LS190 .75	74LS292 1.15

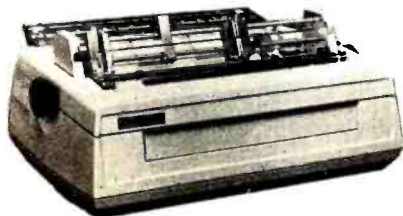
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74S02 .50	74S333 .55	74S236 1.45
74S03 .50	74S334 .55	74S237 1.45
74S04 .50	74S335 .55	74S238 1.45
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74S22 .50	74S353 .55	74S256 1.45
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74S26 .50	74S357 .55	74S260 1.45
74S27 .50	74S358 .55	74S261 1.45
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74S33 .50	74S364 .55	74S267 1.45
74S34 .50	74S365 .55	74S268 1.45
74S35 .50	74S366 .55	74S269 1.45
74S36 .50	74S367 .55	74S270 1.45
74S37 .50	74S368 .55	74S271 1.45
74S38 .50	74S369 .55	74S272 1.45
74S39 .50	74S370 .55	74S273 1.45
74S40 .50	74S371 .55	74S274 1.45
74S41 .50	74S372 .55	74S275 1.45
74S42 .50	74S373 .55	74S276 1.45
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74S44 .50	74S375 .55	74S278 1.45
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74S53 .50	74S384 .55	74S287 1.45
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132 column, 9 x 9 dot matrix, multiple fonts
PRM-27080 Save \$100.00 Call
MX-70
PRM-27070 With Graftax II Call
Interface & Cable for Apple \$110.00



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65 cps. bi-directional, letter quality printer with deluxe tractor mechanism, both parallel and serial interfaces on-board, 16K buffer, ribbon, print thimble, graphics, micro-space justification, data cable, and self test/diagnostic ROM.
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Accessories for TRS-80



DISK DRIVES for TRS-80
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2 double density drives with cabinet, power supply, & cables
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16K MEMORY UPGRADE
Add 16K of RAM to your TRS-80, Apple, or Exidy in just minutes. We've sold thousands of these 16K RAM upgrades which include the appropriate memory chips (as specified by the manufacturer), all necessary jumper blocks, fool-proof instructions, and our 1 year guarantee.
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MEX-16102K Exidy kit \$29.00

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Two computers in one, Z-80 & 6502, more than doubles the power & potential of your Apple, includes Z-80* CPU card, CP/M 2.2, & BASIC 80
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Atari 800 \$799.95

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IOI-2041A A & T \$99.95

AIO, ASIO, APIO - S.S.M.
Parallel & serial interface for your Apple (see Byte pg 11)
IOI-2050K Par & Ser kit \$129.95
IOI-2050A Par & Ser A & T \$159.95
IOI-2052K Serial kit \$89.95
IOI-2052A Serial A & T \$99.95
IOI-2054K Parallel kit \$69.95
IOI-2054A Parallel A & T \$89.95

A488 - S.S.M.
IEEE 488 controller, uses simple basic commands, includes firmware and cable, 1 year guarantee. (see April Byte pg 11)
IOX-7488A A & T \$399.95

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JADE's new dual disk sub-assemblies include: Handsome metal cabinet with proportionally balanced air flow system, assembled & tested dual drive power supply, quiet whisper type cooling fan, power-cable kit, lighted power switch, approved fuse assembly, line cord, Never-Mar rubber feet, and all necessary hardware to mount 2-8" disk drives - it's all American made, guaranteed for six months, and it's in stock!

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END-000421 Cabinet kit \$225.00
END-000420 Bare cabinet \$59.95

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END-000423 Kit w/2 8" drives \$975.00
END-000424 A & T w/2 8" drives \$1195.00

Double sided, double density disk drive sub-system
END-000426 kit w/2 8" drives \$1495.00
END-000427 A & T w/2 8" drives \$1695.00

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MSF-10851R SA-851R \$595.00
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Siemens FDD100-8D2 single sided, double density
MSF-201120 6 mo warranty \$385.00
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Qume Datatrak 8 double sided, double density
MSF-750080 SA-851R compatible ... \$599.95
Special sale price 2 for \$1160.00

JADE DISK PACKAGE
Double density controller, two 8" double density floppy disk drives, CP/M 2.2 (configured for controller), hardware and software manuals, boot PROM, cabinet, power supply, fan, & cables
Special Package Price Kit \$1395.00

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DISKETTES - Jade
Bargain prices on magnificent magnetic media
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MMD-5110103 Soft sector \$27.95
MMD-5111003 10 sector \$27.95
MMD-5111603 16 sector \$27.95
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MMD-5220103 Soft sector \$39.95
8" single sided, single density, box of 10
MMD-8110103 Soft sector \$33.95
8" single sided, double density, box of 10
MMD-8120103 Soft sector \$39.95
8" double sided, double density, box of 10
MMD-8220103 Soft sector \$49.95

Video Monitors

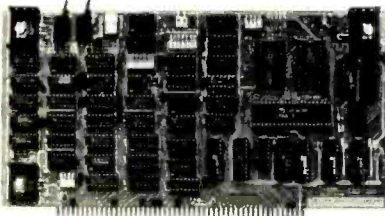
13" COLOR MONITOR - Zenith
The hi res color you've been promising yourself
VDC-201301 \$449.00

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VDM-801210 Video 100 12" B&W .. \$149.95
VDM-801230 Video 100-80 12" B&W \$189.95
VDM-801250 12" Green Phosphor ... \$189.95
VDC-801310 13" Color I \$399.95

Fast Service.

S-100 CPU



CB-2 Z-80 CPU - S.S.M.

2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing. IEEE S-100, front panel compatible.

CPU-30300K Kit \$239.95
CPU-30300A A & T \$299.95

THE BIG Z* - Jade

2 or 4 MHz switchable Z-80* CPU with serial I/O, accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600

CPU-30201K Kit \$145.00
CPU-30201A A & T \$199.00
CPU-30200B Bare board \$35.00

2810 Z-80* CPU - Cal Comp Sys

2/4 MHz Z-80* CPU with RS-232C serial I/O port and on-board PROM, software programmable baud rate generator, 1K of on-board RAM, Z-80 CTC.

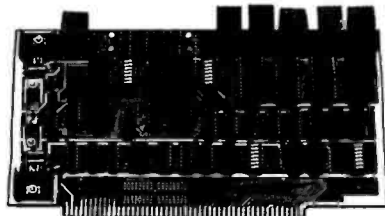
CPU-30400A A & T \$269.95

SBC-200 - SD Systems

4 MHz Z-80* CPU with serial & parallel I/O ports, up to 8K of on-board PROM, software programmable baud rate generator, 1K of on-board RAM, Z-80 CTC.

