

MAY 1980

Volume 5, Number 5

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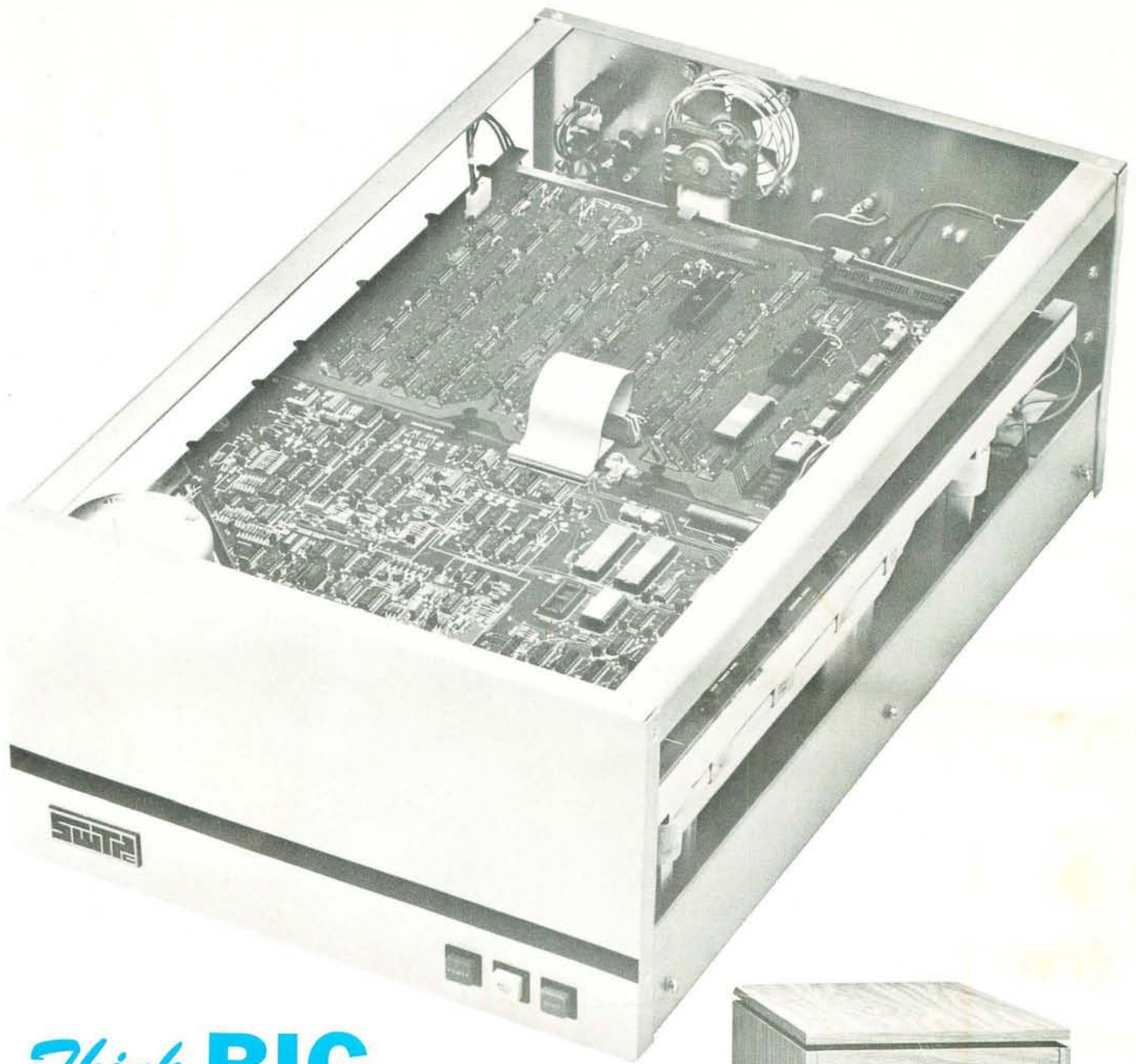
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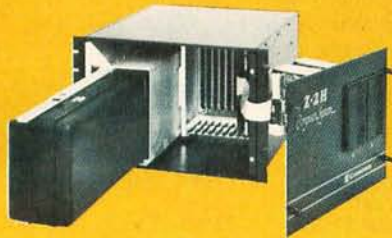
microcomputer field. Software Cromemco is known for. Software like this:

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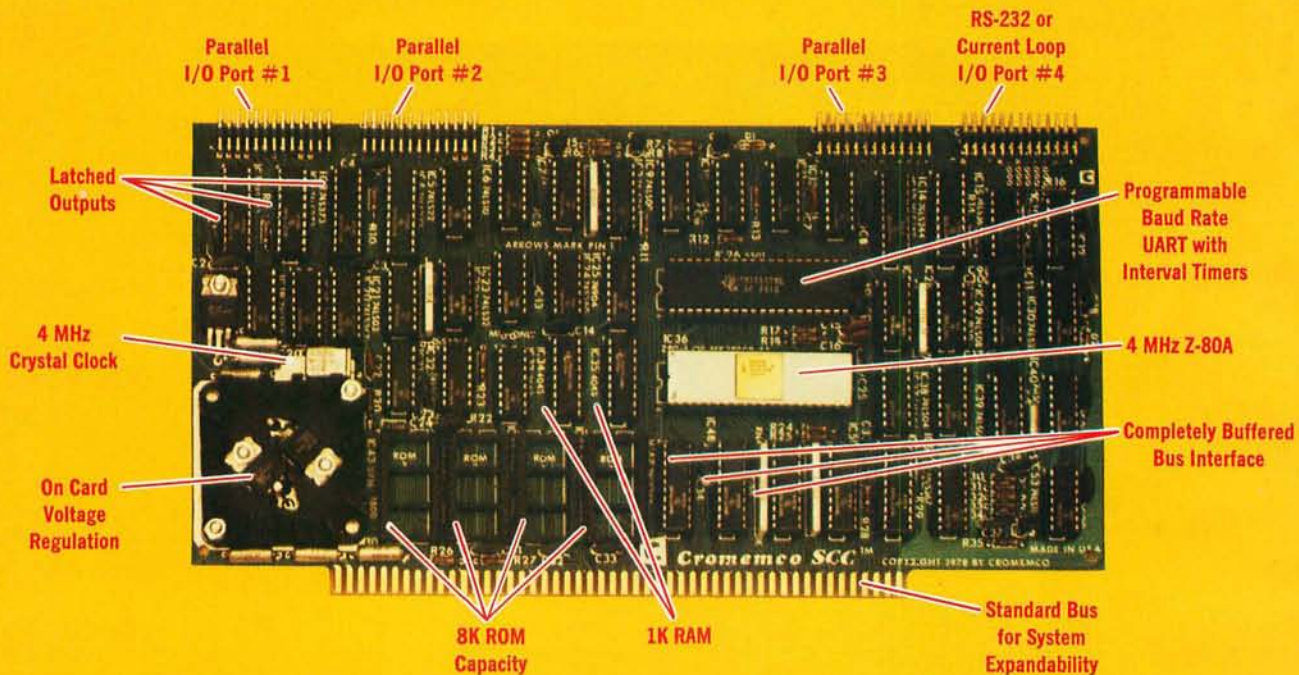
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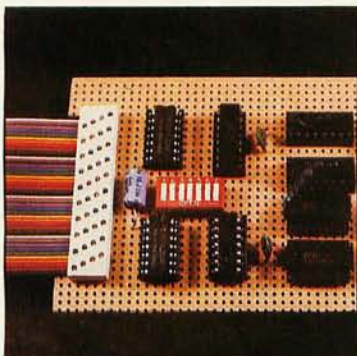
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page 6



page 22



ON LAST MONTH'S COVER

The April cover, which has received so many compliments, was a creation of the photographic artistry of Ed Crabtree. Ed is a professional commercial photographer in Peterborough, N H and has been BYTE's photographer from day one. This was Ed's first BYTE cover. We're sure it won't be his last.

Foreground

20 A DC-TO-DC CONVERTER *by Michael Picco*

Here's a simple converter that uses a standard integrated circuit for producing a 25 mA bipolar source from a single-ended power supply.

22 I/O EXPANSION FOR THE RADIO SHACK TRS-80, Part 1: Principles of Parallel Ports *by Steve Ciarcia*

This month Steve explains the operation of parallel input/output as a prelude to next month's design for an economical RS-232C interface.

44 KIMDOS, Using Your KIM-1 with a Percom Floppy-Disk Drive *by Joel Swank*

Using the LFD-400 disk-controller board, the KIM-1 can access up to 87.5 K data bytes on several 5-inch hard-sectored floppy-disk drives.

72 INTERFACE A FLOPPY-DISK DRIVE TO AN 8080A-BASED COMPUTER *by John Hoepfner*

Building a disk-controller board for a Shugart SA400 disk drive can be done easily and with commonly available parts.

196 GIVE YOUR COMPUTER AN EAR FOR NAMES *by Tom Munnecke*

With the Soundex code, you can locate people's names in your data base by similar, but not exact, spellings.

214 THE COSMAC DOODLER *by Jeff Duntemann*

An electronic sketchpad? Even a small system like the COSMAC ELF can draw designs using a video display.

250 ERROR CHECKING AND CORRECTING FOR YOUR COMPUTER *by Gregory J Walker*

Storage devices can introduce data errors. The system presented here can increase reliability and speed of these peripherals.

Background

12 THE CASSETTE LIVES ON, An Alternative to Floppy-Disk Mass Storage *by Emory Cook*

Floppy disks may be the glamorous way to store programs and data, but the cassette is far from obsolete.

104 A GRAPHICS TEXT EDITOR FOR MUSIC, Part 2: Algorithms *by Randolph Nelson*

The conclusion of this article sets forth the routines to create and use the various arrays described in part 1.

120 USING THE COMPUTER AS A MUSICIAN'S AMANUENSIS, Part 2: Going from Keyboard to Printed Score *by Jef Raskin*

Part 2 continues the examination of the subtle problems encountered when translating information from performance to written score.

130 COMPARING FLOPPY-DISK DRIVES BY SOFTWARE SIMULATION *by Dennis Nendza*

Now you can get some idea of the relative performance of different units by simulating their mechanical functions in a BASIC program.

202 THE CLUB COMPUTER NETWORK *by Joe Kasser*

If your club is considering to form a program- and data-exchange network, the telephone and amateur radio links described here will be a valuable source of ideas.

Nucleus

- | | | | |
|-----|--|-----|--------------------------------|
| 6 | Editorial: Computer-Controlled Viewing of the 1980 Eclipse | 226 | Book Reviews |
| 8 | Letters | 230 | Clubs and Newsletters |
| 144 | BYTELINES (formerly BYTE News) | 234 | BYTE's Bits |
| 152 | Technical Forum: Simplifying the Curve-Plotting Calculation by Geometric Means; Alpha Locking in Software; Maintaining a Single Exit Point | 236 | BYTE's Bugs |
| 190 | Programming Quickies: Decisions, Decisions; Formatted Program Out- | 238 | Event Queue |
| | | 280 | NCC Information |
| | | 286 | What's New? |
| | | 335 | Unclassified Ads, BOMB Results |
| | | 336 | Reader Service, BOMB |

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ON THE COVER

On May's cover, Robert Tinney has formed an abstraction of the most important medium of mass storage in today's era of small computers, the floppy disk. Heightening its shimmering mystery, we find a disk wavering in the heat above some desert landscape. To enlighten you, this issue features several articles that present valuable information about floppy-disk technology. This technology is no mirage — it will even work well in a similar, hot environment of East Africa, as the editorial on page 6 describes.

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 **Shugart**

6 May 1980 © BYTE Publications Inc

Editorial

Computer-Controlled Viewing of the 1980 Eclipse

by Carl Helmers

As noted in the March 1980 editorial, I traveled to Kenya in East Africa to observe the 1980 total solar eclipse with an Apple II Pascal system controlling the photographing of the event. This month's editorial is a commentary about the experience. This commentary was written upon my return to New Hampshire a week after the eclipse.

The final preparations for the Kenya eclipse of 1980 were made in an intensive session of 24-hour workdays, February 2, 3, 4, and 5. One physiological consequence of no sleep for 3 or 4 days is that when traveling through 8 time zones there is no possibility for jet lag! One's body is so tired that all memory of the previous time zone is erased completely. Norm Whyte and Laurel Allen, who coordinated many of the details of the trip to Kenya, arrived in Boston from California on the second of February and spent the weekend at my home. During this final weekend's activity, we each had several chores to finish. One detail, for example, was making sure that both computers would operate simultaneously off Norm's portable Honda AC generator. Another was adding a hardwood extension to Norm's telescope mount so that my camera could be attached along with his.

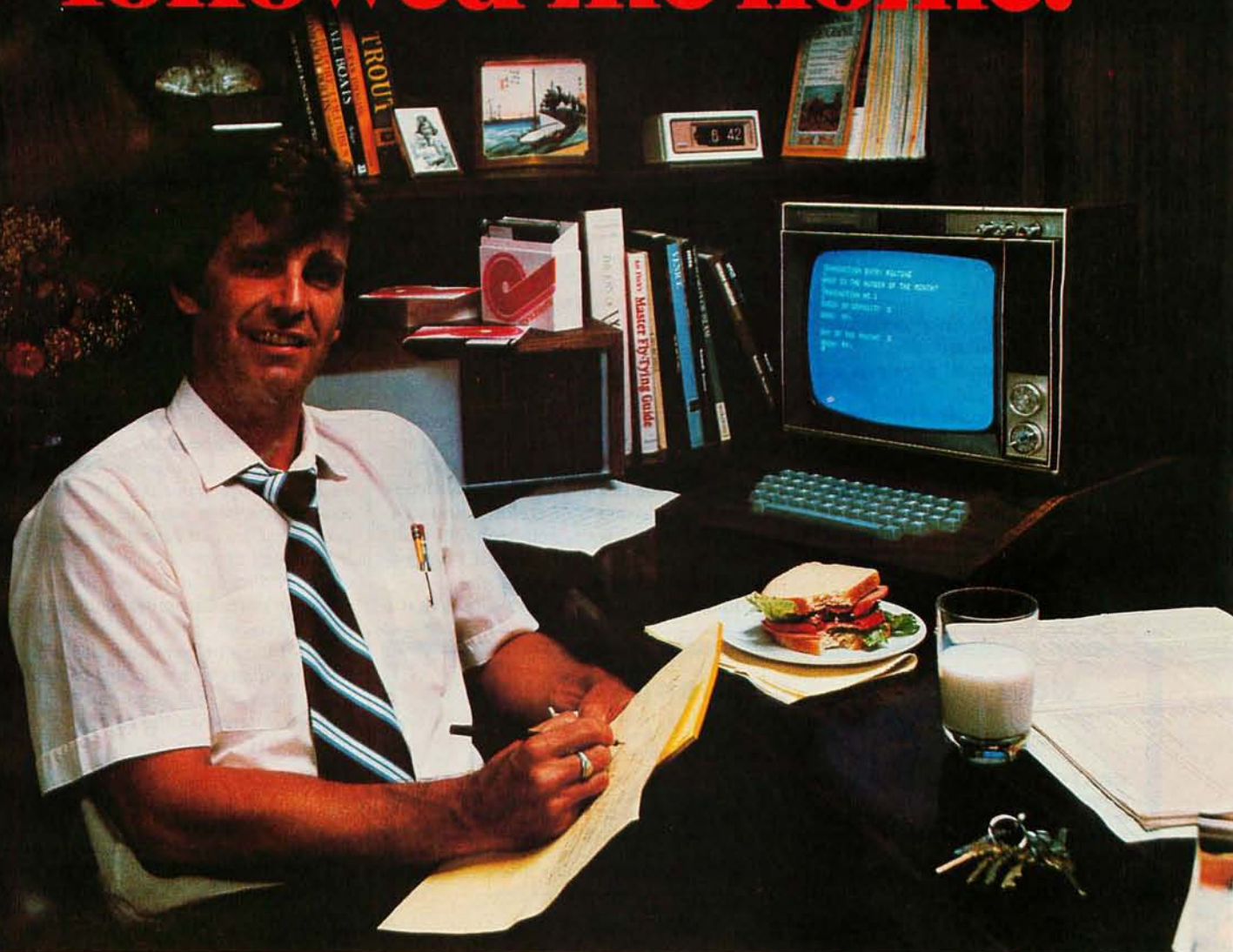
In connection with the program design of my experiment, a number of crucial points had to be verified. With the time allocation procedures completed as described in the March 1980 editorial, writing the real-time procedures to execute the time line proved trivial. These were the procedures left in dummy form in the listing 1 published with the March 1980 editorial. In listing 1 accompanying this editorial, readers will find the final form of the program I used. In approaching this final form I implemented the execution routines using a module named "milli" to carry out time delays of an integer number of milliseconds. The program itself was verified by driving the camera interface using a first approximation to "milli" in the form of Pascal dummy loops used to count time.

Originally I hoped that (by fortuitous circumstance) I could use some combination of Pascal statements in a loop to provide time delays in units of milliseconds. But, after perhaps an hour of fooling with various combinations, I came to the conclusion that this would not be possible. I was either 6% too slow or 6% too fast depending on whether or not I put a unary negation in a timing loop's dummy assignment statement.

Since program development time was limited by a departure schedule, it soon became apparent that the lesser of two evils (imprecision or assembly language) was to write an assembly-language routine called "milli" that links to Pascal with a single integer parameter specifying a loop delay time in milliseconds. I finished this necessary step sometime in the wee hours of February 4. I checked the accuracy with various simple test programs written in Pascal. Of course, my timing assumption was that zero time would be spent outside of "milli" executing the Pascal code of the actual program. This assumption was verified with test runs of the whole eclipse photography sequence, which showed about 1% error. By adjusting the constants in the delay routine slightly, this error was compensated at the gross level of the entire eclipse sequence's 241-second execution time.

Text continued on page 52

"My Shugart followed me home."



"After working all day with the computer at work, it's a kick to get down to Basic at home. And one thing that makes it more fun is my Shugart minifloppy™. We use Shugart drives at work, so when I bought my own system I made sure it had a minifloppy drive.

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See opposite page for list of manufacturers featuring Shugart's minifloppy in their systems.

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Letters

Information on Potter Printer Needed

Can a reader of BYTE help me? I recently purchased a printer from salvage, and I hoped to obtain documentation and a schematic diagram from the manufacturer.

The printer is a Potter Model LP-3000, manufactured by the Potter Instrument Company, formerly of Plainville, New York. I called the firm, and I was told:

- 1) The company is in the process of moving to New Hampshire.
- 2) This particular model of printer is obsolete.
- 3) They have no documentation or schematic for this model.

From my examination of the circuits and machinery, I believe the Potter LP-3000 is a daisy-wheel type with a serial data input. However, whether it uses ASCII or not, I can't tell.

Can someone tell me how I can inter-

face this printer to my Radio Shack TRS-80 Model I Level II computer with expansion interface?

Nick Tountas
838 Juniper Rd
Glenview IL 60025

Questioning "Affordable"!

When you are on Social Security, an affordable computer system that costs \$6000 is like "# @ *"! When your monthly income is \$360, to have an editor smugly talk of plunking down \$6000 cash as if it were a minor outlay tends to be very irritating.

On top of that, the system Mr Helmers described is just the sort (with minor modifications) I have wanted for ages. Another thing that hurts is the industry-wide disinclination to even consider time payments or credit. I know that I'll have to wait, and probably wait over 5 years, but maybe not. If I were just disgusted with your editorial, I wouldn't have bothered to write. What I

would like to know is if any BYTE reader knows of a way I can obtain such a system as Mr Helmers described — perhaps secondhand — without paying thousands of dollars cash? By squeezing, I can afford \$100 a month now, and by July I should be able to afford \$150 a month, perhaps more.

In a way, I have to thank Mr Helmers for that editorial. It made me mad enough to write, and perhaps there is a solution to my problem.

Fred J Remus Jr
POB 2453
San Diego CA 92112

Carl Helmers Replies

Give the industry time. Five years ago, the same system might have been well in excess of \$30,000, with inferior programming languages and comparable on-line storage capacity. Tremendous strides have been made in the past 5 years, and we can expect a certain leveling-off of prices in the future as mass production at 100,000 unit levels per year starts becoming reality. And then, of course, one looks at it from the point of view of increasing demand for these products. If we do not write about the conception of a good machine, we have no interest on the part of users....CH

Gomoku

I was interested in the "Programming Quickie" by John Allwork ("BASIC Game: GOBANG," November 1979 BYTE, page 56) for Gobang is also called "Gomoku." There has been a competition running for Gomoku programs since 1975; I am the current champion. People interested in the contest should contact:

Shem Wang
Dept of Computer and Information
Science
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Guelph, Ontario, CANADA

So far my different programs have run on large mainframe computers, but I hope to have one working on my North Star microcomputer for the next round of competition.

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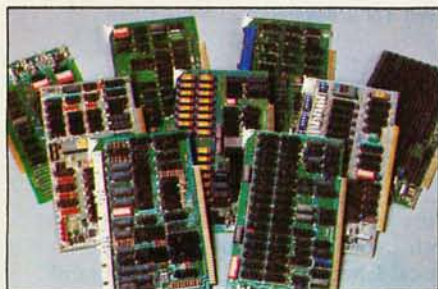
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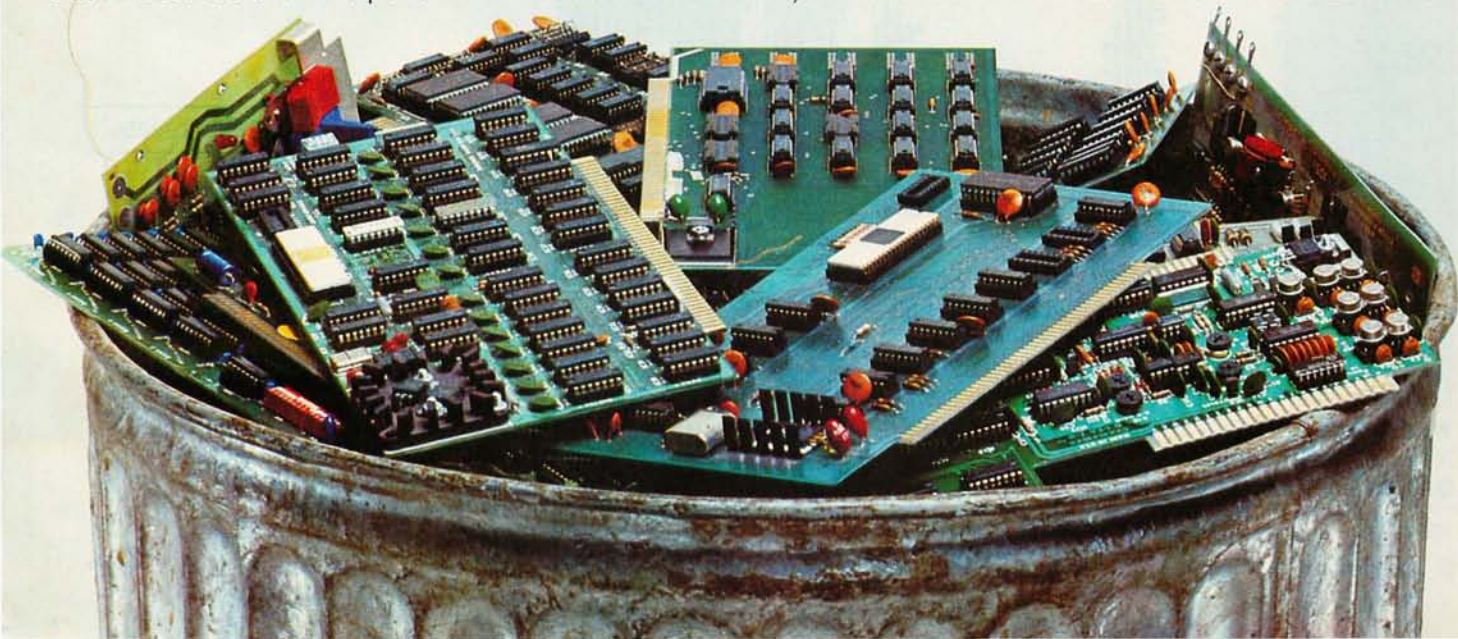
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Whatever your needs, why dump your money into obsolete products labelled "IEEE timing compatible" or other words people use to make up for a lack of product. See the future now, at your Intersystems dealer or call/write for our new catalog. We'll tell you all about Series II and the new IEEE S-100 Bus we helped pioneer. Because it doesn't make sense to buy yesterday's products when tomorrow's are already here.

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Searching for FORTRAN Compiler

I am an avid reader of BYTE and I believe that one of my fellow readers may be able to help me with a problem.

My school is thinking about expanding the courses that are offered in the area of computer science. It is hoped that an extensive course in FORTRAN programming may be offered.

Our computer is a CIP/2200 manufactured by the Cincinnati Milacron Corporation. It has a small disk-operating system and a card reader. The word size is 32 bits, and, at this point in time, the memory size is 32 K bytes. There are plans, however, to expand the memory to 64 K bytes by the time the FORTRAN course is offered.

My problem is that the Cincinnati Milacron Corporation does not make a FORTRAN compiler for our machine. I would like to know if any reader of BYTE could suggest any companies that might sell a compiler that is compatible with our machine.

Daniell B McCormick
Box 675
Presbyterian College
Clinton SC 29325

Seeking Computers for the Blind

Does any reader of BYTE know of a source for a computer system that uses audible output instead of characters displayed on a terminal for its customary interaction with the user, such as that produced by the Votrax speech interface? Such a computer system would be used by blind people. It would be desirable if a BASIC interpreter that used audible output were included.

If anyone has or knows of such a system, please contact me.

Walter F Keleher
56 Robin St
Rochester NY 14613

Altair BASIC Patch Needed

I wonder if any BYTE readers could assist me in locating the patch to Altair 8 K 4.0 Version and Altair Extended 4.0 Version BASICs which will allow these BASICs to run on a Z80.

I recently purchased a TDL ZPU which uses the Z80. The manual notes

this incompatibility stating that Altair BASIC "has as part of its routines several occasions where the parity flag is checked as part of the function. In the Z80 the parity flag indicates OVERFLOW during math routines, not parity." The manual states that it contains a patch in Appendix C, but no Appendix C is included.

If any reader of BYTE knows where this patch may be obtained, please let me know.

Hugh Morgan
7725 Berkshire Blvd
Powell TN 37849

Pascal Examples Needed

Just a short note to tell you how very much I appreciated Carl Helmers' "Pascal Checkbook Balancing Program" which appeared in the January 1980 BYTE.

As a beginner, I don't think he "profaned" Pascal by writing a simple little ... etc. The program was *most informative*, and I studied it in detail. I have adapted it to the formulation of a metrics conversion program. It was certainly clearer than most of the program examples in the few, but confusing, texts on Pascal.

I realize that in general BYTE magazine caters to the experienced programmer, but what we need are more examples like yours—the we being those of us relatively new to the art.

So thank you once again—and *please* some more tutorials and programs!

Max Nareff
5235 Diamond Heights Blvd
San Francisco CA 94131

A Satisfied Reader Comments

I couldn't believe it! Ted Carter's article "Implementing Dynamic Data Structures with BASIC Files" (February 1980 BYTE, page 92) was exactly what I needed for a program I am writing to computerize billing on a newspaper route.

I had tentatively planned my file routines, but I scrapped my ideas after reading the article.

James E Nichol
1416 Oak Knoll Dr
Cincinnati OH 45224 ■



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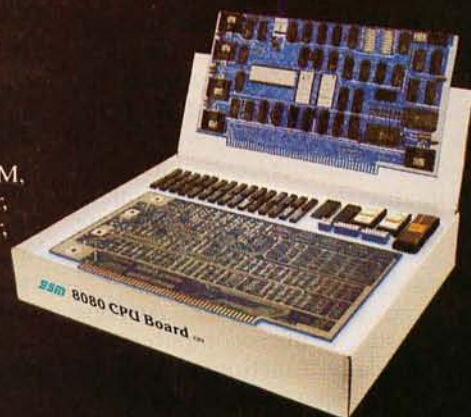
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The Cassette Lives On

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Emory Cook
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In a world where floppy and hard disks are becoming more affordable for the average small-business user and hobbyist, sequential mass storage in the form of cassette tape is gaining disfavor. Still, many disk users get into trouble when something happens to a floppy disk and they have *not* made backup copies. Although any backup system requires the time and inconvenience of regularly carrying out the file-copying procedure, one problem with using floppy disks for file backup is the cumulative cost of the number of disks needed to maintain backup copies of all records.

The Cassette Solution

What is needed is a low-cost filing medium. Cassette storage is the answer, provided we take the necessary precautions to make it reliable. Old files, such as files of records for last quarter, last year, and the years before, *belong* on cassette. The disk-to-cassette transfer for backup purposes becomes sensible in terms of both expense and security. With adequate tape recorders and high-quality cassette tapes (which use both quality tape material and quality mechanical housings) cassette storage can and does become highly dependable.

Let's go a step further. Anyone who is using a microcomputer and needs its daily functioning will be acquiring a spare microprocessor. With a three-head, audio-cassette

machine, which has a separate playback head following the record head (a common piece of high-fidelity equipment), the spare microprocessor can readily be set up with a machine-language program. This program verifies a backup tape by reading the information immediately as the tape is written. [*The same result can be accomplished (a bit slower, however) for those of us who cannot afford a spare microprocessor board or an expensive cassette recorder. This can be attained by using a verification program running on the same microprocessor to reread the newly created tape and compare its information with the contents of computer memory....GW*]

Floppy disks may be a glamorous way to store programs and data, but the cassette is far from dead.

When records are backed up at the end of some reasonable period (ie: day, week, month, etc), the extra time needed to dump the records to cassette at a low transfer rate is not an overwhelming disadvantage. A second backup tape simultaneously made with a second recorder is always a good idea. In other cases, one cassette copy can simply serve as

a backup for printed records, thus saving time, printer wear, ribbons, and paper.

For even the most inexpensive cassette deck, a small amount of money and attention can result in the following:

- excellent performance and reliability (no more trial-and-error adjustment of the volume control)
- a very low error rate (statistically as good as that of a 5-inch floppy disk)
- the lowest possible cost per bit stored

Problems with Cassette Storage

The main problems with currently used cassette-storage methods are dirt, variation in tape speed, problems with azimuth alignment, and inferior tape quality.

Dirt collects on the tape recorder head from several sources, from the room, from dust left on poorly manufactured tapes, and sometimes from sweaty fingers attempting to wipe the head clean. The tape head and the pressure roller can be cleaned using pure alcohol and a cotton-tipped swab.

Periodic cleaning is imperative when using poorly manufactured tapes. Cassette tapes are manufactured by slitting a 30.5 cm (12-inch) wide sheet of magnetic material called a *web*. Slitting is accomplished with knives, which often get dull from cut-

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ting the inherently abrasive magnetic coating. If the knives are not periodically sharpened (which is the case in making some inexpensive cassettes), the dull knives cause a fine powder of magnetic coating to collect on the edges of the tape. As a result, abrasive magnetic powders come in contact with the tape head when the cassette is later played. The poorer the quality of the tape, the greater the chance that this is occurring.

Variation in tape speed can be caused by belts slipping within the cassette recorder, but it is more often caused by flaws in the pressure roller, which with the capstan is meant to push the tape through the machine at a constant speed. Leaving the tape recorder set in play mode with the motor disengaged (as is done in several current personal computer systems that let the computer control the tape motor) may eventually cause indentations on the pressure roller, with some inevitable variation in tape speed. This variation impairs the reliability and the data-transfer rate of the cassette interface, so it is important to keep the pressure roller clean at all times and disengaged when not in use.

Azimuth of the tape head refers to the angle between an imaginary line drawn in the direction of tape movement and the vertical, magnetic gap on the record/playback head of the cassette recorder. This angle should be 90°—that is, the tape should run

straight across the tape head, perpendicular to the magnetic gap. If the tape head is somehow knocked out of alignment (which happens frequently, although nobody knows how), it must be restored if the tape recorder is to faithfully play back a recorded tape.

There is an adjustment mechanism, usually a small Phillips screw, on the left-hand side of most tape heads. However, some tape recorders do not allow you to reach the mechanism when the recorder is in the play mode. Because of this, it is important to do one of two things: either buy a cassette recorder that has an azimuth access hole, or have a good craftsman carefully drill a hole over the screw so that it can be reached with a tiny screwdriver when the recorder is in the play mode.

Recording with a Peak-Signal-Strength Meter

It is the peak output, *not* the average or the root-mean-square value of the cassette signal, that most tape interfaces are sensitive to. In order to repeatedly load cassette tapes on the first try, you must be able to send a signal of known strength to the cassette interface. However, most computer systems give us no feedback on cassette signal strength—in other words, we are operating “blindly.” Let us use the TRS-80 Level II tape format as an example. The cassette input port terminates within

the TRS-80 with a resistance of 100 ohms. A signal from the cassette with a peak level of about 2 V is needed to insure a correct load. If the cassette record/playback head is correctly aligned with the tape, and the signal is adjusted (via the volume control and our peak-signal-strength meter) to a peak level of 2 V, then the TRS-80 (or whatever computer you have) should load correctly every time.

Figure 1 presents the circuit for a peak-signal-strength meter. The signal from the cassette recorder comes in jack 1 and goes out jack 2 to the computer. Two halves of an LM358N dual operational-amplifier device are used to create a circuit that is highly sensitive to voltage changes in the 2 V region.

Although component layout is not critical, a full-size, printed-circuit-board pattern for this circuit is given in figure 2. A 9 V transistor radio battery will have a life of around 2000 hours of continuous use. The unit can be calibrated by marking the milliammeter dial while applying a known voltage from a DC 1.5 V flashlight battery cell; the reading should not change significantly when the polarity of the input voltage is reversed. The circuit is reasonably accurate in measuring peak voltages of signals with a frequency of up to 20 kHz, and it will then give good accurate readings as long as the 9 V battery supplies 5 V or greater.