CPC-30200K Kit \$339.95
CPC-30200A Jade A & T \$399.95

S-100 I/O



I/O-4 - S.S.M.

2 serial I/O ports plus 2 parallel I/O ports

IOI-1010K Kit \$159.95
IOI-1010A A & T \$219.95
IOI-1010B Bare board \$35.00

S.P.I.C. - Jade

Our new I/O card with 2 SIO's, 4 CTC's, and 1 PIO

IOI-1045K 2 CTC's, 1 SIO, 1 PIO .. \$199.00
IOI-1045A A & T \$259.00
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IOI-1046A A & T \$319.00
IOI-1045B Bare board w/ manual ... \$59.95
IOI-1045D Manual only \$20.00

Motherboards

ISO-BUS - Jade

Silent, simple, and on sale - a better motherboard
6 Slot (5 1/4" x 8 3/4")

MBS-061B Bare board \$19.95
MBS-061K Kit \$39.95
MBS-061A A & T \$49.95

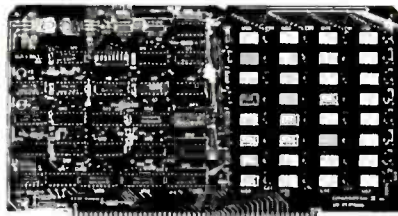
12 Slot (9 1/4" x 8 3/4")

MBS-121B Bare board \$29.95
MBS-121K Kit \$69.95
MBS-121A A & T \$89.95

18 Slot (14 1/2" x 8 3/4")

MBS-181B Bare board \$49.95
MBS-181K Kit \$99.95
MBS-181A A & T \$139.95

S-100 Memory



EXPANDORAM II - SD Systems

4 MHz RAM board expandable from 16K to 64K

MEM-16630K 16K kit \$275.95
MEM-32631K 32K kit \$295.95
MEM-48632K 48K kit \$315.95
MEM-64633K 64K kit \$335.95
Assembled & tested add \$50.00

64K RAM - Calif Computer Sys

4 MHz bank port / bank byte selectable, extended addressing, 16K bank selectable, PHANTOM line allows memory overlay, 8080 / Z-80 / front panel compatible.

MEM-64565A A & T \$575.00

MEMORY BANK - Jade

4 MHz. IEEE S-100, bank selectable, 8 or 16 bit, expandable from 16K to 256K

MEM-99730B Bare board \$55.00
MEM-99730K Kit, no RAM \$219.95
MEM-16730K 16K kit \$249.95
MEM-32731K 32K kit \$289.95
MEM-48732K 48K kit \$324.95
MEM-64733K 64K kit \$359.95
Assembled & tested add \$50.00

32K STATIC RAM - Jade

2 or 4 MHz expandable static RAM board uses 2114L's

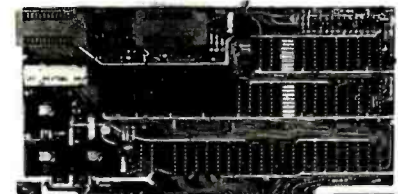
MEM-16151K 16K 4 MHz kit \$169.95
MEM-32151K 32K 4 MHz kit \$299.95
Assembled & tested add \$50.00

16K STATIC RAM - Cal Comp Sys

2 or 4 MHz 16K static RAM board, IEEE S-100, bank selectable, Phantom capability, addressable in 4K blocks

MEM-16160A 16K 2 MHz A & T ... \$286.95
MEM-16162A 16K 4 MHz A & T ... \$289.95
MEM-16160B Bare board \$50.00

S-100 PROM Boards



PB-1 - S.S.M.

2708, 2716 EPROM board with built-in programmer
MEM-99510K Kit \$139.95
MEM-99510A A & T \$199.95

PROM-100 - SD Systems

2708, 2716, 2732, 2758, & 2516 EPROM programmer
MEM-99520K Kit \$219.95
MEM-99520A Jade A & T \$269.95

EPROM BOARD - Jade

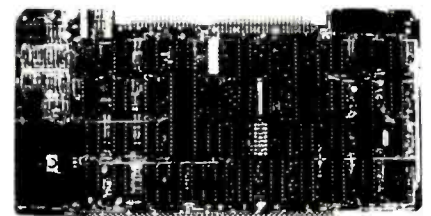
16K or 32K uses 2708's or 2716's, 1K boundary
MEM-16230K Kit \$79.95
MEM-16230A A & T \$119.95

Mainframes

MAINFRAME - Cal Comp Sys

12 slot S-100 mainframe with 20 amp power supply
ENC-112106 A & T \$429.95

S-100 Disk Controller



DOUBLE-D - Jade

Double density controller with the inside track, on-board Z-80A* printer port, IEEE S-100, can function on an interrupt driven buss

IOD-1200K Kit \$299.95
IOD-1200A 8" A & T \$389.95
IOD-1205A 5 1/4" A & T \$389.95
IOD-1200B Bare board \$65.00

DOUBLE DENSITY - Cal Comp Sys

5 1/4" and 8" disk controller, single or double density, with on-board boot loader ROM, and free CP/M 2.2* and manual set.

IOD-1300A A & T \$369.95

VERSAFLOPPY II - SD Systems

New double density controller for both 8" & 5 1/4"

IOD-1160K Kit \$339.95
IOD-1160A A & T \$379.95

S-100 Video

VB-3 - S.S.M.

80 characters x 24 lines expandable to 80 x 48 for a full page of text, upper & lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has keyboard input.

IOV-1095K 4 MHz kit \$345.00
IOV-1095A 4 MHz A & T \$395.95
IOV-1096K 80 x 48 upgrade \$39.95

VDB-8024 - SD Systems

80 x 24 I/O mapped video board with keyboard I/O, and on-board Z-80A*

IOV-1020K Kit \$399.95
IOV-1020A Jade A & T \$459.95

VIDEO BOARD - Jade

64 characters x 16 lines, 7 x 9 dot matrix, full upper/lower case ASCII character set, numbers, symbols, and greek letters, normal/reverse/blinking video, S-100.

IOV-1050K Kit \$99.95
IOV-1050A A & T \$125.00
IOV-1050B Bare board \$29.95

2114L Low Power 4MHz

1 - 19 \$3.35
20 - 99 \$2.99
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MODEM SALE \$129.00

THE STAR
MODEM
from
LIVERMORE

FEATURE
FITS GTE HANDSETS!
2 YEAR WARRANTY

EXCLUSIVE ACOUSTIC CHAMBERS
The exclusive triple seal of Livermore's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world, the STAR offers the utmost in flexibility and transmission reliability.