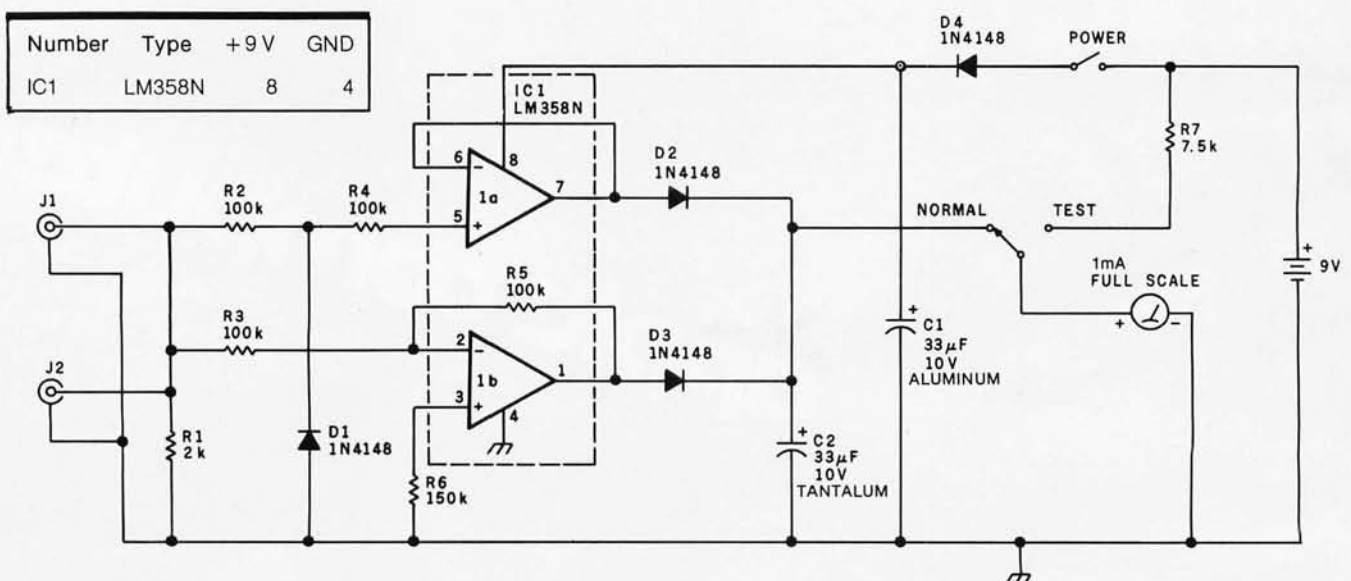
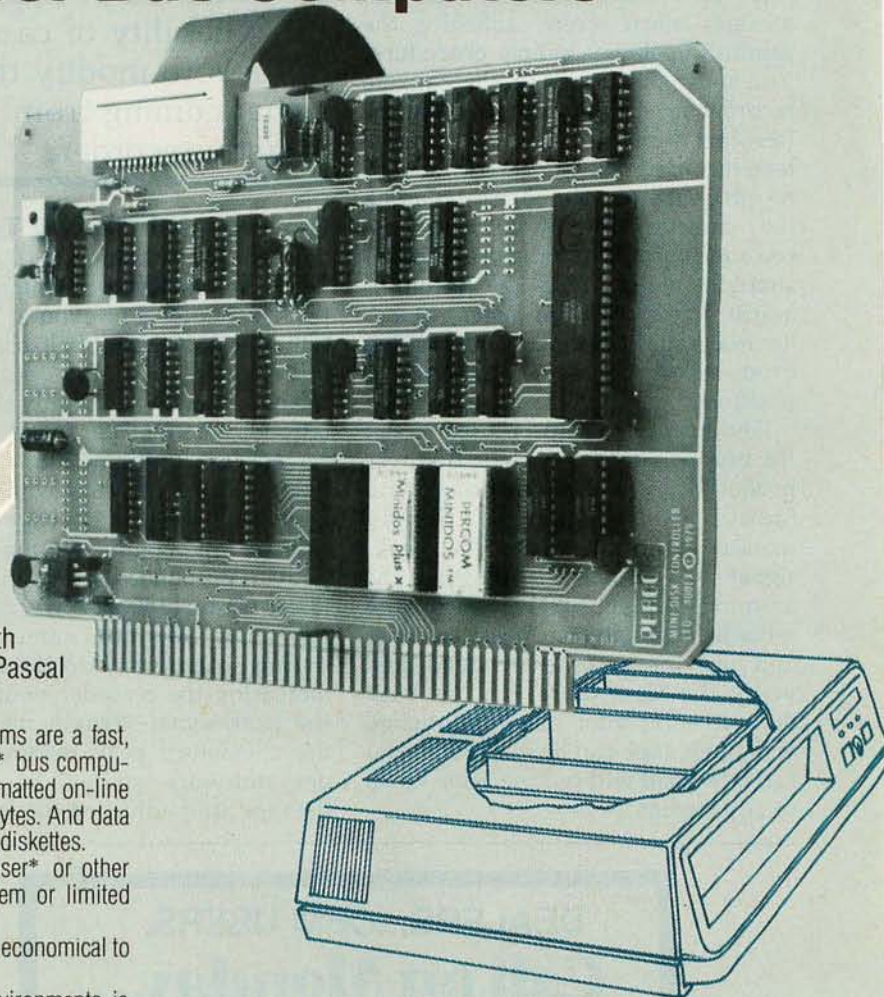


Figure 1: Schematic diagram of peak-signal-strength meter. This meter enables the user to present the cassette interface with a signal of known peak intensity—usually, about 2 V. The circuit is designed to be sensitive to voltage changes around the 2 V area.

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Checking the Recorder Azimuth

If your tape recorder has an azimuth-adjust screw, adjusting the azimuth angle is a simple procedure. You must first place in the cassette recorder an azimuth-calibration tape (see text box) or a similar cassette tape recorded on a machine *known* to be properly aligned. Then, playing the cassette and monitoring the recorder output with the peak-signal-strength meter, turn the azimuth-adjust screw until the meter reaches its maximum reading. The reading drops off on both sides of the optimal position.

The meter can also be used to get the best reading from a tape that was produced on a tape recorder with faulty head alignment. Simply monitor that tape with the peak-signal-strength meter, adjusting the azimuth-adjust screw until the recorder gives the strongest reading, and use the recorder to load and verify the tape. Once this has been done, the recorder can be realigned and a new tape can be made that you can later load without the same kinds of adjustment.

One method of improving the reliability of cassette tapes is to modify the signal coming from the cassette recorder.

Problems with Reading Tapes

With most computers, you will need to load a tape using an input peak-signal level of about 2 V (which will appear as about half-scale on the milliammeter of the peak-signal-strength meter). With only slight variations due to a particular computer/recorder combination, the same reading from the peak-signal-strength meter will result in effective loads. A cassette tape coming from a recorder with a misaligned head will give a lower reading than a correctly recorded tape for the same volume setting. First try to load the tape after increasing the recorder volume until the peak-signal-strength meter gives the customary peak reading. If this does not work, you will have to load the tape after adjusting the azimuth in

the manner previously described.

Whenever the tape head is misaligned with respect to the tape path, the peak-signal intensity will flutter, even if the tape being played was recorded correctly. This effect is called *skew*. If the signal variation is severe enough, you will be unable to load the tape properly due to data dropout. Signal flutter due to skew is a subtle problem; it will not show on a meter because no meter needle can move fast enough to follow the flutter.

Flutter can also be caused by *tape weave*, which has a variety of causes. If the pressure pad opposite the record/playback head is not positioned properly, it will tend to push the tape away from the center of the head. This is aggravated by the fact that most cassette recorders do not maintain tension on the supply reel, allowing the pressure pad to pull out tape freely and push the tape away from the center line of the head. Also, a tape with a thin backing is more susceptible to tape weave.

Altering Tape Waveforms

Another method of improving the reliability of cassette tapes is to modify (and sometimes rerecord) the signal coming from the cassette recorder. For example, several waveform-changing interfaces that improve the loading reliability of the cassette are available for the Radio

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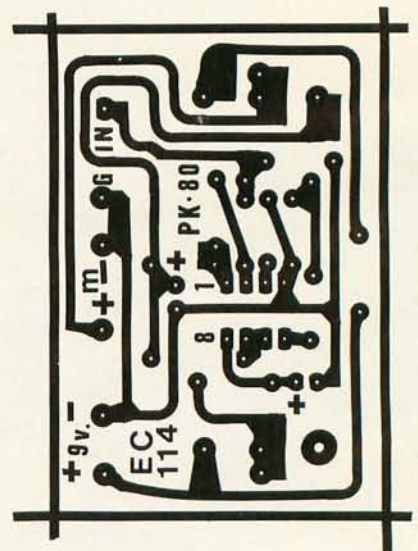
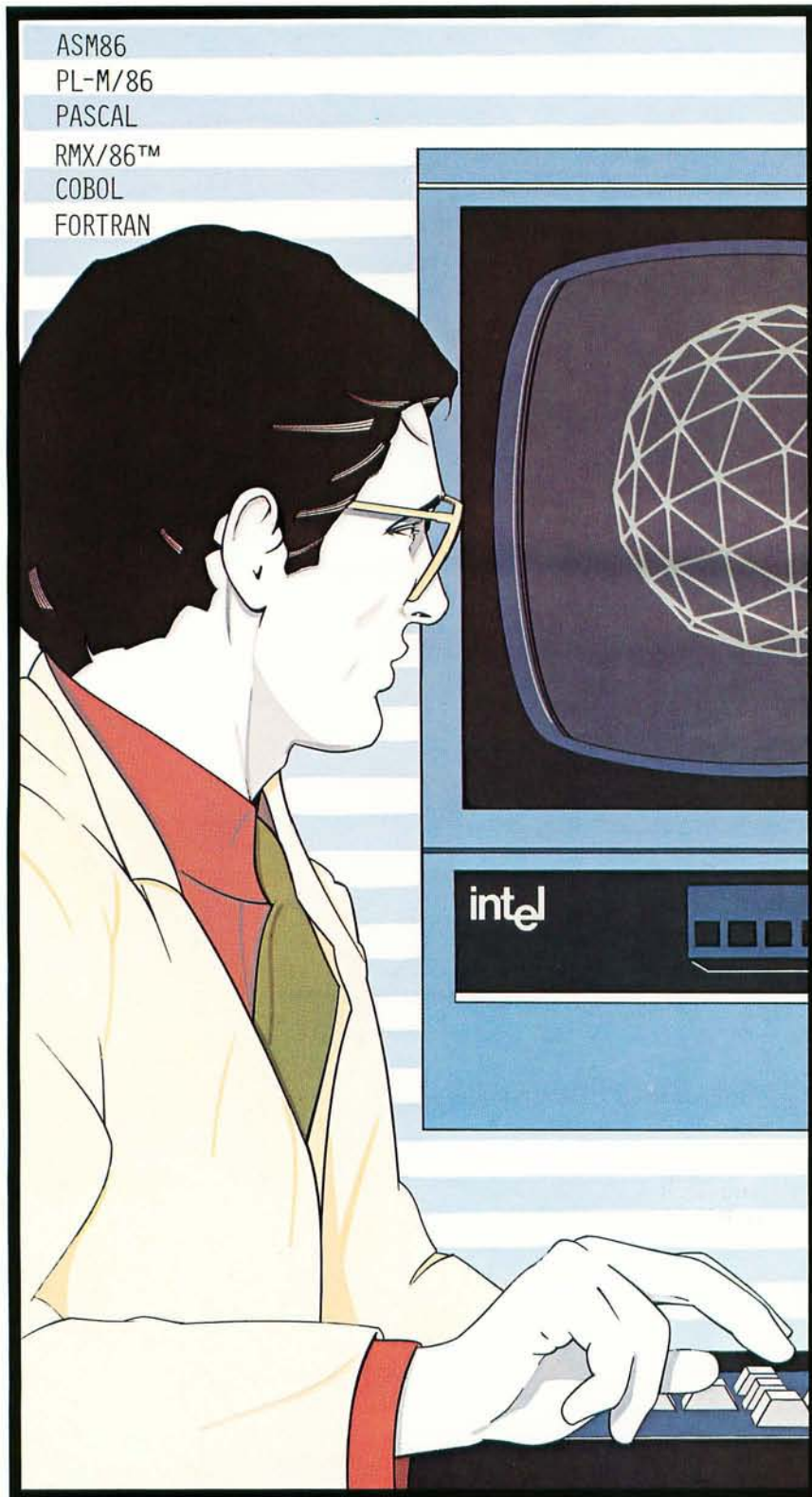


Figure 2: Full-sized, printed-circuit-board pattern for the peak-signal-strength meter circuit of figure 1.

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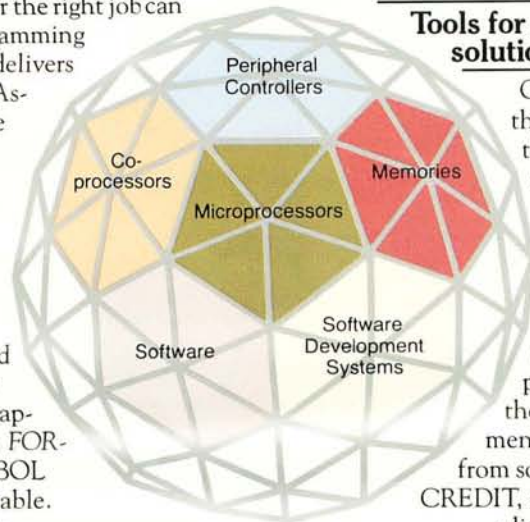
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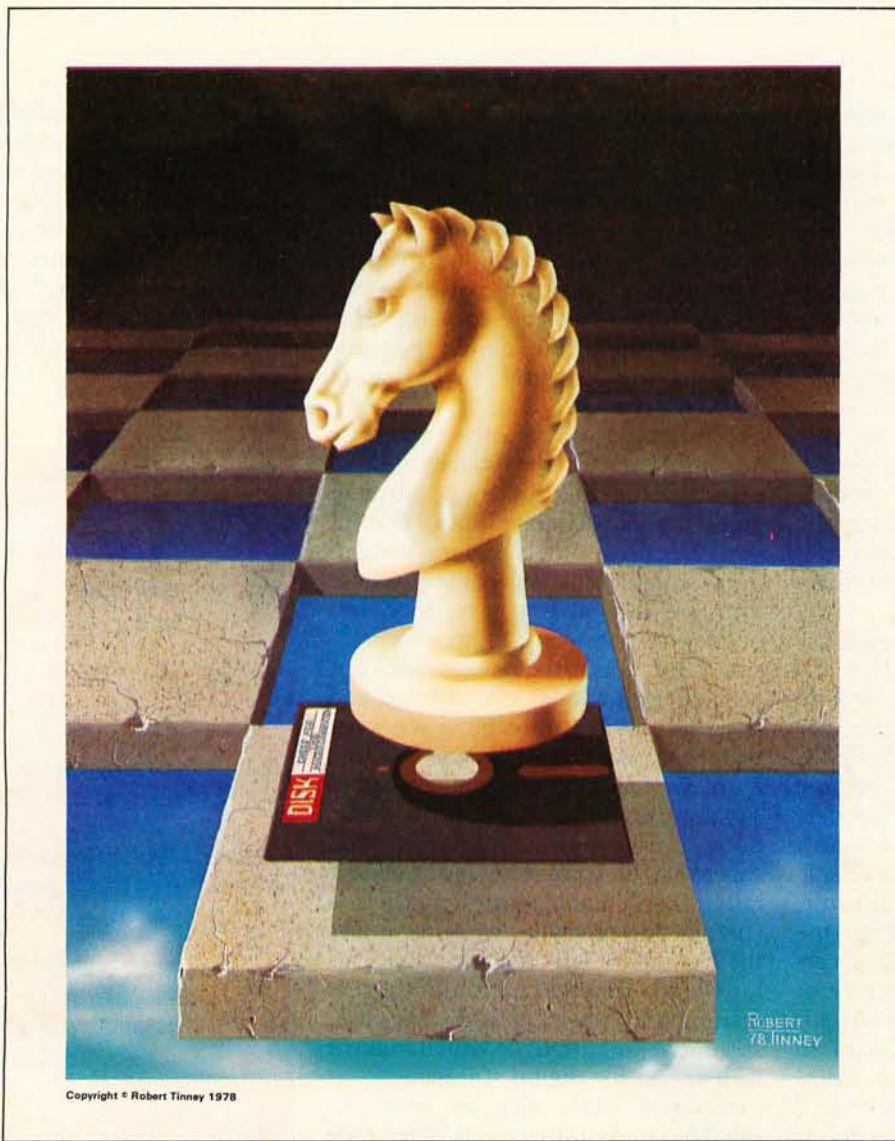
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Shack TRS-80. About two winters ago here at Cook Laboratories, we developed a modified tape format that records more reliably on the TRS-80. Without going into the details of the TRS-80 tape format, I can say that the unaltered tape signal crowds too much information into a given space and thus opens itself to reliability as well as saturation problems. The latter problem is what makes the TRS-80 normally so volume sensitive. The waveform we use at Cook Laboratories, when recording tapes for the TRS-80, reorders the waveform shape and narrows the pulse width so that the cassette interface does not get confused.

The various waveform modifications could certainly be used to improve the reliability of the cassette storage on other microcomputers. For example, on the old-model PETs, there is no way to alter the volume level of the built-in cassette recorder. However, Commodore can provide a documented program called S-21. This program, when running, monitors tape being played in the PET cassette deck and displays certain information about the quality of the tape signal on the PET screen. This is a very effective program to have if you know how to use it; Commodore is the only manufacturer I know that supplies a program like it.

Tape Is Also a Factor

Several factors having to do with

the cassette tape itself can also affect the reliability of tape loading. As I mentioned before, a tape that is too thin will likely give in to tape weave. Tape stiffness is a property of the thickness of the backing and is proportional to the third power of the gauge thickness of the backing. This indicates that you should not use long-playing cassettes for program and data storage.

The thickness of the magnetic coating affects the reliability of cassette storage, but in a different way. Standard audio tapes, chromium dioxide or otherwise, are not optimal for digital recording because they are designed to give good frequency response in the low frequencies. But low frequencies are not needed here; rather, well-defined and sharp waveform transitions are what count. A thinner magnetic coating than what is used in standard audio cassettes results in nice improvements both in waveform resolution and sharpness of transition. Not incidentally, Cook Laboratories markets a custom line of digital cassettes under the trademark MICROFUSION. This tape has a thinner chromium dioxide coating and a heavier and, therefore, stiffer backing, both of which make it well suited for digital storage.

Cassette tapes can be used for reliable mass storage if the tape recorder is kept clean and properly aligned, if quality tape (especially tape made for digital storage) is used,

and if the signal going from the cassette to the computer is monitored and kept constant (from tape to tape) with a peak-signal-strength meter. Although disks are readily available and bubble memories are not far away, no medium will ever become obsolete as long as it provides a needed function. Cassettes, too, are here to stay. ■

The following items are available from Cook Laboratories, 375 Ely Ave, Norwalk CT 06854:

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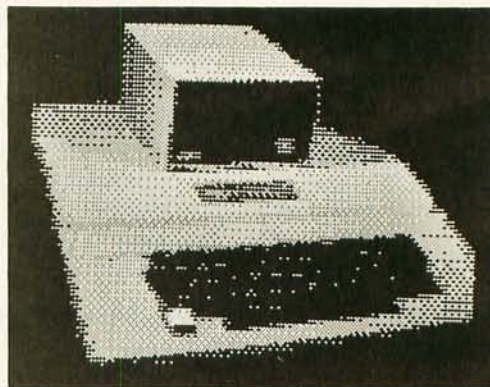
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The heart of this circuit is a 555 timer that provides a drive signal of approximately 20 kHz to a voltage doubler. This signal is removed if the

magnitude of the output voltage exceeds that of the supply voltage. In this sense, the converter operates as a switching-mode regulator.

The output voltage is set by controlling the timer via the reset input (ie: pin 4). When the output voltage reaches a negative potential with the same magnitude as the supply voltage, a low logic state is placed on the reset input, causing the timer output to go low and the increase in voltage magnitude to cease. ■

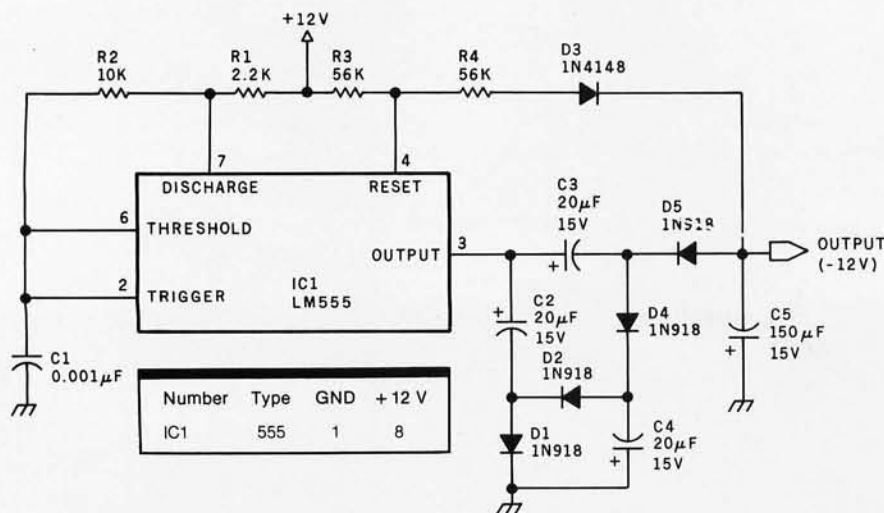


Figure 1: Schematic for the DC-to-DC converter. The 555 timer produces a rectangular wave at about 20 kHz, which is inverted by the diode-capacitor voltage-doubler arrangement. A feedback signal reaching the reset pin of the 555 regulates the magnitude of the output, which is -12 V at 25 mA.

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I/O Expansion for the Radio Shack TRS-80

Part 1: Principles of Parallel Ports

Steve Ciarcia
POB 582
Glastonbury CT 06033

I receive a lot of mail: enough that I'm beginning to feel like the "Dear Abby" of the personal computer ranks. The sources of the letters range from high school students asking for advice on science fair projects to major corporations seeking consultant services. Even though it takes considerable time to answer this mail, I regard it as a significant opportunity to gauge reader interest. Every letter in some way contributes to my choice of article topics, either through suggestions or by continued occurrence of similar questions.

Recently, my mail has been dominated by owners of the Radio Shack TRS-80 Model I thirsting for hardware expansion by means other than Tandy Corporation equipment. The majority of questions concern connection of my interfaces to the TRS-80 expansion connector.

In general, I have tried to present projects that are computer independent. That is, the interfaces described are driven through parallel input/output (I/O) ports rather than directly from a computer bus. This had not been a problem in the past, because virtually all of the early personal computers incorporated some parallel I/O capability. For those experimenters interested in enhanced I/O capabilities, I presented the article

"Memory-Mapped I/O" in the November 1977 BYTE on page 10 (reprinted in *Ciarcia's Circuit Cellar* Volume I, BYTE Books), which detailed parallel-port construction.

In the 2½ years since that article was first published, a number of

A port is a hardware channel for the computer to transmit and to receive data via an external peripheral device.

significant changes have occurred in personal computing. Most importantly, the Radio Shack TRS-80, the Apple II and the Commodore PET were introduced. The difficulty in maintaining and operating a computer is no longer a serious consideration for most computer enthusiasts. Much of my mail indicates that a new explanation of parallel and serial I/O is in order, and that it is time for hardware-expansion circuits to be detailed.

This month's *Ciarcia's Circuit Cellar* is the first of a two-part article on serial and parallel I/O port expansion of the TRS-80. The first part em-

phasizes parallel I/O, and the second part is concerned with serial interfacing. The result will be a complete Radio Shack software-compatible communications interface capable of supporting a variety of serial- and parallel-interfaced peripheral devices. The hardware was designed and the components were selected to be economical to build and easy to check out. First, here is a brief review of the basics.

What Is an I/O Port?

Just as some people are initially confused with the terms *hardware* and *software*, some find the concept of input and output ports difficult to understand without substantial explanation. The classical definition: a *port* is a hardware channel for the computer to transmit and receive *data* via an *external* peripheral device. The key words in this definition are *external* and *data* which imply externally collected information; the channel through which this data is obtained is called a *port*. A printer is a typical external peripheral device. The characters to be printed are sent from the computer to the printer. In some of the more sophisticated units, status signals such as *busy* and *out of paper* are returned to the computer from the printer.

Ports can be either parallel or serial. In *parallel* mode, data is transferred in increments equivalent to the word size of the computer. On the Z80, for instance, an 8-bit microprocessor, an output instruction through a parallel port transfers 8 bits at a time. A 16-bit processor such as the Intel 8086 transfers data in 16-bit increments. The number of bits transmitted simultaneously by a parallel port is dependent upon the size of the microprocessor data bus and how many bits the processor can transfer simultaneously.

However, serial data is always transmitted a single bit at a time, according to a fixed schedule defined by the data rate (usually expressed in bits per second, or *bps*) and a few specific options. The microprocessor has no single instruction that transmits serial data. It must rely on another device called a universal asynchronous receiver/transmitter (UART) to put the data word into serial form and transmit it. Any communication between the processor and the UART is in parallel form and is done through the processor's memory reference or I/O data-transfer instructions. A more in-depth discussion of serial ports will be presented next month in Part 2.

Address, Data, and Control Buses

Consider a computer system that includes a printer, video terminal with keyboard, and an audio cassette recorder with keyboard, and an audio cassette recorder. Data would have to be relayed to the printer, to and from the video terminal, and to and from the cassette recorder. How can the computer tell the difference between data destined for the terminal and the data destined for the printer?

Most microprocessors incorporate a bidirectional *data bus* and an *address bus*: this is shown in figure 1. To keep track of the data transfer between the processor and its peripherals, the system uses a quantity of control signals which together can be called the *control bus*. The usual 8-bit processor has an 8-bit data bus, a 16-bit address bus, and a dozen or so control signals.

When the microprocessor is reading a data byte from memory, the address of the memory location being referenced is placed on the address bus. Memory information stored at

that location goes on the data bus and flows from memory to the processor. When data is being written into memory, the operation is reversed. A 16-bit address bus allows the processor to directly address 65,532 (ie: 64 K) memory locations.

In an 8080 or Z80 processor there is a specific set of instructions that perform input/output functions. The operation of these I/O instructions is similar to that of memory-reference instructions, except that only 8 bits of the address bus are used. These 8 bits

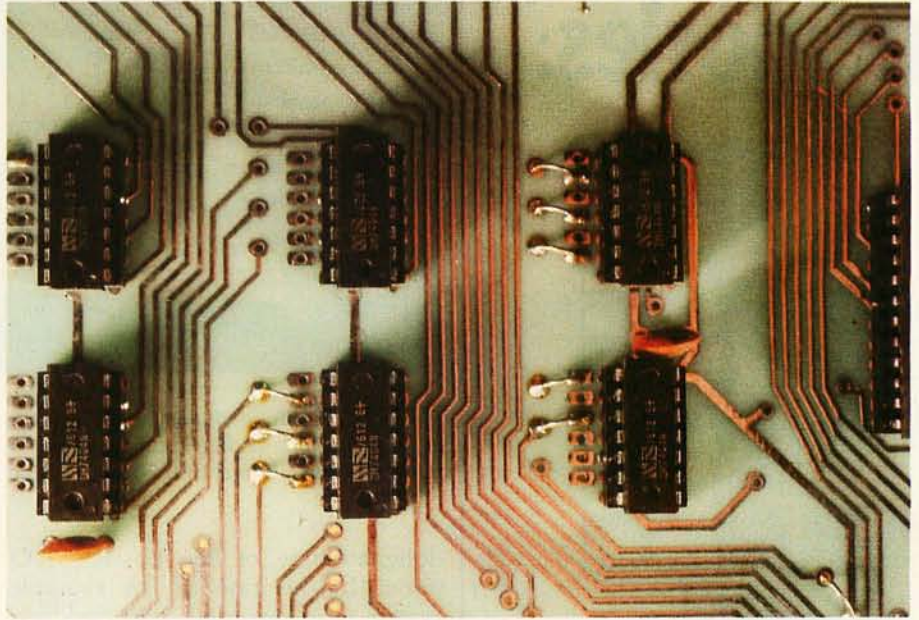


Photo 1: There are a variety of ways to decode the address for a particular input/output (I/O) port from the signals present on the address bus. The least expensive method uses inverters and printed-circuit-board jumpers to select the correct logic polarities. Three address lines are connected through each 7404 hex inverter with two possible connections for each address line. A connection to the upper trace on the circuit board decodes a logic 1; a connection to the lower trace decodes a logic 0.

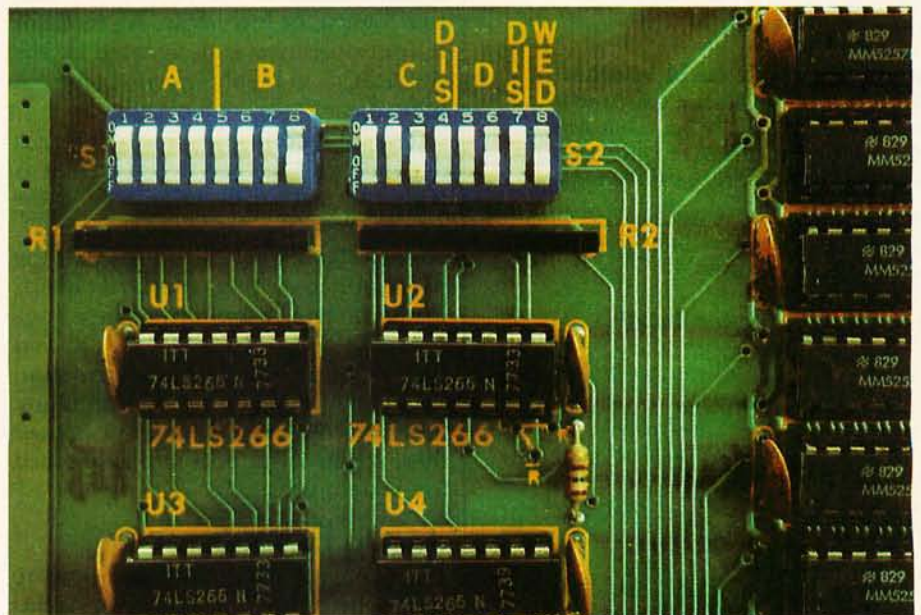
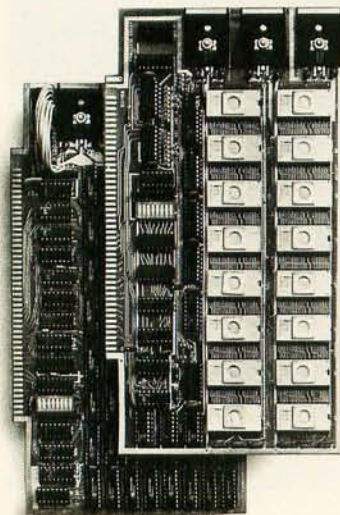


Photo 2: A more expensive and more easily changed addressing scheme employs dual-in-line-pin (DIP) switches and exclusive-NOR gates. The schematic diagram for this is shown in figure 3b.

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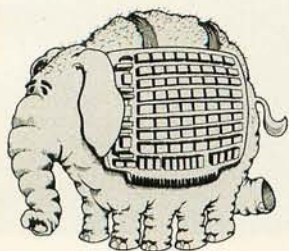
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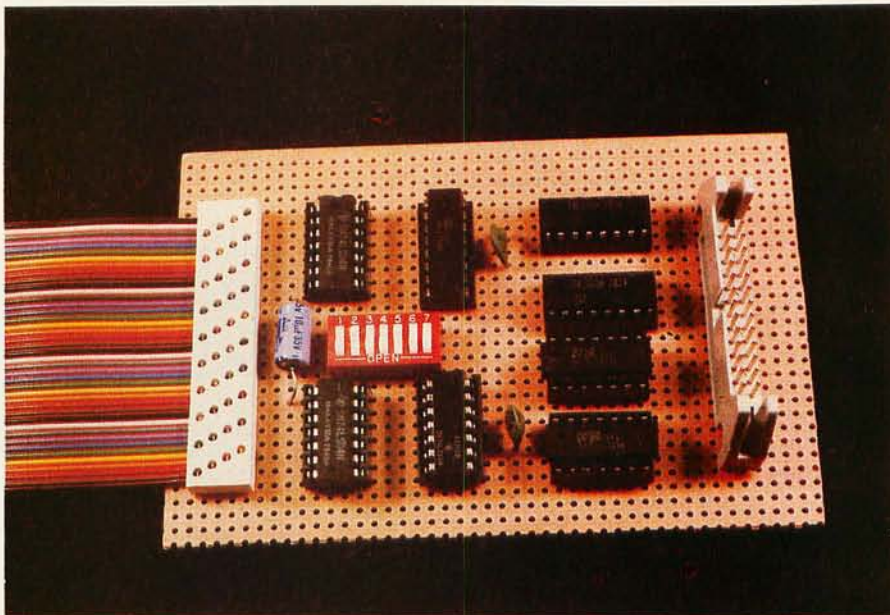


Photo 3: Prototype of an 8-bit I/O port for the Radio Shack TRS-80. The ribbon cable at left connects to the expansion port on the keyboard/processor unit. The two I/O ports are brought out to the ribbon-cable connector on the right edge of the board.

designate one of 256 possible I/O ports. In the case of the example system, a separate port address would be used for each peripheral.

Keeping track of bus direction and information flow is a matter of properly decoding the control signals during program execution. In a Z80 for instance, any memory-reference operation is signified by the control signal \overline{MREQ} in the processor going to a logic 0, or low, state. An input or output operation is designated by the $\overline{I/OREQ}$ control signal being at logic 0.

The direction of the data bus depends on whether the processor is trying to read or to write data. If the processor is in a read mode, the \overline{RD} control signal becomes a logic 0; if the processor is writing, the \overline{WR} line is in the 0 state. Monitoring these four lines, \overline{MREQ} , $\overline{I/OREQ}$, \overline{RD} , and \overline{WR} , gives us all the information necessary to support I/O decoding functions. Figure 2 demonstrates how these control outputs are combined for system use.

Address Decoding

So far we have discussed how to determine when the processor wants to send a character to an output device. In such an operation the $\overline{I/OREQ}$ and \overline{WR} lines are both low. To tell the difference between

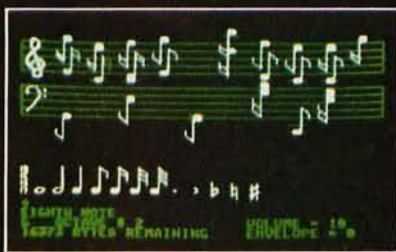
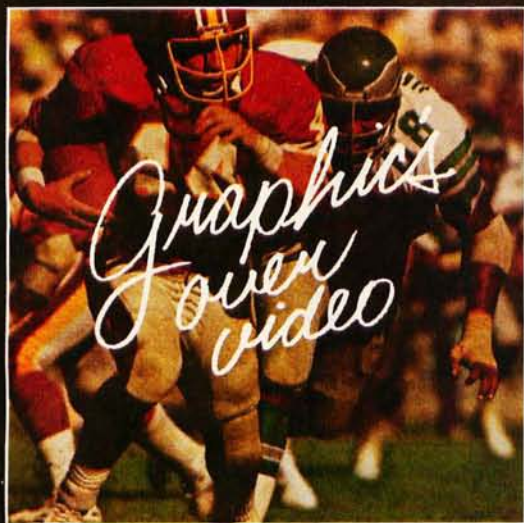
data for the printer and data for the terminal, we must decode the 8-bit port address.

The port address is determined by the logic voltages present on the low-order eight lines (that is, the 8 least significant bits) of the address bus during I/O operations. Various techniques can be employed to decode these lines. Figure 3 outlines a few simple methods. The objective, whatever the logic employed, is to produce a single pulse (ie: a strobe) whenever the logic states representing a particular address appear on the address bus. To eliminate false outputs when the processor is executing instructions not dealing with I/O, it is best to combine control and address signals as demonstrated in figure 4.

If you own a 6800- or 6502-based system, you have probably noticed that the processor has no special I/O instructions. This does not mean that these processors have no external communications capability, only that these processors communicate with peripheral devices differently. How can we discover this different method? Let us begin by looking closely at the I/O functions of the 8080 and Z80 that we have just discussed.