Specifications:

- Data Rate: 0 to 300 baud
- Compatibility: Bell 103 and 113; CCITT
- Frequency Stability: ±0.3 percent. Crystal controlled
- Receiver Sensitivity: -50 dBm ON, -53 dBm OFF
- Modulation: Frequency shift keyed (FSK)
- Carrier Detect Delay: 1.2 seconds ON; 120 msec OFF
- EIA Terminal Interface: Compatible with RS 232 specifications
- Teletype Interface: 20 milliampere current loop
- Optional Interfaces: IEEE 488; TTL; TTY 43
- International (CCITT) frequencies available
- Switches: Originate/Off/Answer; Full Duplex/Test/Half Duplex
- Indicators: Transmit Data, Receive Data, Carrier Ready, Test
- Power: Supplied by 24 VAC/150 MA UL/CSA listed wall-mount transformer. Input 115 VAC, 2.5 watts. (A 220 VAC, 50 Hz adaptor is available upon request.)
- Dimensions: 10" x 4" x 2"
- Weight: 1.74 lbs. (3 lbs. shipping weight including AC adaptor.)
- Warranty: Two years on parts and labor, excluding the AC adaptor which carries the manufacturer's warranty

Part No.	Description	List Price	SALE PRICE
LIV-STAR	RS232, TTL, 20 MA Current Loop	\$199.00	\$129.00
LIV-STAR-V21	CCITT European Standard	\$229.00	\$208.00
LIV-IEEE	IEEE 488 Standard	\$395.00	\$278.00
LIV-IEEE-V21	IEEE 488, CCITT Standard	\$465.00	\$369.00

CABLES

Part No.	Description	Price
CND-RS232BF	RS232 8 Cond 8 ft	\$19.95
LIV-121	IEEE to IEEE 2 Meter	\$59.95
LIV-12PET	IEEE to Pet 2 Meter	\$59.95

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PROTECT YOUR DATA WITH



GOF-IBAR46

- Inductively isolated grounds
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Part No.	SOLDER TAIL PRICE			
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450ns 8K EPROM 8/\$32.00

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450ns 5 Volt only 8/\$48.00
16 K EPROM

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4096 BIT (1024x4) 300ns
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100 + \$3.00

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4096x1 300ns
LOW POWER STATIC RAM
8/\$50.00
100 pcs. + \$4.75

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4116's RAMS
from Leading Manufacturers

100% GUARANTEED (16Kx1 200ns) 1,000's SETS SOLD
8 for \$28.00

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FOR TRS-80 KEYBOARD

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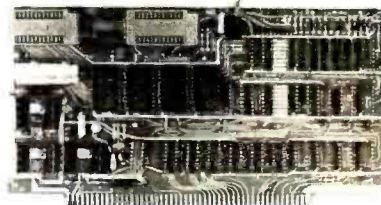


SHU-SA801R \$425.00
2 OR MORE \$395.00 ea.



California Computer Systems

CSS2422A LIST \$400.00
FLOPPY DISK CONTROLLER SALE \$375.00
WITH CP/M VERSION 2.2
IEEE S-100 COMPATIBLE SINGLE/DOUBLE DENSITY
5 1/4" 1/8" DISK DRIVES
SINGLE/DOUBLE HEADED
ASSEMBLED & TESTED



PB1 2708/2716 PROGRAMMER & 4K/8K EPROM BOARD

PB1 has two separate programming circuits so 2708 or 2716 (5v) type of EPROMs can be programmed without modifying the board. Programming voltage is generated on-board; no need for an external power supply. Programming sockets are Dip Switch addressable to any 4K boundary. And complete software is provided for programming and verifying EPROMs.

Unused EPROM sockets don't take memory space, so you are never committed to the full 4K or 8K of memory.

SPECIFICATIONS

Memory capacity 4096/8192 bytes (four sockets)
Memory type 2708 EPROM (not included)
2716 EPROM + 5V type (not included)

Addressing: Any 4K boundary
programmer Dip switch selection
..... Separate 2708 and 2716 sockets
On-board Any 4K/8K boundary above 8000 Hex
EPROMs Dip switch selection
..... Unused sockets do not enable data bus drive
Wait states 0 to 4 clock cycles
Buffering All lines buffered
Special feature LED indicator for programming mode
Switch to turn-off programming
voltage prevents accidental ROM programming
Textool sockets (for programming only)

	List Price	Our Price
SSMPB1K Kit		\$179.00
SSMPB1A Assembled & Tested	\$265.00	\$230.00

MB8A 1K/16K EPROM BOARD

The MB8A provides sockets to support up to 16 2708 EPROMs—the most widely used EPROM in the microcomputer industry. The board disables in 1K increments simply by removing the 1K EPROMs. For example, with 8 EPROMs, it acts as an 8K board.

The MB8A's Magic Mapping enables the user to overlay RAM and ROM at the same address in any desired increment when used with RAM boards equipped with Phantom Disable.

	List Price	Our Price
SSMMB8AK Kit		\$114.00
SSMMB8AA Assembled & Tested	\$179.00	\$159.00

ECONOROM 2708

16K x 8 EPROM BOARD USING 2708

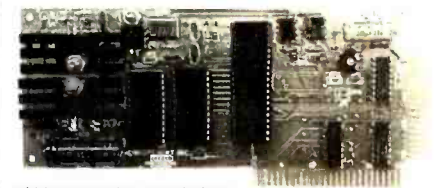
The ECONOROM 2708 EPROM board is the ideal memory board for the user who wishes to place his software in reliable, low cost, and non-volatile 2708 EPROMs. With its on-board Power-On-Jump circuitry, the ECONOROM 2708 board is the ideal addition to any IEEE 696/S-100 system.