A close inspection of the I/O functions of an 8080 or Z80 should point

Text continued on page 30



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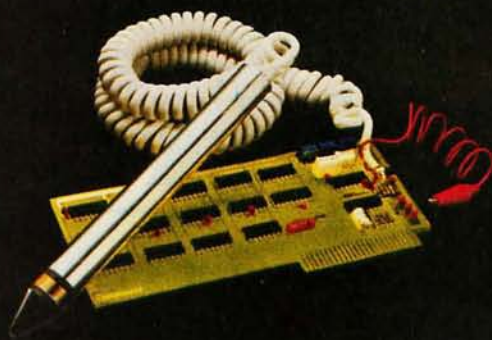
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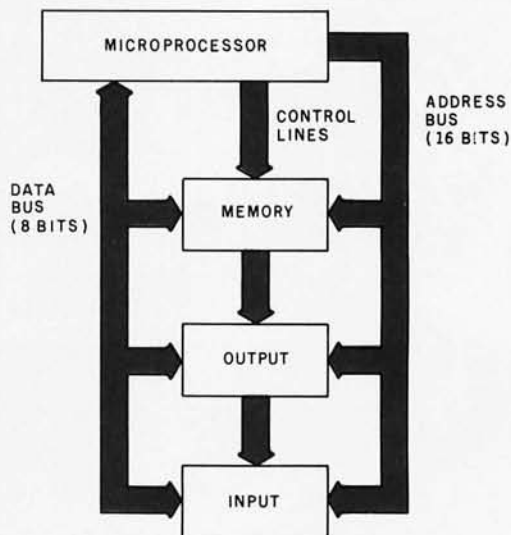


Figure 1: Block diagram of a microcomputer system that uses an 8-bit microprocessor such as the Z80. This system uses bussing techniques that are both multiplexed and bidirectional.

Z80 SIGNALS

CONTROL STROBES

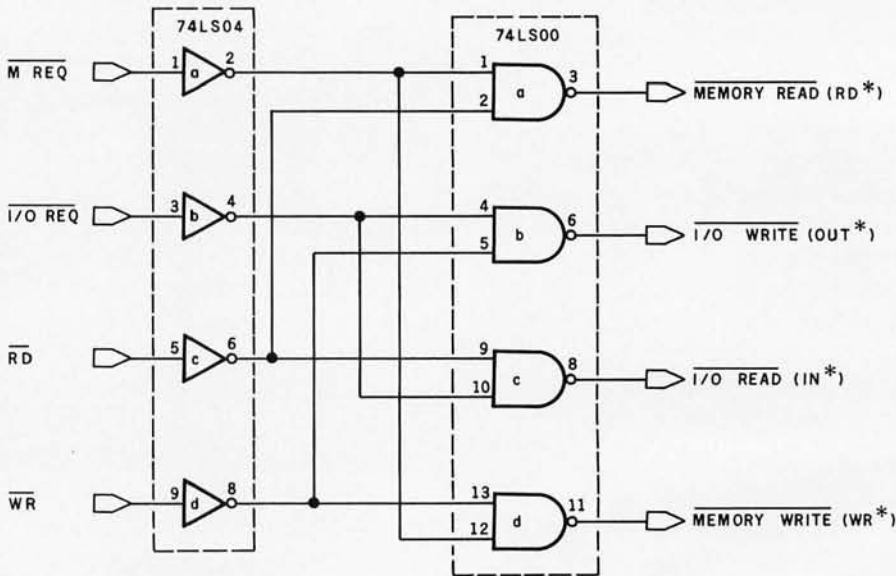
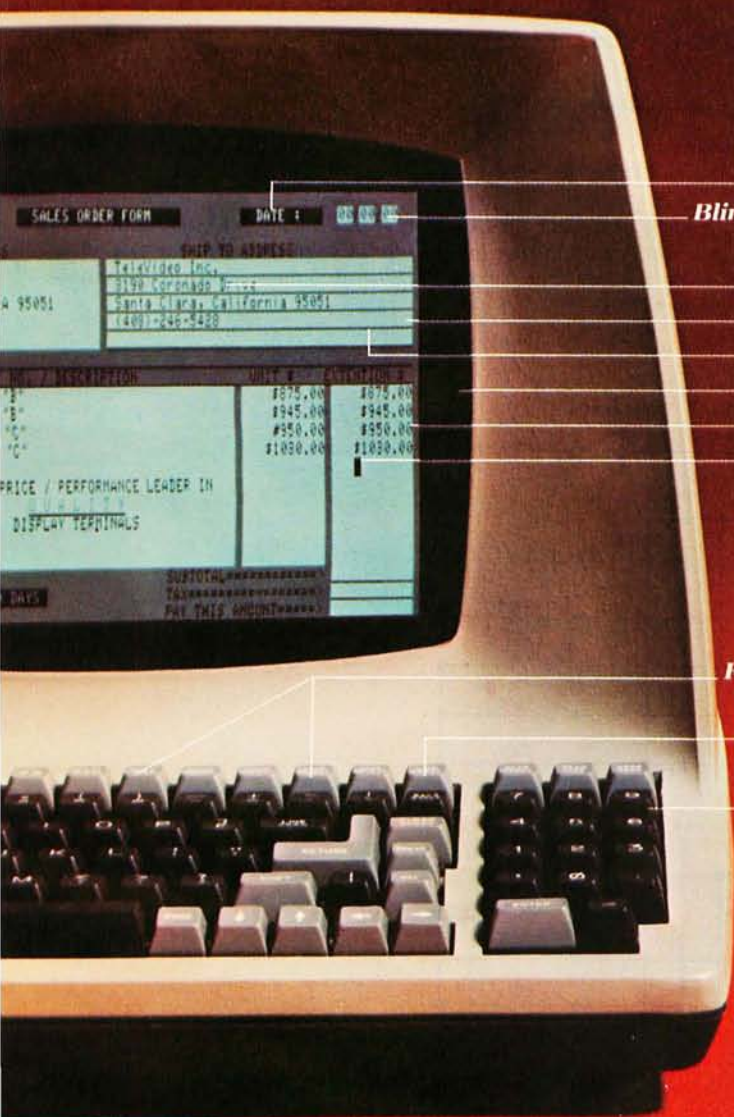


Figure 2: Control signals on the Z80 microprocessor. The Z80 uses a variety of control signals to keep data flowing at the right time and in the right direction. Four control signals are as follows: the \overline{MREQ} line goes to a low state (ie: a logic 0) when a memory-reference operation is in progress; the $\overline{I/OREQ}$ line goes to a low state when an input/output (I/O) operation is in progress; the \overline{RD} line goes low when the processor is reading data from memory or from a peripheral device; the \overline{WR} line goes low when the processor is writing data to memory or to a peripheral device. The \overline{RD} and \overline{WR} signals control the direction that data flows along the bidirectional data bus. Monitoring these four lines gives us all the information necessary to support I/O decoding functions.

Signals from the four processor control lines are logically combined to form control-strobe signals that perform specific functions. The characters in parentheses give the names by which the control-strobe signals are known in the documentation for the Radio Shack TRS-80.

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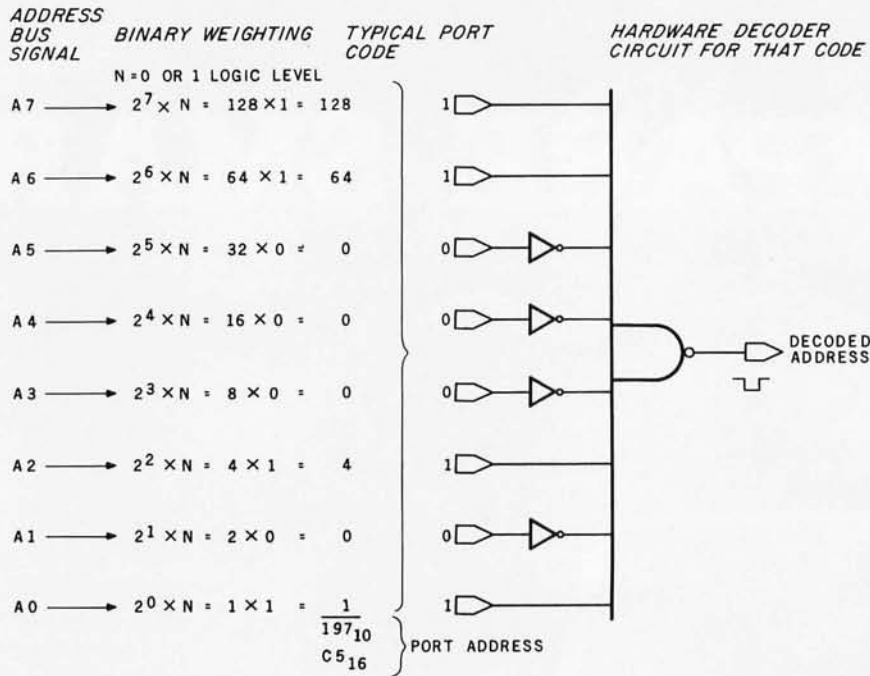


Figure 3a: Various methods can be employed to decode the address signals that appear on the address bus during I/O operations. Here, various inverters and an eight-input NAND gate are hardwired in a configuration that will produce a logic 0 output for one of 256 possible I/O port addresses. The logic 0 output can be used to activate the interface for the peripheral device. Here the circuit decodes the address hexadecimal C5, or decimal 197.

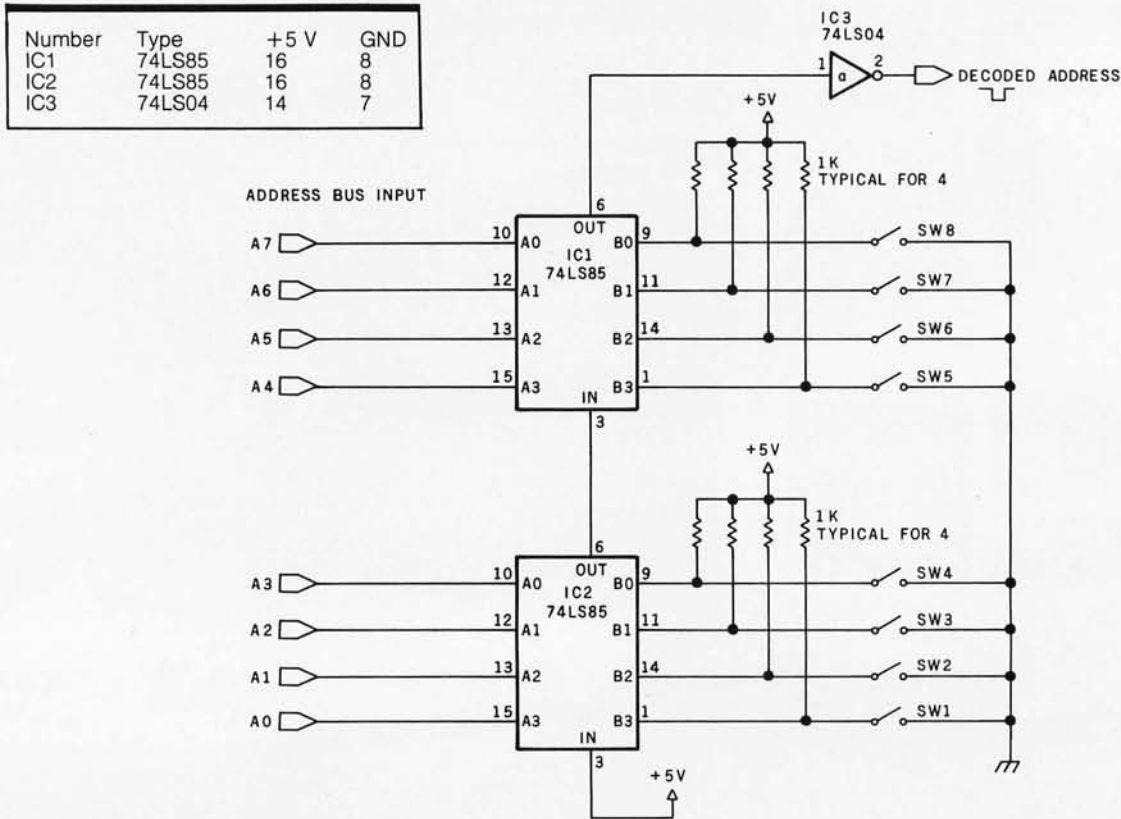


Figure 3b: Another method of decoding an address signal. Two 4-bit comparators can be cascaded together to decode an 8-bit address. The desired 8-bit port address is set up on switches SW8 thru SW1. When the combination of high and low logic states that corresponds to the desired address appears on the address bus, the output signal produced at pin 2 of IC3 (the 74LS04 inverter) will go low to a logic 0 state. This decoding method allows the port addresses to be easily changed, but the method here is considerably more expensive than the decoding method shown in figure 3a. The switches are single-pole, single-throw (SPST) types; an open switch shows logic 1, and a closed switch shows logic 0.

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Text continued from page 24:

out that the I/O instructions bear a surprising resemblance to memory-reference instructions. The 6800 and 6502 microprocessors actually allocate a certain portion of their memory address space to be decoded and to function as I/O ports.

This technique, which can be used on the Z80 and 8080 just as easily, has certain advantages in speed and ease

of use over direct I/O instructions. This technique is referred to as *memory-mapped I/O*. An illustration of the logic associated with this method is in figure 5. For a more rigorous analysis of memory-mapped I/O, I refer you to the November 1977 "Ciarcia's Circuit Cellar" article previously mentioned.

The final area for consideration is the actual transfer of data to and

from the bidirectional data bus. The circuits of figure 4 and figure 5 tell only *when* the I/O operation occurs. Additional logic has to be provided to place data on the bus during an input instruction or to latch and hold the contents of the data bus during output instructions.

When the 8080 or Z80 assembly language instruction OUT (N),D is executed, the contents of the accumulator, D, are placed on the data bus and written into device N. The same is true for the BASIC-language instruction OUT N,D. The data is actually valid during only a few clock cycles, perhaps 500 ns. Making this data available for longer periods of time requires the addition of an 8-bit *latch*: the latch is made from a set of clocked flip-flops.

The output lines are attached to the data bus. When the proper output instruction is executed, signified by a strobe signal from our address and I/O WRITE decoder circuit as shown in figure 6, the contents of the data bus are transferred into the 8-bit register in synchronization with the processor clock signal. This combination of circuitry is commonly called an *8-bit latched parallel output port*.

External devices cannot be directly connected to the data bus for input, because of the possibility that interference and bus-loading problems will result. A three-state buffer is used as a *gate* to allow signals from the peripheral device to be placed onto the bus at the appropriate time.

During an input operation the process used for output is reversed. When the proper input sequence is executed, signified by the appropriate output from the address decoder and I/O READ decoder, the 8-bit three-state buffer is strobed into operation during the few clock cycles it takes for the processor to execute the input instruction. Logic levels present on the buffer input lines during that instant become impressed onto the data bus and are transferred into the accumulator. Figure 6 shows the logic elements that perform these functions.

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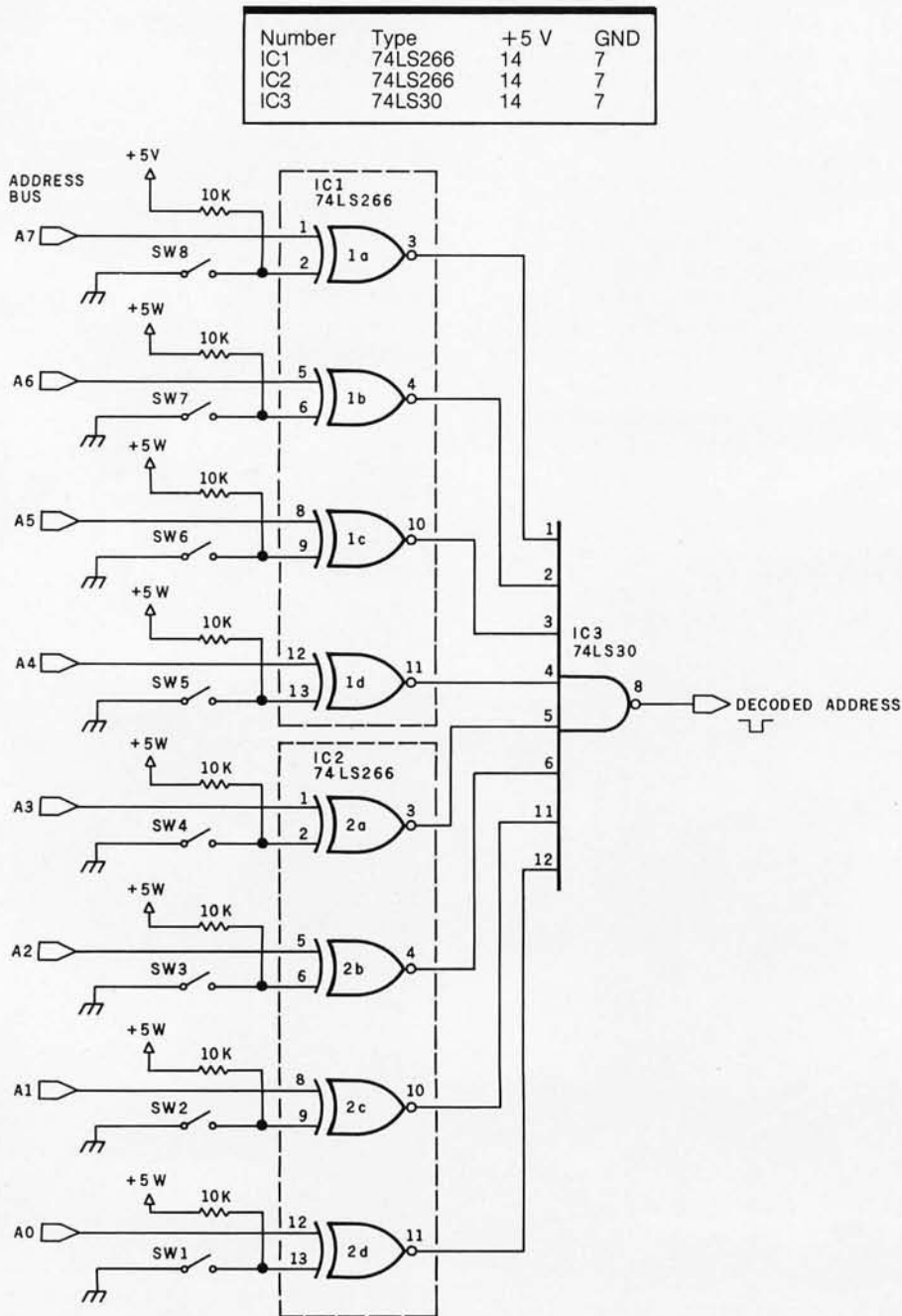


Figure 3c: Another method of decoding an 8-bit address, using exclusive-NOR gates and an eight-input NAND gate. As in figure 3b, the desired port address is set up on switches SW8 thru SW1.

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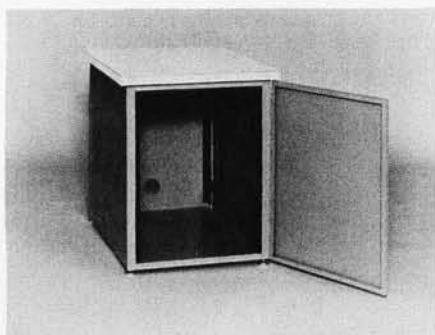
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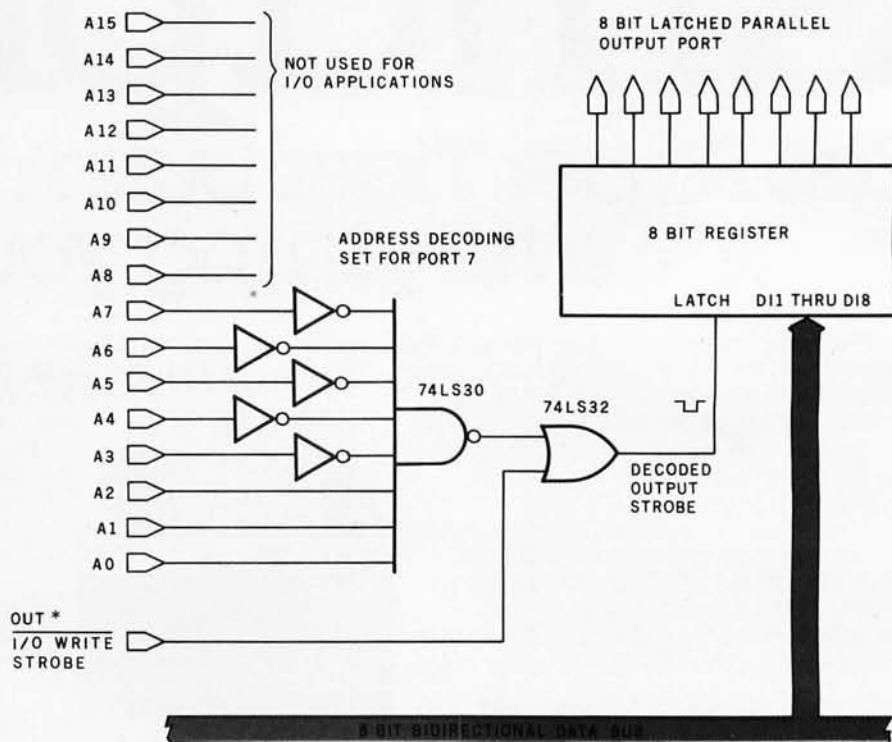


Figure 4a: Block diagram of a typical parallel output port. The logic that decodes the 8-bit port address was shown in three forms in figure 3. The signal from the address-decoding circuit is logically combined with one of the control signals from figure 2 (I/O WRITE) to produce an output strobe signal that activates the 8-bit output latch register.

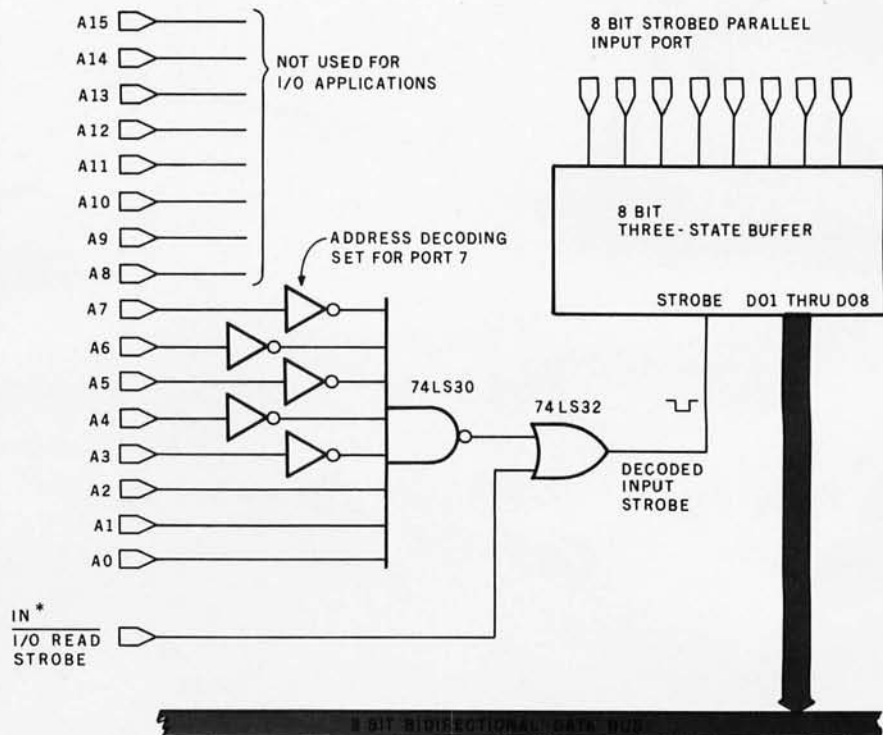
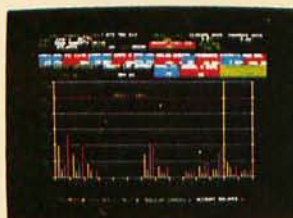
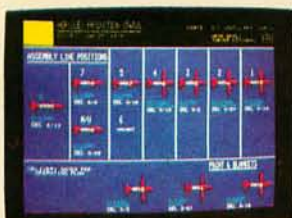
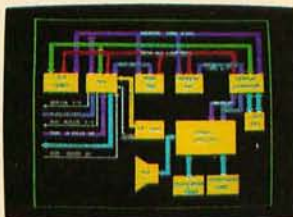


Figure 4b: Block diagram of a typical parallel input port. Note the resemblance to the output port of figure 4a.

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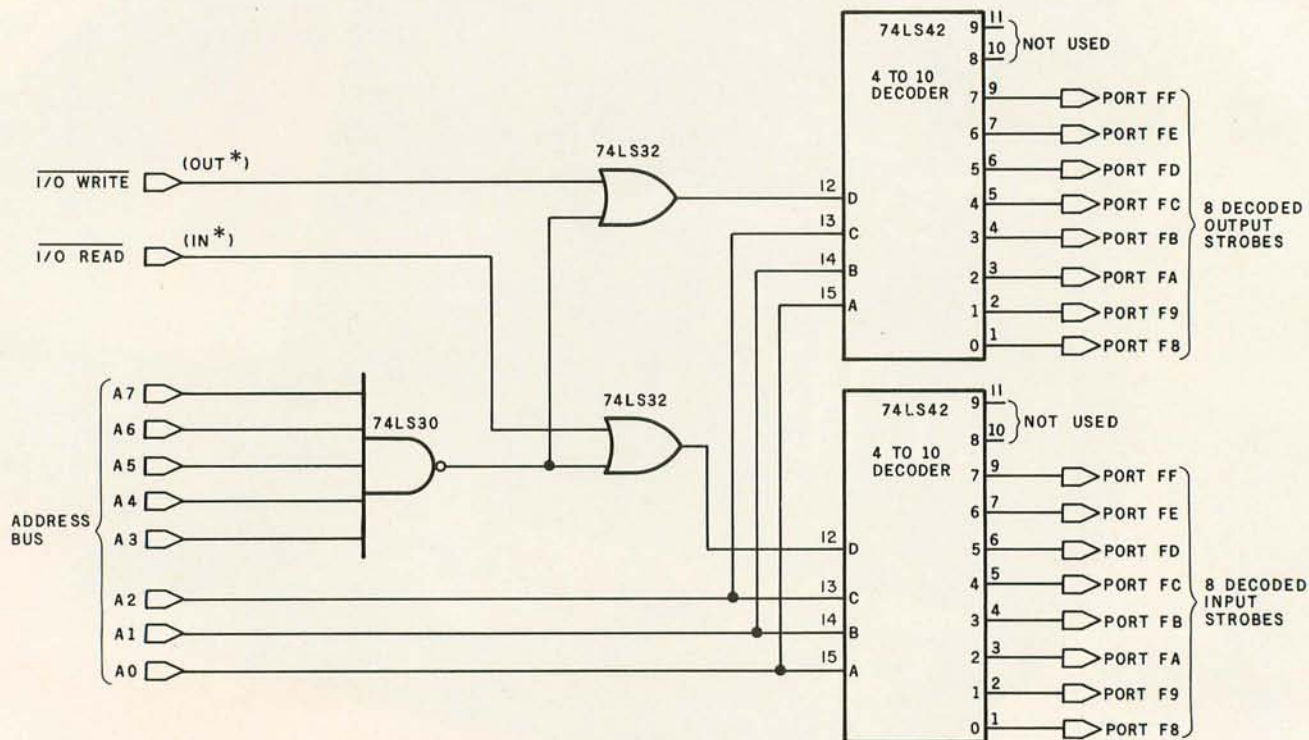


Figure 4c: Schematic diagram of a circuit that produces eight decoded input-strobe signals and eight decoded output-strobe signals. The port addresses produced are hexadecimal F8 thru FF.

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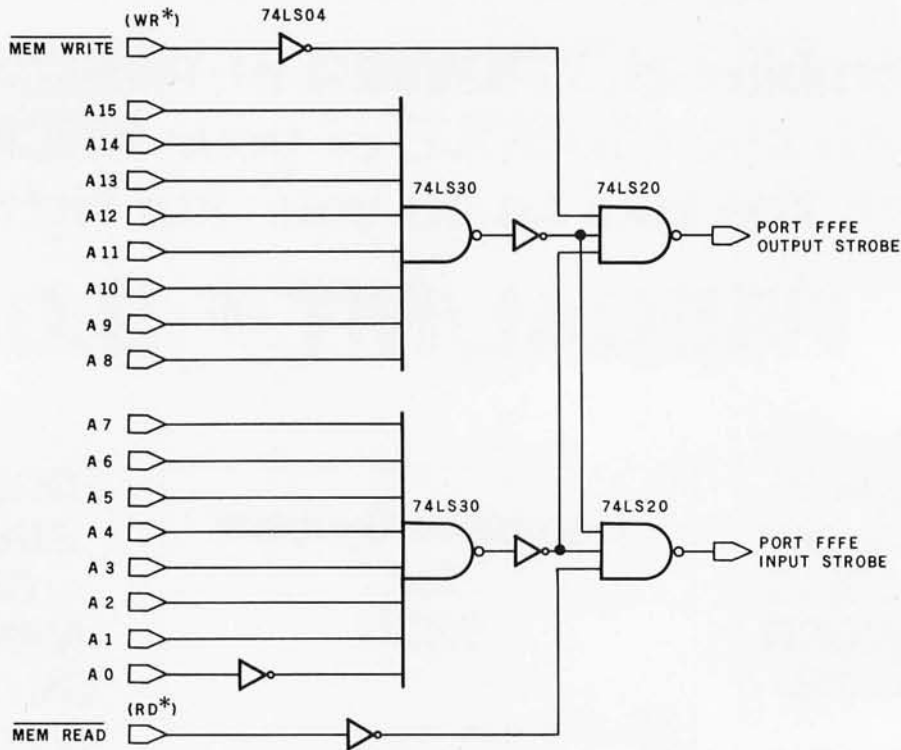


Figure 5: Memory-mapped input and output. Some microprocessors do not have specific input and output instructions. In systems that use such microprocessors, the I/O port hardware is wired as a memory location; I/O operations take place using the memory-reference instructions (eg. load-into-accumulator and store-in-memory instructions) of the microprocessor. This type of addressing is called memory-mapped I/O, and all sixteen lines on the address bus must be decoded to perform an I/O operation.

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IC2	74LS244	20	10
IC3	7404	14	7

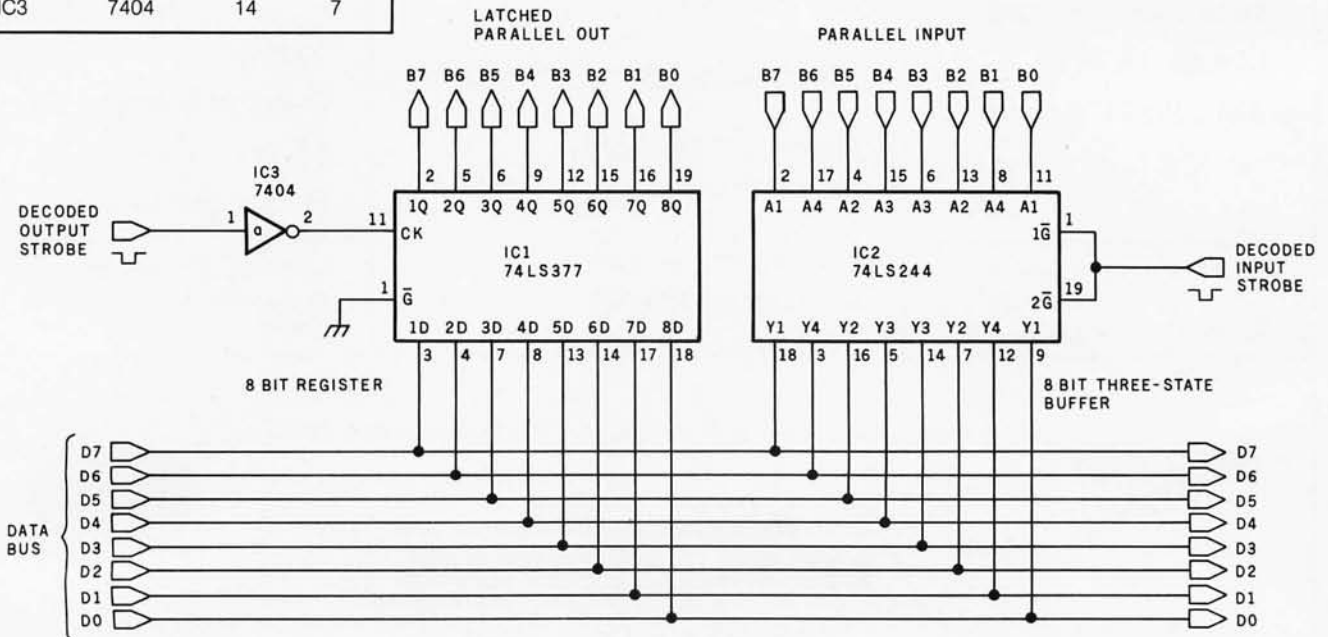


Figure 6: Data connections in input and output ports. Once the proper port address has been decoded and combined with the read- or write-control signal to form an I/O strobe signal, the actual process of accessing the data bus for data transfer is relatively easy. For input to the accumulator (the most common pathway for I/O), a three-state buffer is used in conjunction with the decoded input-strobe signal that controls the enable line of the buffer. For output from the accumulator, an 8-bit latch is connected to the data bus. During the execution of the output instruction, the contents of the data bus are clocked into the latch register and are latched there by the output-strobe signal.