	List Price	Our Price
GBT125U Unkit		\$ 85.00
GBT125A Assembled & Tested	\$135.00	\$120.00
GBT125C CSC	\$195.00	\$175.00

Ciarcia's Circuit Cellar

MICROMOUTH

SPEECH PROCESSOR
AS FEATURED IN JUNE BYTE, PAGE 46



- 144 expression vocabulary
 - Assembled and Tested
 - Complete Documentation
 - Connect to a speaker or Power Amplifier
 - Plugs into Apple II
 - Plug compatible with TRS-80 Model 1
 - May be adapted to run on the S-100, H-8, or any parallel port.
- OUR PRICE
MMI-94V0 APL for use with APPLE II, or parallel to run with other parallel parts \$149.00
MMI-94V0 TRS1 TRS-80 Model compatible complete with interface cable and AC Adapter, less enclosure. \$169.00



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9161-B DEERING AVE. • CHATSWORTH, CA 91311

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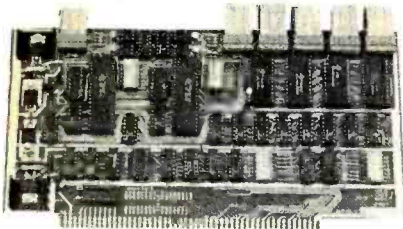
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I/O 2 Parallel & 2 Serial I/O Board

Number of parts • Two serial ports with status • Two parallel inputs • Two parallel outputs • **Serial Interface** - Current-loop by optical isolators • 20/60 ma current loop • EIA receivers and drivers • 55 to 9600 baud • 134.5 baud (optional) for running electrics • UART presets by dip switch: —stop bits, —word length, —parity even and odd • + 5V, 12V & — 12V available at connector • **Parallel Interface** - Latch type—8212 • + 5V & — 12V available at connector • **Addressing** - Dip switch addressing of serial I/O to any four port boundary • Dip switch addressing of parallel I/O to any two port boundary • **Prototyping area** - 2 x 16 pin spare patterns

	List Price	Our Price
SSM04K Kit		\$210.00
SSM04A A&T	\$290.00	\$260.00

INTERFACE I 2 Serial

Our I/O board gives you unparalleled flexibility and operating convenience. We include such features as:

- 2 Independently addressable serial ports (dip switch selectable addresses)
- Real LSI Hardware UARTs for minimum CPU housekeeping.
- RS232C, current loop (20mA), & TTL signals on both ports.
- Precision, crystal-controlled Baud rates up to 19.1 Kbaud (individually dip switch selectable)
- Transmit & receive interrupts on both channels, jumperable to any vectored interrupt line.
- Industry standard RS232 level converters with five RS232 handshaking lines per port.
- Optically isolated current loop with provisions for both on-board & off-board current sources.
- UART parameters, interrupt enables, & RS 232 handshaking lines are software programmable with power-on hardware default to customer specified hard-wired settings for maximum flexibility.

	List Price	OUR PRICE
GBT133U UNKIT		\$199.00
GBT133A A&T	\$249.00	\$219.00

INTERFACER II 3P/1S

- 1 Independently addressable serial port
- RS232C: 20mA current loop, & TTL signals
- Precision crystal controlled Baud rate generator
- Up to 19.2K Baud
- Transmit and receive interrupts, jumperable to and vectored interrupt line
- Five RS232 handshaking lines
- Optically isolated current loop
- 3 parallel I/O
- Utilizes LS TTL octal latches for latched I/O data with 24mA drive current
- Enable & strobe bits on each port (each with selectable polarity)
- Interrupts for each input port
- Separate 25 pin connector with power for each channel and a status port for interrupt mask & port status

	List Price	OUR PRICE
GBT150U UNKIT		\$199.00
GBT150A A&T	\$249.00	\$219.00

TOLL FREE!!!

1-800-423-5922



SPECTRUM S-100 COLOR GRAPHICS BOARD

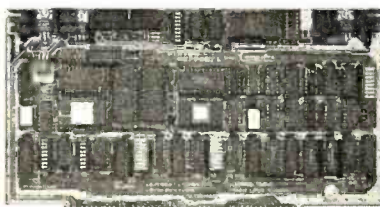


The SPECTRUM COLOR GRAPHICS Board is actually three products in one: a full-function color graphics generator; a parallel I/O port; and an 8K static RAM board. These three sections work together to create a new standard of flexibility in the generation of color graphics.

ALPHANUMERIC AND GRAPHICS MODES AVAILABLE

MODE	DENSITY	AVAILABLE COLORS	RAM USED
ALPHA	32 X 16	2	512 BYTES
SEMIGRAPH	64 X 32	8	512 BYTES
GRAPHICS	64 X 64	4	1K BYTES
GRAPHICS	128 X 64	2	1K BYTES
GRAPHICS	128 X 64	4	2K BYTES
GRAPHICS	128 X 96	2	1.5K BYTES
GRAPHICS	128 X 96	4	3K BYTES
GRAPHICS	128 X 192	2	3K BYTES
GRAPHICS	128 X 192	4	6K BYTES
GRAPHICS	256 X 192	2	6K BYTES

	LIST PRICE	OUR PRICE
GBT144U UNKIT		\$299.00
GBT144A A&T	\$399.00	\$349.00
GBT144C CSC	\$449.00	\$399.00
GBT20 SUBLOGIC UNIVERSAL GRAPHICS INTERPRETER SOFTWARE		\$35.00



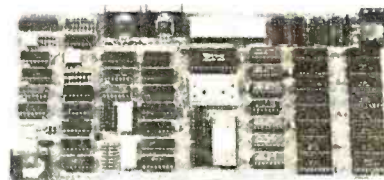
SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

This multi-purpose S-100 board provides your computer with the most needed system support functions - at less cost than buying numerous single function boards. Includes sockets for 4K of extended address EPROM or RAM (2716 pinout), 1 socket with battery backup; crystal controlled month/day/year/time clock with BCD outputs; optional high speed math processor (9511 or 9512); full RS-232 serial port; three 16 bit interval timers (cascade or use independently); two interrupt controllers service 15 levels of interrupts; power fail indicator with provision to switch CMOS memory to battery backup; and comprehensive owner's manual with numerous software examples. Conforms fully to all IEEE 696/S-100 standards.

Want to make your S-100 system more versatile? System Support 1 is the answer.

- 4K of EPROM or RAM (2716 type).
- 15 levels of vectored interrupts.
- 3 interval of 16 bit interval timers.
- Real time clock/calendar with battery backup capability
- Full RS-232C serial port with software selectable baud rate.
- Optional high speed math processor (9511 or 9512, your choice).
- 1, 2, 4 or 8 wait states selectable to accommodate the fastest CPUs.
- ROM/RAM can be enabled or disabled by PHANTOM.
- ROM/RAM can respond to full IEEE extended address (24 bits).

	List Price	Our Price
GBT 162U unKit		\$295.00
GBT 162A A&T	\$395.00	\$360.00
GBT 9512 Math Chlp		\$195.00



VB3 80 Character Video Board

VB3 is the perfect video interface for word processing and other applications requiring 80 characters per line. It produces a standard 80 x 24 display or as much as 80 x 48 for a full page of text. VB3 can display upper and lower case characters, up to 256 user defined symbols, and a 160 x 192 matrix for graphics.

VB3 is memory mapped, but occupies memory only when activated. So one or more VB3s can be located at the same address with a full 65K of memory still available to the user.

It generates both US and European T.V. rates and includes a keyboard input. Software includes a CP/M compatible driver routine.

SPECIFICATIONS:

Display - 80 char. per line, up to 48 lines • Graphics up to 160 x 192 matrix • Upper & lower case characters • Up to 256 user defined symbols (optional EPROM) • Software controlled options: Inverted video, graphic char. (2x4), 1 level of gray, blinking char., underline, strike thru, blank-out char., cursor.

Timing • Software controlled timing, top & bottom margins, horiz. position • U.S. & European T.V. timing • Full Interlace or non-interlace • Crystal—16 MHz (dot rate)

Interface • Composite video, =75 OHM • Vert./horiz. drive output & sync input • Memory mapped Keyboard • Keyboard port with status • Dip switch addressing of ports

On-board RAM • 4096 Bytes (8192 bytes optional) • 2114L (250 nsec or 450 nsec) • Switch addressing, 8K increments • On-board bank-select of RAM

Buffering • All lines buffered

Software • CP/M compatible driver routine • Powerful terminal simulator routine

	List Price	SALE PRICE
SSM-VB3K24 80x24 KIT	\$425.00	\$359.00
SSM-VB3A24 80x24 A&T	\$499.00	\$450.00
SSM-VB3K48 80x48 KIT	\$475.00	\$425.00
SSM-VB3A48 80x48 A&T	\$549.00	\$495.00
SSM-VB3UP 24x48 Line Upgrade Kit		\$50.00

Video Interface Software

- CP/M Compatible 8" Disk, containing
- CP/M BIOS Driver
- Super Intelligent Terminal Routines
- Graphics Routine
- Menu-Driven Initialization Routine
- Misc. User - Contributed Programs

	OUR PRICE
SSM-VB3SFT Video Interface Software	\$50.00

VB1C Memory Mapped Video Board

One of the most popular S-100 video boards available, this VB1C is software controlled and memory mapped. Memory Mapping means that locations in the 1K (1024 byte) on-board RAM memory correspond with locations in the 64 x 16 (1024) character display.

The 1K memory can be addressed at any 1K increment via DIP switch.

The VB1C features a 128 x 48 matrix for graphics upper and lower case, Greek letters, and black on white or white on black. Software includes a driver routine for cursor control, scroll-up, and X-Y graphic control.

	List Price	SALE PRICE
SSM-VB1CK KIT	\$179.00	\$159.00
SSM-VB1CA A&T	\$242.00	\$205.00

VB2 I/O Mapped Video Board

The VB2, is an I/O controlled video interface board. With a TV monitor, the VB2 becomes a video terminal. No other I/O card is required for keyboard input and video display.

The VB2 cursor, linefeed, carriage return, backspace, and clear-screen are hardware controlled. The display is 64 x 16, all upper case, and is selectable for white on black, or black on white. The board produces a clear, bright display, and features adjustable picture size and character width. Circuitry is provided to drive a speaker for a tone.

	List Price	SALE PRICE
SSM-VB2K KIT	\$199.00	\$169.00
SSM-VB2A A&T	\$269.00	\$229.00

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Single and dual trace, 15 thru 100 MHz. All high sensitivity Hitachi oscilloscopes are built to demanding Hitachi quality standards and are backed by a 2-year warranty. They're able to measure signals as low as 1mV/division (with X5 vertical magnifier). It's a specification you won't find on any other 15 or 30 MHz scopes. Plus: Z-axis modulation, trace rotation, front panel X-Y operation for all scope models, and X10 sweep magnification. And, 30 thru 100 MHz oscilloscopes offer internal signal delay lines. For ease of operation, functionally-related controls are grouped into three blocks on the color coded front panel. Now here's the clincher: For what you'd expect to pay more, you actually pay less. Check our scopes before you decide. All scopes complete with probes.

Hitachi...The measure of quality.
HITV302B

30MHz DUAL TRACE OSCILLOSCOPE
List \$995.00
SALE \$819.00



HITV152B DUAL TRACE 15MHZ (no delay)
LIST \$735.00 **SALE \$629.00**



HIT-V202
20MHz DUAL TRACE

LIST PRICE: \$850
SALE PRICE: \$775.00

- Dynamic range 8 div.
- TV sync-separator circuit
- Built-in signal delay line (V-352)
- X-Y operation
- Sweep-time magnifier (10 times)
- Trace rotation system
- Fine-adjusting, click-positioning function

HIT-V352
35MHz DUAL TRACE WITH DELAY

LIST PRICE: \$1150.00
SALE PRICE \$950.00

- Economically priced dual trace oscilloscope
- Square CRT with internal graticule (illuminated scale)
- High-accuracy voltage axis & time axis set at $\pm 3\%$ (certified at 10° to 35°C)
- High-sensitivity 1mV/div.
- Low drift
- 2 Year Warranty

50MHz & 100 MHz
DUAL TRACE WITH
CALIBRATED TIME DELAY

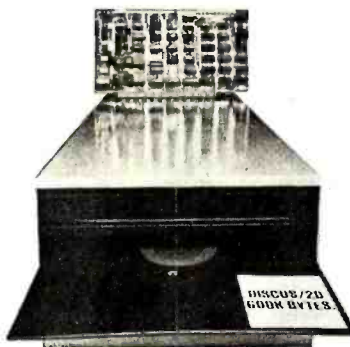
HIT V550B
50MHz with
3rd TRACE
TRIGGER VIEW
LIST \$1745.00
SALE

HIT V1050
100MHz with
3rd & 4th TRACE
TRIGGER VIEW
LIST \$2390.00
SALE

\$1495.00 \$1995.00

The HITACHI V550B (50MHz) and V1050 (100MHz) offer all the capabilities you might expect from a lab grade oscilloscope. Capabilities such as 3rd trace trigger view, a bright 6" square CRT, and a max. sweep rate of 2ns/div (V1050) 5ns/div (V550B). Also, features you may not expect like, sensitivity of 1mV/div (V550B) .5mV/div (V1050) @ 10MHz, automatic focus correction.

MORROW DESIGNS



DISCUS/2D™
DOUBLE DENSITY DISK SYSTEM

COMPLETE WITH
CP/M V2.2 AND
MICROSOFT BASIC V5.2

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 Morrow Designs TM hasn't just made full-size, double-density disk memory affordable...we've made it more functional.

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 and Microsoft Basic V5.2 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, 4 and 5 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.