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IC2	74LS125	14	7
IC3	74LS75	5	12
IC4	74LS75	5	12
IC5	74LS155	16	8
IC6	74LS04	14	7
IC7	74LS04	14	7
IC8	74LS30	14	7

Text continued from page 30:
 is not configured to be easily interfaced to the projects I present each month. The widely sold Level II BASIC, 16 K-byte memory version has no parallel I/O capability, aside from the single-bit cassette-motor control. With the addition of the expansion interface, the user gets one

parallel output port and one half (ie: 4 bits) of an input port. If these ports are used, as Radio Shack intends, to drive a printer, then the only way to provide usable parallel I/O capability is to add a separate I/O interface.
 Considering the pertinent elements of the previous discussions, it is easy to construct both parallel input and

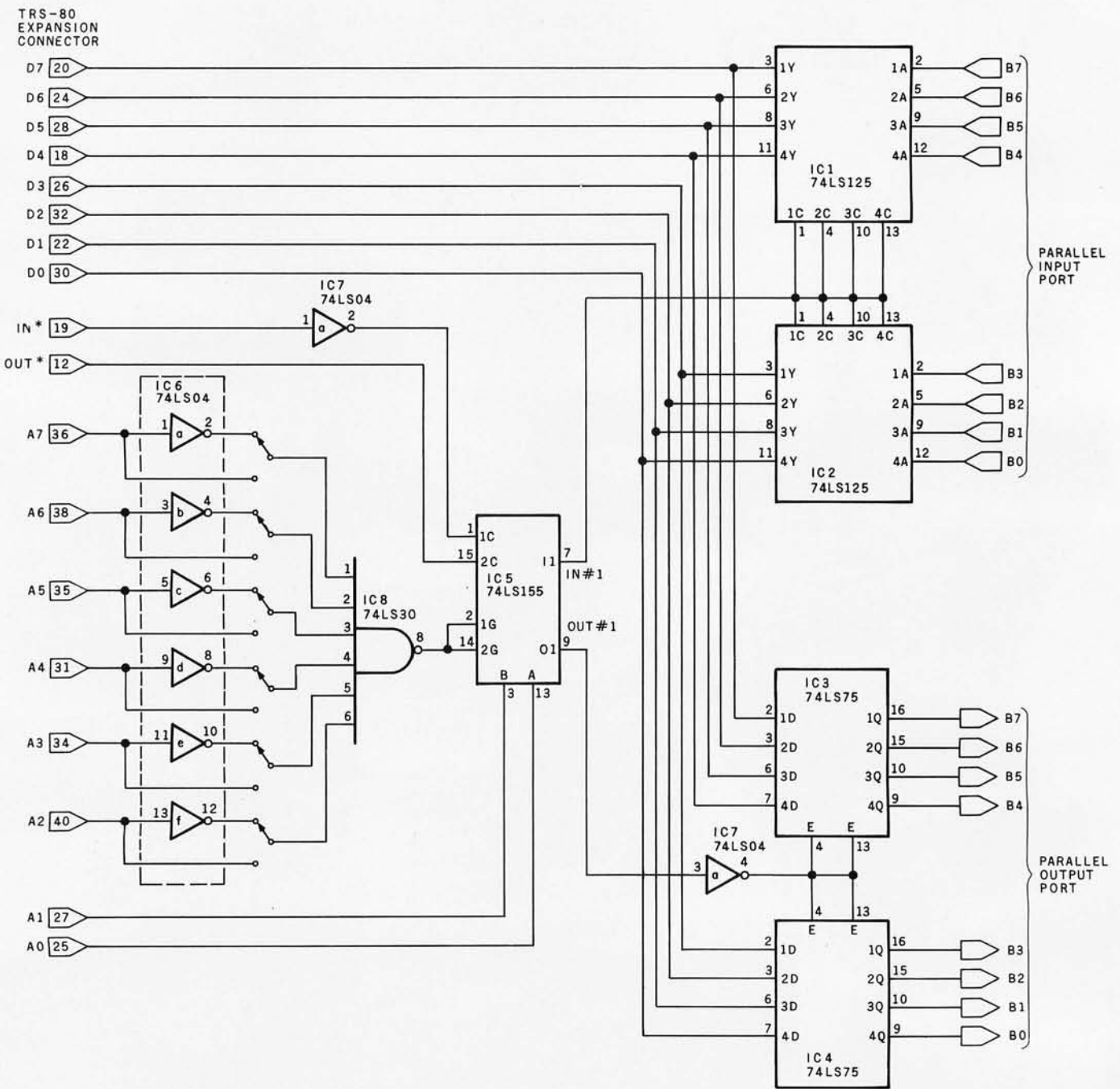


Figure 7: A complete, economical, parallel I/O interface circuit for use with the Radio Shack TRS-80 computer, or with other computers that use a similar bidirectional data bus. This interface can be connected directly to the expansion connector at the rear of the TRS-80 keyboard/processor unit, or it can be connected through the expansion-interface unit. As the circuit is shown here, there are six presently undefined additional strobes available on IC5. These six strobes can be used to support three additional ports. Refer to figure 3 and figure 4 to determine the proper selection of the I/O port address for this interface.

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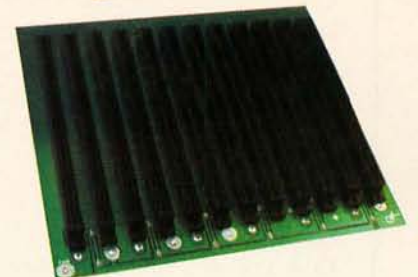
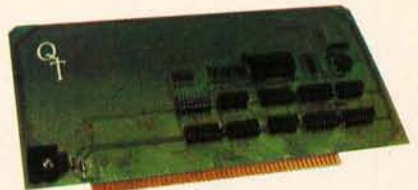
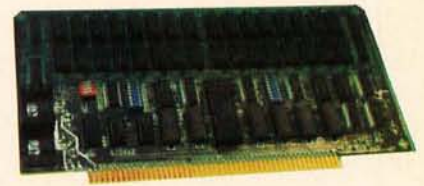


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parallel output ports for the TRS-80. The interface shown in figure 7 provides one input and one output port. The signals necessary to drive this interface are available on the forty-pin

expansion connector of the keyboard/processor unit or on connector J2 on the expansion interface. In either case, a separate +5 V supply is necessary to power the circuit. The

signals on the expansion connector are listed in table 1, and the pinouts are shown in figure 8.

The schematic diagram of figure 7 shows a port address FF. To set another port address simply refer to figure 3 and 4 and place the switches for the proper code.

There are many other methods for implementing I/O capability. An 8255 programmable peripheral interface, a parallel I/O device, could have been used. The circuit I have

I hope to enable many TRS-80 owners to build this I/O circuit and to use it to attach other "Circuit Cellar" projects to their computer systems.

chosen to present is intended to be inexpensive and easy to operate. By minimizing potential parts-acquisition problems and keeping down the software handshaking necessary when using large-scale circuits like the 8255, I hope to enable many TRS-80 owners to build the circuit and use it to attach other "Circuit Cellar" projects to their computer system.

Those experimenters who hesitate to build hardware might want to purchase the entire communications interface. An assembled and tested unit, with power supply and containing a parallel port (for the Centronics printer) and a serial RS-232C-compatible interface, is available. The complete communications unit, called the COMM-80, will be presented in part 2 of this article and is available for \$179.95 from:

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(New York residents please add applicable sales tax.)

Next Month

I shall complete the COMM-80 presentation by discussing the construction of a software-compatible RS-232C interface for the TRS-80 that has selectable data rates from 50 to 19200 bps. ■

Pin Number	Signal Name	Description
1	RAS*	row-address strobe output for 16-pin dynamic memories
2	SYSRES*	system-reset output, low during power-up initialization or when the reset switch is depressed
3	CAS*	column-address strobe output for 16-pin dynamic memories
4	A10	address output
5	A12	address output
6	A13	address output
7	A15	address output
8	GND	signal ground
9	A11	address output
10	A14	address output
11	A8	address output
12	OUT*	peripheral-write strobe output
13	WR*	memory-write strobe output
14	INTAK*	interrupt-acknowledge output
15	RD*	memory-read strobe output
16	MUX	multiplexer control output for 16-pin dynamic memories
17	A9	address output
18	D4	bidirectional data bus
19	IN*	peripheral-read strobe output
20	D7	bidirectional data bus
21	INT*	interrupt input (maskable)
22	D1	bidirectional data bus
23	TEST*	placing a logic 0 on this line causes a high-impedance condition on address lines A0 thru A15, data lines D0 thru D7, WR*, RD*, IN*, OUT*, RAS*, CAS*, and MUX
24	D6	bidirectional data bus
25	A0	address output
26	D3	bidirectional data bus
27	A1	address output
28	D5	bidirectional data bus
29	GND	signal ground
30	D0	bidirectional data bus
31	A4	address bus
32	D2	bidirectional data bus
33	WAIT*	processor-wait input, to allow for slow memory
34	A3	address output
35	A5	address output
36	A7	address output
37	GND	signal ground
38	A6	address output
39	—	on Level I machines: low-current +5 V output on Level II machines: no connection
40	A2	address output

Table 1: Description of function for the pins on the expansion port at the rear of the TRS-80 keyboard/processor unit. This pin assignment is also used in expansion slots in the expansion-interface unit. This information is provided through the courtesy of Radio Shack, a division of Tandy Corporation.

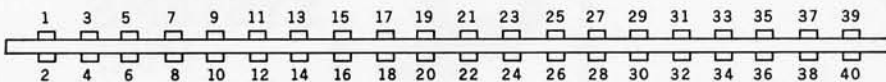


Figure 8: The configuration of output pins on the expansion port on the rear of the TRS-80 keyboard/processor unit. See table 1 for an explanation of the function of each pin.

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KIMDOS

Using Your KIM-1 with a Percom Floppy-Disk Drive

Joel Swank

4655 SW 142nd Apt 186
Beaverton OR 97005

Any owner of the MOS Technology KIM-1 knows the utility of the KIM's built-in audio-cassette interface. But, any KIM-1 owner who has expanded his system knows just as well how inappropriate the cassette is for storing long files. The standard KIM cassette format is intolerably slow, and even using the Hypertape method (a faster cassette-storage format for the KIM), a 4 K-byte file takes a minute and a half to load, not counting the time needed to position the tape.

The natural storage alternative is, of course, the floppy disk. However, there are some difficulties. A floppy-disk system requires a considerable amount of software to make it useful. In addition, many floppy-disk systems available today come with proprietary software for the 8080/Z80 or 6800 processors. Interfacing such systems to a KIM-1 requires the hobbyist to write his or her own 6502 software, working from the machine code for the other processor. While it is possible to do this, few hobbyists are willing to translate machine code to get their disk system up and running.

I decided to interface a Percom LFD-400 disk system to my KIM-1. The LFD-400 system contains a disk controller capable of controlling up to three 5-inch floppy-disk drives. It comes with complete, annotated source code for the 1 K-byte MINIDOS disk-operating system, written for the 6800 processor. MINIDOS allows the reading and writing of contiguous memory files, and is the nucleus of MINIDOS-

PLUSX, a 6800-based disk-operating system sold by Percom.

KIMDOS is a KIM-1-compatible version of the Percom MINIDOS. It allows a KIM-1 to read and write files that are compatible with the Percom format. This article will concentrate on explaining the workings of the KIMDOS software. The LFD-400 system easily interfaces to the bus lines of any KIM-1 system (see table 1); because of this, hardware interfacing will not be discussed here.

The LFD-400 uses hard-sectored

disks with ten 256-byte sectors per track and thirty-five tracks per disk. This gives 87.5 K bytes of usable data per disk. The controller board has sockets for up to 3 K bytes of 2708-type erasable programmable read-only memory (EPROM). KIMDOS has been written to fit in one 2708 device.

The controller board requires unregulated power supplies of +14 V, -14 V, and +8 V; or regulated power supplies of +12 V, -5 V, and +5 V. The controller is



Photo 1: The author's personal computer system. It contains the following commercially built equipment: a MOS Technology KIM-1 microcomputer, three 8 K-byte Digital Group static memory boards, a Percom LFD-400 floppy-disk controller and two Shugart 5-inch floppy-disk drives, a Southwest Technical Products Corporation GT-6144 graphics board, an ACT-IA terminal with Leedex monitor, an Olivetti TE-300 hard-copy terminal, and several Lambda power supplies. Homebrew equipment in the system includes a programmer for erasable programmable read-only memories (EPROMs), a programmable integrated-circuit tester, a calculator interface, the motherboard, and the input/output (I/O) interface board.

Photograph taken by John M Hannam.

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composed of twenty-seven transistor-transistor logic (TTL) integrated circuits and the Z5023 universal synchronous receiver/transmitter (USRT) on a 15.24 by 25.4 cm (6 by 10 inch) two-sided printed-circuit board. Low-power Schottky (LS) components are used to reduce power consumption and minimize bus loading.

Floppy-Disk Drive

The Shugart 5-inch floppy-disk drive comes assembled and tested from Percom. A copy of the Shugart instruction manual is included in the system documentation; it is thirty-three pages long, and contains schematic diagrams and complete specifications for the drive and its operating principles. Troubleshooting procedures are also detailed.

Each disk drive must be set up to respond to a specific drive number. This programming is accomplished by plugging a shunt block into a fourteen-pin dual-in-line pin (DIP) socket. A seven-pole DIP switch can replace the shunt block; the drive numbers may be easily changed using the switch.

Because the Shugart floppy-disk drive allows only three drive-select lines, the controller board in the Percom LFD-400 system uses only the drive-select lines that are numbered 01 thru 03. A drive-select line for device 00 exists, and can be selected by the KIMDOS software; however, this line is not usually connected to anything. With the addition of the proper jumpers to the controller and disk-drive boards, a four-drive disk system can be configured using device numbers 00 thru 03. The Micropolis disk drive could be used for this purpose, since it has a fourth drive-select line on pin 34 of the thirty-four-pin ribbon cable.

Functions of the Controller

The LFD-400 uses a crystal oscillator to time the data and clock bits from the drive. The data is separated from the clock bits and is shifted into the universal synchronous receiver/transmitter. The USRT latches each 8-bit byte and sets a flag to notify the processor to read the byte. For a write operation, the USRT sets a flag when it is ready to receive data from the processor. After the processor has stored the data in the USRT, the data is shifted out,

LFD-400	KIM Connector	Function	Comments
9	E-7	RST	
10	E-V	R/W	
11	E-22	VMA	VMA always true on KIM-1
12	E-U	ϕ_2	
19		+ 14 V	or use regulated + 12 V
20		- 14 V	or use regulated - 5 V
21		+ 8 V	or use regulated + 5 V
22		+ 8 V	
23		+ 8 V	
24	E-22	ground	
25		ground	
26		ground	
27	E-A	A0	
28	E-B	A1	
29	E-C	A2	
30	E-D	A3	
31	E-E	A4	
32	E-F	A5	
33	E-H	A6	
34	E-J	A7	
35	E-K	A8	
36	E-L	A9	
37	E-M	A10	
38	E-N	A11	
39	E-P	A12	
40	E-R	A13	
41	E-S	A14	
42	E-T	A15	
43	E-8	D7	
44	E-9	D6	
45	E-10	D5	
46	E-11	D4	
47	E-12	D3	
48	E-13	D2	
49	E-14	D1	
50	E-15	D0	

Table 1: Hardware connections from the KIM-1 single-board computer to the Percom LFD-400 disk-drive controller. Also given is the function of each line used.

merged with the clock bits, and is sent to the drive.

The controller also takes care of maintaining the current sector count. The motor-control circuit contains a monostable multivibrator (commonly called a one-shot) that turns the motor off after about 3 seconds of nonuse. The drive select is a 2-bit number that is latched and decoded to select one of three drive-select lines, as discussed previously. The drive-select line for device 00 is not used. The step and direction bits are also latched. The track-0 and the write-protect lines are buffered for the microprocessor. Address decoding is provided for all controller addresses and for the 2708s. The data bus is buffered with 8835 three-state buffer devices.

Hardware Modifications

The only incompatibility between the KIM-1 and the LFD-400 lies with the use of a "low-true" logic conven-

tion on the SS-50 data bus. In the low-true convention, a voltage potential of 0.4 V or less is regarded as a true or binary 1 logic signal. This convention is used because the 8835 devices are *inverting* buffers.

The KIM-1 uses a high-true convention on its data bus; potentials of 3.5 V or greater are regarded as a true or binary 1 logic condition. To remedy this problem, I replaced the 8835 buffers with their noninverting counterparts, 8833 buffers. Since the disk-controller board does not have sockets, the 8835s had to be unsoldered. An alternative method would have been to write software that accepts and translates the inverted data coming from the controller, but the software method seemed more difficult and error-prone than the hardware method of replacing the three-state buffers.

My KIM-1 system has regulated voltage sources of +5 V, -12 V, and +12 V. I chose to bypass the

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85577A

LFD-400 regulators for +5 V and +12 V and drive the circuits that require these voltages directly from the system power supply. I fed the -12 V source into the -5 V regulator on the LFD-400 to obtain that regulated voltage.

The only other modification required was due to a problem with the oscillator circuit, which did not always start when the system was powered up. To correct this, I short-

circuited the 0.001 μ F capacitor near the crystal, effectively removing it from the circuit. According to the engineers at Percom Data Corporation, no one else has reported this problem.

There are five ten-pin Molex connectors on the controller board. Mates for these are available from Percom; however, it may be more convenient to simply remove the Molex connectors and replace them with

another type. The pin numbers on the controller board and the KIM-1 equivalents are given in table 1.

Software and Hardware Interaction

All communication between the microprocessor and the disk controller takes place through hexadecimal memory addresses CC00 thru CC06. Because address lines A4 thru A9 are not decoded, addresses as low as hexadecimal CC10 to CC16 and as high as hexadecimal CFF0 to CFF6 also respond identically; but these addresses are not used. A complete list of controller addresses and functions is found in table 2.

The data on each floppy disk is arranged in thirty-five tracks or concentric circles. The motor rotates the disk at 300 rpm — one rotation takes 200 ms. Each track is divided into ten sectors in this hard-sectoring scheme.

In *hard sectoring*, the sector boundaries are detected by means of physical holes punched through the recording surface of the disk. As the disk rotates, these holes pass between a light-emitting diode (LED) and a photoelectric detector. Percom floppy disks have ten sector holes evenly spaced around the hub hole of the disk, with a single additional *index hole* placed halfway between two of the sector holes. This index hole is used to identify one sector on the disk as sector 0. Timing circuits in the controller detect the shorter distance between holes when the index hole passes the photodetector. When the index hole is detected by this method, the sector counter is reset.

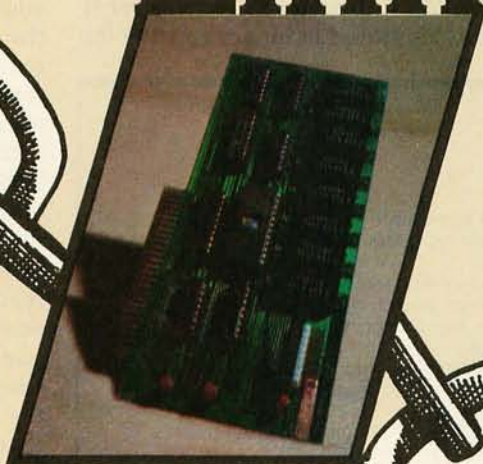
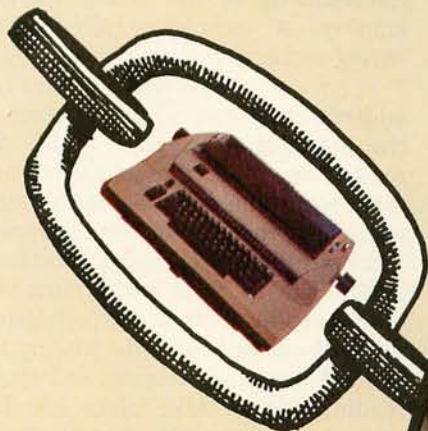
Each sector occupies one tenth of the circumference of a track on the disk and passes across the disk data-transfer head in 20 ms. Data is written to the disk at a rate of 1 byte every 64 μ s, theoretically giving room for up to 312 bytes per sector. It is not possible to fully use these 312 bytes. The Percom format uses a maximum of 287 bytes for leader, header, useful data, and trailer, with the data length variable from 1 to 256 bytes. Table 3 details the format of data stored in each sector.