• ROM utility subroutines:

Bootstrap load	Seek
Terminal input	Set sector
Terminal output	Set DMA address
Horne	Disk read
Disk write	DMA status
Select drive	Disk status
Terminal panic detect	Disk error
Terminal status	Switch density

SINGLE SIDED

MDSF-1218	Single Drive	.....	List Price	\$1199.00	SALE PRICE	\$950.00
MDSF-1228	Double Drive	.....	\$1994.00		\$1598.00	

DOUBLE SIDED

MDSF2218	Single Drive	.....	\$1545.00	\$1198.00
MDSF2228	Double Drive	.....	\$2740.00	\$2190.00

CompuPro™ from GODBOUT ELECTRONICS

10 MHz STATIC RAM SALE



32K ECONORAM XX

32K Bank Select. IEEE S-100 compatible. Features one 32K block that can be addressed on 4K boundaries. Compatible with the IEEE proposed standard of 24 address lines as well as all currently used bank select configurations. Any or all of the eight 4K byte blocks may be disabled to create as many windows in memory to avoid any system memory conflicts.

10 MHz OPERATION

GBT164A16	16K RAM A&T	.....	List Price	\$399.00	SALE PRICE	\$319.00
GBT164A24	24K RAM A & T	.....	\$539.00		\$449.00	
GBT164A32	32K RAM A&T	.....	\$699.00		\$499.00	



ECONORAM 17
64K STATIC S-100 MEMORY

For critical high density applications where dynamic memory poses possible problems with DMA or speed, the Godbout RAM 17 64K STATIC RAM board represents the long awaited solution. Conforming fully to the IEEE 696/S-100 bus standard, RAM 17 provides 24 address lines for 16 megabytes extended addressing capability, and runs on far less power than dynamic memory.

- Meets or exceeds all IEEE 696/S-100 specifications
- Fully static design uses less power than dynamics (2W)
- 24 bit extended addressing
- 2K Window at E000, E800, F000, or F800 HEX (ideal for many floppy disk controller boot prompts)
- THAT'S RIGHT 64K STATIC-2 WATTS
- On board RAM's may be replaced by 2716 EPROM's (pin for pin)
- CSC and Assembled/Tested boards are designed for CPU speeds up to 10 MHz
- Thorough bypassing of all supply lines
- INCREDIBLE LOW POWER OPERATION (2 WATTS)
- Does DMA
- THAT'S 2 WATTS OF STATIC 64K RAM

GBT 175A4B	48K A&T	.....	List Price	\$1048.50	Sale Price	\$950.00
GBT 175A64	64K A&T	.....	\$1395.00		\$995.00	

GBT 161 8085 CPU BOARD
GBT 1612 8085/8088 CPU BOARD

- 8088 & 8085A CPU
- S-100 IEEE COMPATIBLE
- SWITCHABLE CPU'S
- 5 MHZ OR 2 MHZ SWITCHABLE
- POWER ON JUMP TO ANY 256 BYTE BOUNDARY
- POWER ON JUMP CAN BE DISABLED
- CPU CAN JUMP ON POWER ON ONLY OR POWER ON AND RESET
- 24 BIT EXTENDED ADDRESSING
- IMSAI FRONT PANEL COMPATIBLE
- AVAILABLE WITH 8085A ONLY

BOARD WITH 8085 ONLY

GBT161A	Assembled & Tested	List Price	\$325.00	Our Price	\$305.00
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BOARD WITH 8085 & 8088

GBT1612A	Assembled & Tested	\$425.00	\$399.00
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TEAMS UP WITH PRIORITY ONE ELECTRONICS TO INTRODUCE THE NEXT GENERATION OF IEEE/696 S-100 COMPUTERS

8 BIT

There are still a lot of 8 bit machines out in the world, matched with plenty of 8 bit software - but very few of these machines are working up to their peak capacity. We want the "Big 8" system to change all that, and bring professional level computing power to all the owners of older S-100 machines. And if you're assembling an 8 bit system from the ground up, "Big 8" gets you off to the best possible start ... regardless of price.

Here's what you get

1. CPU Z, our high speed, high performance Z80* based CPU board. Includes a 6 MHz CPU for maximum throughput and highest operating speed.
2. Disk 1 DMA floppy disk controller.
3. 64K of fast static RAM with 24 bit extended addressing.
4. InterfacE71 - Dual Serial I/O card or InterfacE II 3 Parallel 1 Serial I/O Card.
5. CP/M* -80 2.2.
6. All documentation and manuals.

It all adds up to \$2712.00

TOTAL PACKAGE PRICE

\$1950.00

SAVE \$762.00

ORDER PART NO. GBT-SPEC-C

Big 8 System with InterfacE I

ORDER PART NO. GBT SPEC-D

Big 8 System with InterfacE II

SAVE EVEN MORE, when you add 2 Shugart 801R disk drives, and a dual Cabinet with Power Supply.

This package adds up to \$3962

TOTAL PACKAGE PRICE

\$3050.00

GBT-SPEC-E with InterfacE I

GBT-SPEC-F with InterfacE II

16 BIT

Step up to the world of 16 Bit computers now and save hundreds, even thousands of dollars if you act right now! We have made a one time only special buy from Godbout on the nucleus of a Powerful 16 Bit S-100 Computer. We have a limited number of these systems in stock, because of the special pricing we can't go back for more, so hurry! Orders will be filled on a first come basis. NO RAINCHECKS.

Here's what you get

1. 16 bit/8 bit Dual Processor (w/6 MHz 8088)
2. System Support 1 with Serial I/O. Real time clock, Interval Timers & More!
3. Disk 1 DMA Floppy Disk Controller (w/BIOS for CP/M *2.2)
4. 64K of fast static RAM (w/IEEE 24 bit extended addressing)
5. Sorcim's powerful PASCAL/M* - 8086 software on disk
6. Digital Research's CP/M* - 86 software on disk
7. I/O and Disk Controller cables, plus full documentation on all hardware and software

*PASCAL M is a trademark of Sorcim; CP/M is a registered trademark of Digital Research

It all adds up to \$3430.00

A) TOTAL PACKAGE PRICE

\$2495.00

SAVE \$935.00

ORDER PART NO. GBT SPEC-A

SAVE EVEN MORE, when you add 2 Shugart 801R disk drives, and a dual Cabinet with Power Supply.

This package adds up to \$4680.

B) TOTAL PACKAGE PRICE

\$3595.00

SAVE \$1085.00

ORDER PART NO. GBT-SPEC-B

THE ULTIMATE SYSTEMS CALL FOR THE ULTIMATE SYSTEMS ENCLOSURE



Power Supply

- Twenty-five Amps at 8.0 volts D.C.
- Three Amps each at + 16 and - 16 volts D.C.
- Outputs vary less than 5% over input range of 100 VAC to 130 VAC
- Constant voltage transformer
- All outputs fused

Enclosure

- Quiet fan provides for cool system operation
- Two switched convenience outlets on the rear
- Line filter for electrical noise suppression
- Circuit breaker for safe operation
- Lighted RESET BUTTON FOR "POWER ON" indication
- Punchouts on rear for 12 DB-25 connectors
- Punchouts on rear for 2 DD-50 connectors
- Positive pressurized for ease of filtration
- Provisions for mounting a front panel
- Physically 18.5" deep, 7" high, and 17" wide (rack front panel 19" wide)

CompuPro™ from GODBOUNT ELECTRONICS

Now ... a place to put all those CompuPro or other S100 boards. The enclosures are available in either desk top or rack mount (including slides) and both have the following features:

ORDER TODAY!

SAVE!



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Motherboard

- Actively terminated at both ends of motherboard
- Ground shield between every signal trace
- Front panel provisions on the 20 slot version

	LIST PRICE	OUR PRICE
GBT ENC20RM	895.00	825.00
20 slot Rack Mount		
GBT ENC20DK	825.00	760.00
20 slot Desk Top		
Shipping Weight 55 lbs		
When purchased with any of the above systems.....		
GBT ENC20RM		\$750.00
GBT ENC20DK		\$685.00

FLEX-FORTH



apple

\$25

KIM

\$21

A Complete Structured Language With:

- COMPILER/INTERPRETER
- OPERATING SYSTEM
- 6502 ASSEMBLER (With Macros)
- FIG SCREEN EDITOR

FLEX-FORTH is a full-featured F.I.G. standard FORTH with virtual memory files.

For: APPLE II 48K (Disk) \$25.
KIM 16K (Cassette) \$21.
Price includes user manual.

Source listing with either, add \$20.
Shipped Free.

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Seattle, Wa. 98177

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Rational Fortran preprocessor allows structured programming using Fortran. An excellent, fast implementation with extensions and manual. Requires Model-I, 48K, 2 disks \$49.00

PPRATFOR- Automatically pretty prints and indents Ratfor. Requires Ratfor. \$30.00 Alone / \$74.00 For Both

SOFT-TOOLS are professional quality software tools developed for the TRS-80 by a PhD in Computer Science.

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Dealer Inquiries Invited

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Double Side Disk Drives



Disk Drive Subsystem with Dual Double Side Drives, Power Supply and Cable. Total Capacity 2.4 M-Byte. Fully Assembled and Tested

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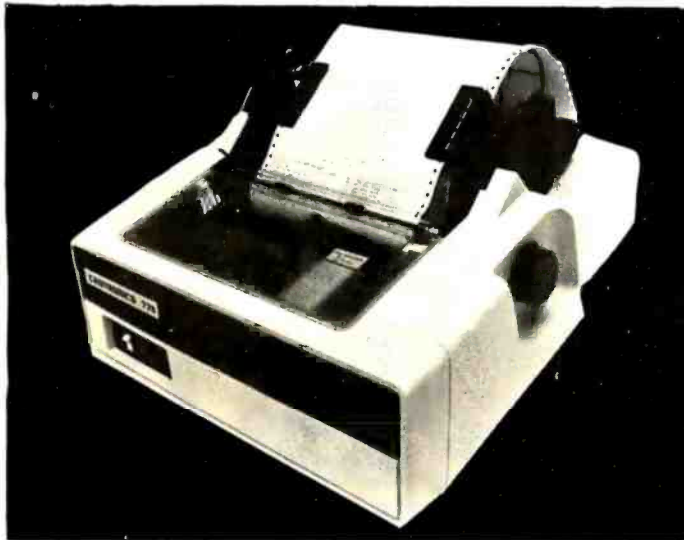
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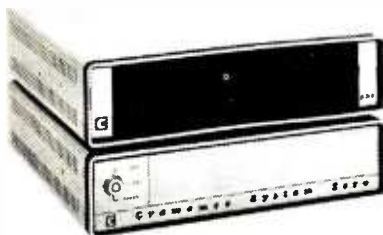
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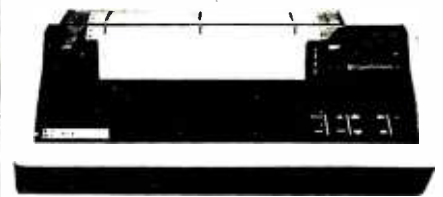
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WANTED: S-100 bus computer, must have video display, two 8-inch disk drives, and 48 K programmable memory. I have amateur radio equipment for trade. Dale Hutchinson, 10818 Brentway Dr, Houston TX 77070.

FOR SALE: Heathkit H-8 computer with 32 K bytes of memory. System includes serial I/O interface, cassette recorder/player, and H-9 video terminal. All manuals, documentation, and software included. Extras are dust covers and special program tapes. \$1100 includes shipping. Keith Morlock, Rt #5 Box #263, Columbus MS 39701. (601) 328-8880.

WANTED: Information where I can find the King James Version of the Bible in computer-readable format on disk or cassette. I will accept collect calls if you have this information. Steven Tilden, 4771 S Warren Ave, Tucson AZ 85714. (602) 746-0569.

FOR SALE: TI Programmable 58. In excellent condition; almost brand new. Master Library Module and manuals included. Will sell for \$75 or best offer. Eddie Stein, 7 Cumberland Ct, Rockville MD 20850. (301) 279-9533.

FOR SALE: Floating-point math board for RCA VIP with driver software, uses MM57109 uP; \$35 US. HP-55 programmable calculator with timer, includes statistics and math manuals. Best offer or will consider trade for R/S Quick Printer II. Frank Shinyer, 10545 129 St, Edmonton Alberta, T5N 1W9 Canada.

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FOR SALE: Barely used Apple communication card and Novation CAT modem. With cables and software. \$275. Chris Pino, 125 Mansfield, New Haven CT 06511. (203) 562-0773.

FOR SALE: Centronics 101 printer, uppercase and lowercase. Cost over \$5000, sell for \$2500 or best offer. Machine is too large for my Commodore. Jerry Gaines, 4104 Fountain Green, Lafayette Hill PA 19444. (215) 828-4800.

WANTED: Old mechanical calculators. Please describe what you have in detail, and include a picture if possible. SASE please. Dick Rubinstein, 15 Maugus Ave, Wellesley Hills MA 02181.

FOR SALE: Apple graphics tablet in excellent condition; \$450. Hitachi high-resolution 9-inch black-and-white monitor; \$125. SwTPC PR-40 printer with parallel card for Apple slot two; \$175. Comprint 912s, a fast 80-column printer with full uppercase and lowercase for RS-232 input; \$250. Apple serial interface card, bidirectional RS-232 with DB-25 connector; \$100. Frank Jaubert, 823 Euclid St, Houston TX 77009. (713) 868-0034.

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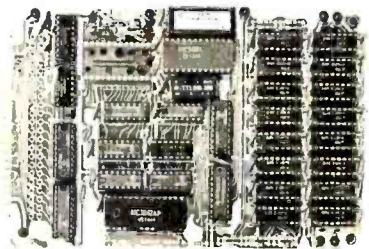
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FOR SALE: Heath H-9 modified for a 24 by 80 display. All manuals included. \$200. Michael L Couch, 1218 18th St. West Des Moines IA 50265. [515] 223 0549.

WANTED: Good clean copy of BYTE magazine for December 1975 (#4). Please give price including packaging and transportation. George Frater, 1730 Mariposa Dr. Las Cruces NM 88001.

FOR SALE: HP-67 calculator with standard pack. cards, manuals, and all original accessories, including case, charger, and program pad. Brand new in original box. Perfect condition. \$300 or best offer. Robert Perrino, 470 Claremont Rd. Springfield PA 19064. [215] 544-0947 after 9 PM.

FOR SALE: SwTPC 4 K memory; \$50. 8 K memory; \$100. JPC CK-7 real-time clock with auxiliary power supply; \$50. MicroWare RT/68 monitor read-only memory; \$50. All in excellent working condition with full documentation. C R Silvia, POB 234. Hines IL 60141.

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WANTED: Contact with owners of Disk Jockey 2D 8-inch disk system and switchboard I/O. Would like to interface Centronics 779 to system. Also, Wameco OMB12 for sale. \$75 or best offer. Daniel Snyder, 561 5th St. Butler PA 16001. [412] 287-1625.

WANTED: Manuals for Altair 8800 computer system. Will purchase. Don Averill, Eastern New Mexico University Sta #33, Portales NM 88130.

WANTED: Still photographs of pre-1960 computers, computer facilities, and computer scientists and engineers; also, cine footage, sound or silent, in any size, of same. Would also like to hear from other computer archivists/historians to form possible association or similar special-interest group. H Kent Craig, POB 975. Cary NC 27511. [919] 851-5017 evenings.

FOR SALE: Dot-matrix printer. Emako 20 (manufactured by C Koh). 60 lpm, pin feed, 96 ASCII characters, 80-column, with cable for TRS-80, plugs into expansion interface. Original \$770, asking \$400. Also, twelve 5-inch diskettes; \$2.50 each. Philip Crawford, 1720 E 1st St #10. Long Beach CA 90802. [213] 591-2484.

FOR SALE: Okidata Microline 80 printer with forms tractor, pin and friction feeds. State of the Arts 80 cps dot matrix. Includes parallel interface cable, 80- or 132-column. Excellent condition, complete with manual. \$500. Clay Roberts, POB 129. Comptche CA 95427. [707] 937-4753.

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WANTED: I am interested in exchanging ideas about possible ways computers can be used as an aid for guitar playing, in particular the application of computers for arranging and composing music on the guitar. I am currently writing a program that will find an optimum tuning for a given piece of music from the thousands that are possible. Bruce Johnston, 655 Sharp Ln 130. Baton Rouge LA 70815.

GIFT: HP-9100-A computing calculator. Sixteen registers store 197 steps. All math and trig functions, conditional jumps. In operating condition, but erratic. Will donate for cost of shipping. Winslow Palmer, 114 Montrose Dr. Fort Myers FL 33907. [813] 481-0027.

FOR SALE: APF Imagination Machine microcomputer. Power supply, RF modulator, cassette recorder, joysticks, and much software included—ready for hookup to television (it has color graphics and sound). Like new condition, over twenty programs, including Space Destroyers, Boxing, Baseball, and Hangman. The value of this system with software is over \$800, willing to sacrifice for \$600 or best offer. Bruce Chapman, 316 Newtown Rd. Richboro PA 18954.

FOR SALE: Pascal Microengine. Western Digital desk-top computer with 16-bit processor, 32 K words (64 K bytes) of programmable memory, floppy-disk controller, two RS-232C asynchronous/synchronous ports, and software (UCSD Pascal), \$3400. G Mann, 9 Aberdeen, Irvine CA 92714. [714] 731-6145.

FOR SALE: Z80 Starter Kit from S D Systems, assembled and tested. Will sell for \$325. Lee Rathbun, POB 126B, Minden NV 89423. [702] 782-4455.

FOR SALE: Altair 8800B with processor, front panel, and motherboard; \$400. 3P+S; \$100. 8 K static 300 ns; \$100. Two 216 16 K static memory boards; \$200 each. North Star single-density disk controller board; \$50. 4 K MITS static memory; \$75. Will sell as package for \$900. Bob Fiorella, 27 Kirkwood Dr. Glen Cove NY 11542. [516] 676-1480 after 6 PM ET.

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FOR SALE: 16 K Atari 800 personal computer. Brand new and unused. Unopened in original carton, with manual. Cost \$1080, for \$810 plus shipping. Atari disk drive, brand new. Cost \$700, for \$520 plus shipping. HP-97 desk-top programmable printing calculator, one month old. Cost \$750, for \$650 plus shipping. Extensive software library for Atari, TRS-80; write for details. Doug Solomon, 208 Overbrook, Freehold NJ 07728.

FOR SALE: SwTPC 6800 computer, 16 K programmable memory, teletypewriter interface, parallel interface, cassette recorder, cables, dual cassette recorder, 16 by 32 terminal, 64-character set, 9-inch black-and-white monitor. Complete with \$100 worth of software and 4 K and 8 K BASIC. Editor/Assembler tapes. Asking \$550 or best offer. John Antypas, 49 DeLaurenti Ct, Walnut Creek CA 94598. [415] 943-7409.

WANTED: Bally computer users. Would like to exchange information on the Bally home computer. Want old newsletters, system information, and read-only memory listings. If you know of a group (or person) using the Bally, I would like to have their mailing address. Also, give them my address so we can exchange information. Interested in additional unit at a good price, also other hardware. BALL.Yuser@exch. POB 28355, Columbus OH 43228.

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March BOMB Results

Gregg Williams and Franklin C Crow tied for first place for their articles, "Structured Programming and Structured Flowcharts" and "Three-Dimensional Computer Graphics, Part I." A check for \$100 will be sent to Mr Crow. (Being a BYTE employee, Gregg is not eligible for the prize money.) The second-place prize of \$50 goes to Tim Ahrens, Jack Browne, and Hunter Scales for their article, "What's Inside Radio Shack's Color Computer?" The next two places went to Steve Ciarcia's "Build the Disk-80" and Jim Howard's "What Is Good Documentation?"

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