Each track on the disk has ten sectors. The sectors are numbered in decimal from 000 to 349. In this three-digit numeral, the two high-order digits denote the track number in

2a			
Hexadecimal Address	Function When Used as Input		
CC00	Read USRT status: bit 0 = 1 means disk unit ready to send byte to computer at address CC01 during read operation bit 7 = 1 means disk unit ready to receive byte from computer at address CC01 during write operation		
CC01	Address used to transmit data from disk drive to computer during read operation		
CC02	During read operation, bits 0 thru 3 contain current sector number in binary		
CC03	Drive status byte: see table 2b.		
CC04	Accessing this location with a load instruction (LDA) causes a read operation to take place		
2b			
Bit	Value	Meaning	
0	1	Write-protect notch in disk covered; disk is protected	
1	1	Head is at track 0	
2	0	Drive motor is on	
3	0	Drive circuit is ready to write to disk	
4	1	Sector pulse; drive detects sector hole	
5	1	Index pulse; drive detects special index hole	
6,7		Binary number of drive selected (01 thru 03)	
2c			
Hexadecimal Address	Function When Used as Output		
CC00	Defines value that controller will recognize as the SYNC byte at the beginning of a read operation; hexadecimal FB used in Percom format		
CC01	Address used to transmit data from computer to disk unit during write operation		
CC02	Defines value that controller will recognize as the filler byte (written after trailer until disk motor turns off); hexadecimal FF used in this software		
CC03	Data to select drive and head-movement direction: bit 4 = direction of head movement: 1 = in, 0 = out bit 5 = step pulse bit; causes data-transfer head to jump to next track in direction given by bit 4 bits 6, 7 = binary number of drive to be selected		
CC04	Accessing this location with a store instruction (STA) causes a write operation to take place		
CC05	Accessing this location with either a load (LDA) or store instruction causes a motor-on pulse to be sent to the disk drive		
CC06	Accessing this location with either a load or store instruction causes a motor-off pulse to be sent to the disk drive		

Table 2: Memory addresses used by the LFD-400 disk-controller board. Communication takes place between the disk and the computer via memory-mapped bytes as listed. Table 2a gives the function of 5 bytes used for input from disk to computer. Table 2b defines the permissible values of bits in the drive-status byte (hexadecimal location CC03). Table 2c gives the function of 7 bytes used to control output from the computer to the disk.

The Missing Link



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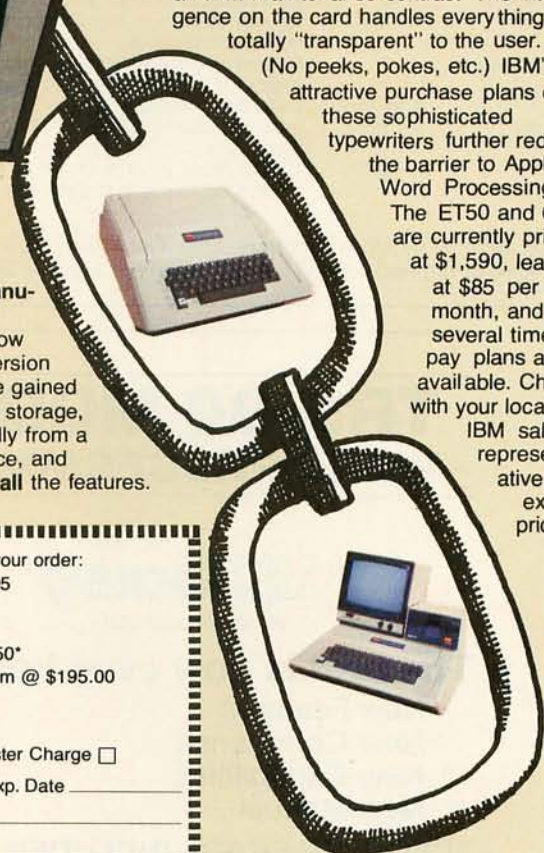
for the Apple II is now affordable with IBM's Electronic Typewriters - Models ET50 (proportionally spaced), 60, and 75. Our "Missing Link" plugs directly into Apple's I/O BUS and to the IBM electronics. It's fully isolated; uses no solenoids, linkages, baseplates, etc; does not affect normal typewriter operation; does not void IBM's warranty or the availability of an IBM maintenance contract. The intelligence on the card handles every thing totally "transparent" to the user.

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which the sector is located. The low-order digit specifies the sector within the track. When we prefix this three-digit numeral with the number of the disk drive, we obtain the *external* drive/track/sector (DTS) number, a four-digit quantity which is stored in binary-coded-decimal (BCD) form in 2 bytes.

For use in actual disk-addressing operations, the external DTS number

is reformatted into a binary, *internal* drive/track/sector number. The internal DTS number has the following properties. The number of the disk drive (1 thru 3) is stored in binary form in the 2 high-order bits of the first byte of the internal DTS number. The track number (1 thru 34) is stored in the 6 low-order bits of the first byte. The individual sector number (1 thru 9) is stored in binary form in the

second byte.

While the reformatting of the drive and track numbers from external to internal format involves only a simple decimal-to-binary conversion, the reformatting of the sector number employs a technique called *alternating-sector addressing*.

Why is alternating-sector addressing necessary? The sectors of the spinning disk pass under the read/write head consecutively, and there is no time between sectors during which the disk-operating system can perform housekeeping functions. While KIMDOS is performing the housekeeping routines for one sector, the next sector is already passing the head. Since housekeeping and sector reading cannot take place simultaneously, reading the sectors in sequential order would require the computer to wait for a full rotation of the disk to occur to read the sector that passed the head during housekeeping. Since every sector must be treated this way, only one sector could be read during each rotation of the disk if sectors were to be read sequentially. To remedy this problem, the sequential sector numbers are converted into alternating sector numbers.

KIMDOS reads or writes alternate sectors on the disk; the disk must rotate twice for all sectors on the track to be read or written. The order of physical sectors is therefore not the order of logical sectors. In the two complete rotations of the disk, the physical sectors are read in the following order: 0, 2, 4, 6, 8 (first rotation); 1, 3, 5, 7, 9 (second rotation). Sectors are accessed alternately to allow time in between data-transfer operations for executing housekeeping routines.

Each sector contains a *sector header* that holds information about the sector and the file of which it is a part. The first two bytes of the sector header contain the DTS number of the current sector; this is used to assure proper head position when reading. Each sector is linked via a forward pointer to the next sector and via a backward pointer to the previous sector. A forward pointer equal to 0 indicates the last sector in a file; a backward pointer equal to 0 indicates the first sector in a file.

The header also contains a data-length byte, a file-type byte, and the

Text continued on page 158

Field Name	Length in Bytes	Contents
Leader	16	Binary zeros
Sync	1	Hexadecimal FB to indicate start of data
Current DTS number	2	Drive/Track/Sector numbers of this sector
Backward link	2	DTS number of previous sector in file
Forward link	2	DTS number of next sector in file
Byte count	1	Length of data in this sector, in hexadecimal (00 means hexadecimal 100)
Target address	2	Address of memory from which data was written
File type	1	Indicator of the nature of the data
Data	1 to 256	Data being stored
Check sum	2	2-byte cyclic redundancy check sum of all bytes after sync byte
Trailer	2	DTS number of first sector of this file, or execution address if this is last sector in this file

Table 3: Table of sector fields and format. The drive/track/sector (DTS) number, stored here in internal binary format, points to a given sector.

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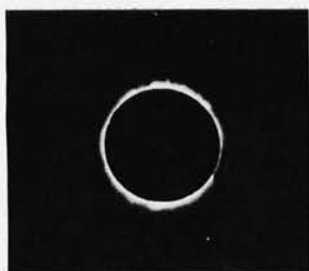
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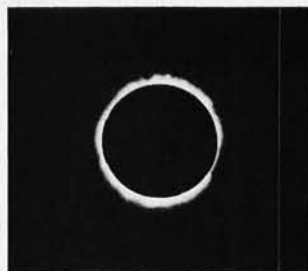
See us at NCC, Booth 85



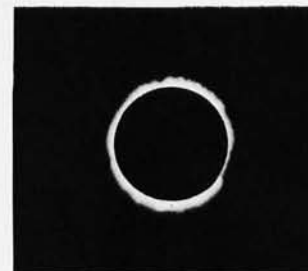
(3a) 1 millisecond



(3b) 2 milliseconds



(3c) 5 milliseconds



(3d) 10 milliseconds



Photo 1: A 5-second exposure with ASA 64 Ektachrome brings out significant coronal detail twice per 25-exposure cycle.



Photo 2: A minimal length exposure shows the beginnings of some prominence detail and the inner corona. This exposure corresponds to the shortest nominal exposure time, 1 ms plus the minimum trigger-pulse width of 20 ms. The electromechanical system which is the Nikon MD-2 Motor Drive unfortunately has a minimum shutter-open time on the order of 20 ms. Thus the exposures nominally programmed at 1, 2, 5, and 10 ms were actually on the order of 21, 22, 25, and 30 ms.

Text continued from page 6:

With this crucial timing step completed, I turned my attention to refining the Pascal program shown as listing 1 in the March 1980 BYTE editorial. These refinements included one conceptual change and some trivial changes in the experiment's design.

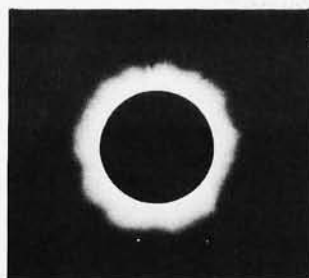
The conceptual change was that of adding a single long exposure made during the "slack time" interval at the end of the eclipse sequence during totality. As noted earlier, the model for the eclipse photography sequence used two manual inputs: one to start a sequence of diamond-ring exposures followed by automatic totality photography, and a second manual input to start the final diamond-ring sequence after a "slack time" for synchronization. My conceptual change was to open the shutter of the camera during this slack time, thus allowing one extremely long exposure to take place while waiting for the second manual input. Thus by specifying a smaller number of exposures during totality and a longer slack time, I would obtain this one long exposure.

The relatively trivial changes began with the alteration of the table of exposure times to provide a total of twenty-five different times instead of ten. In making this change I used the UCSD text editor to change the name of the table in every occurrence throughout the program. I also changed the initialization to provide a 1, 2, 5 sequence of exposure times in each decimal order of magnitude. (See photo 3's captions for the values resulting.)

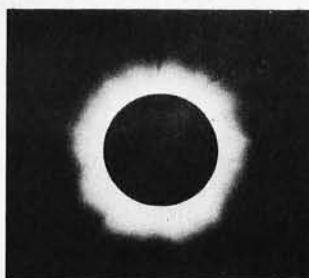
Another relatively minor change was to allow multiple tries at allocation of the exposures, rather than falling inexorably into a run of the photography sequence. This change proved quite useful in the field where it provided a means of verifying that



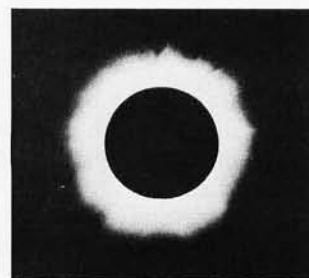
(3e) 20 milliseconds



(3f) 50 milliseconds



(3g) 0.1 second



(3h) 0.2 second

the computer had not died in the last minutes prior to totality. The program also had to be modified to talk to a 40-character-wide field on the Apple II video display instead of the 80-character width available on the terminal I normally use. This change amounted to condensation of the texts displayed during the allocation procedures. The final form of the program as used by the shores of Lake Jipe on February 16, 1980 is shown in listing 1.

The final equipment check prior to leaving was the verification that the display on a 2-inch diagonal Sanyo television screen was adequate. A jumper cord once used to interface between a tape recorder and my old homebrew computer provided the means for routing the output of the Apple's auxiliary RF modulator to the Sanyo television. The display wavered a bit when running on the portable generator. It was a tiny display but adequately readable for my purposes.

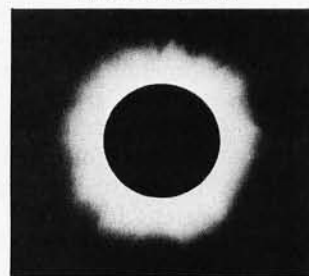
After this crucial experiment, the final detail was to make redundant copies of my eclipse application program's disk, as well as the UCSD Apple Pascal system's disks Apple1, Apple2, and Apple3. Redundancy was important. If I were to have a directory crash due to dust or dirt while on the other side of the equator 11,000 miles from home, a second chance would have been well worth it.

On Tuesday morning February 5, we hastened to Boston where the air travel to Kenya began with a trip to New York's Kennedy Airport. The party at this time consisted of myself, Tully Londoner, Norm Whyte, and Laurel Allen. Rick Lutman, the fifth member of our party, would join us in Nairobi. In due course we boarded Pan American's flight 190, an 18-hour international puddle jumper with stops at Roberts Field, Liberia, and Lagos, Nigeria. The computer equip-

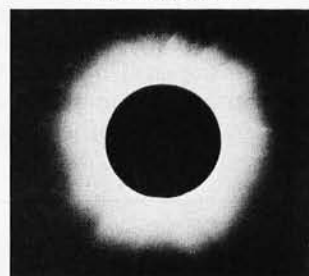
ment and telescope mount in addition to trunks and pack frames full of clothes, sleeping bags, and tools constituted our luggage.

On reaching Nairobi at about 8 PM that Wednesday, we met our guide, Iain Allan, and his associate Vince Fayad. Iain does business as Tropical Ice (Mountain Guides) Ltd, Post Office Box 57341, Nairobi, Kenya. Making the connection with Iain was the only redeeming virtue of an otherwise hopelessly botched set of travel arrangements made by our US travel agents (who shall remain anonymous). Iain was our guide to the wilds of Kenyan culture for the next two weeks. His good humor and knowledge of local flora, fauna, and climate are highly recommended to anyone traveling in East Africa for purposes of game trekking or technical mountain climbing. Iain wrote the guidebook on Mt Kenya and other climbs in Kenya. He also frequently guides technical climbing trips on Tanzania's Kilimanjaro, when not tackling various other challenging rock climbs in places as diverse as Nepal and Yosemite.

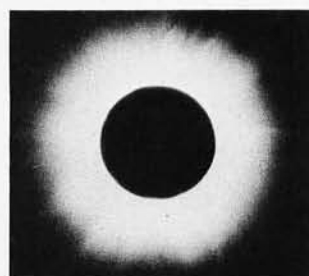
As in any trip of this kind, there were some difficulties. The most significant (and in retrospect, completely avoidable) difficulty was the need to post a 30,000 shilling bond on our equipment with Kenyan customs on entry. We later had to recover our customs bond on departure (minus an exorbitant 10% fee exacted by the local branch of a major US multinational bank). The fact that we had to post a bond at all was due to an un-



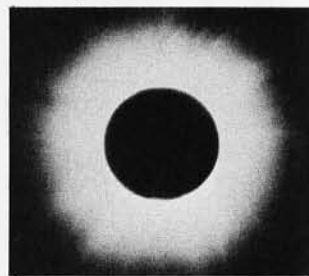
(3i) 0.5 second



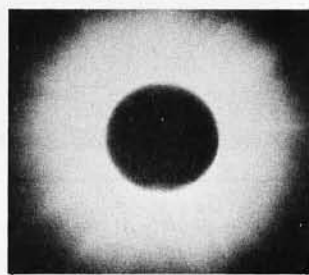
(3j) 1.0 second



(3k) 2.0 seconds



(3l) 5.0 seconds



(3m) 10.0 seconds

Photo 3: Black and white reproductions of the entire series of different exposures taken with the aid of the final version of the Pascal control program for the camera. Times are nominal shutter-open intervals stored in a table in the program. Actual times reflect a fixed lower-limit overhead of approximately 20 ms.

fortunate mistake by one of our party, a slipup which can possibly be avoided by readers in similar circumstances.

When listing personal computer equipment being carried for such an expedition, never ever list its monetary value or speak of its value. To satisfy US customs, all you need is a list of serial numbers of your personal equipment carried abroad. This list can be used to advantage when entering another country. But if you give the customs officer at another country the list of items and values you prepared for your insurance agent, it is like waving a red flag in front of a bull.

We had to post a customs bond on Norm's equipment using credit cards to obtain nearly \$4000 in cash, then retrieve the cash bond at the end of the trip by pleading lack of time to Kenyan customs officials in order to

get all the paperwork completed by our departure. We wasted two out of sixteen days figuring out all the "catch-22"-style sophistries of this problem.

Kenya is a very British relic of a former era, where dual languages of Swahili and English dominate. Iain pointed out that it would have been much more complicated in several countries in which he has traveled for purposes of mountain climbing. In one Asian country he has visited for climbing, Iain points out, there is not even a recognizable set of paperwork to be filled out. It was quite a relief to get back to a (relatively) sane United States at the end of the trip.

So much for the bureaucratic problems of taking computers abroad to equatorial Africa. What about the engineering problems? We did as thorough a job of preparation as we could, yet would the computers and

generator still play together when we reached our final encampment on the shores of Lake Jipe in Kenya's Tsavo West National Park?

We answered this question by an ancient technique: crossing fingers and applying power. We arrived at Lake Jipe 2 days before the eclipse, after a 6-hour trek over some incredible roads in Iain's Volkswagen bus with trailer in tow. The computers were inside the bus with seven human bodies and food packed with solid CO₂ in the famous Tropical Ice Box. All the rest of our gear was carried in the trailer. The roads we traveled from Amboseli to Lake Jipe included one 5-mile stretch of a semi-improved lava flow, an unmarked dead end which looked like the main road of two alternatives, and other miscellaneous "hazards" like herds of elephants and troops of baboons.

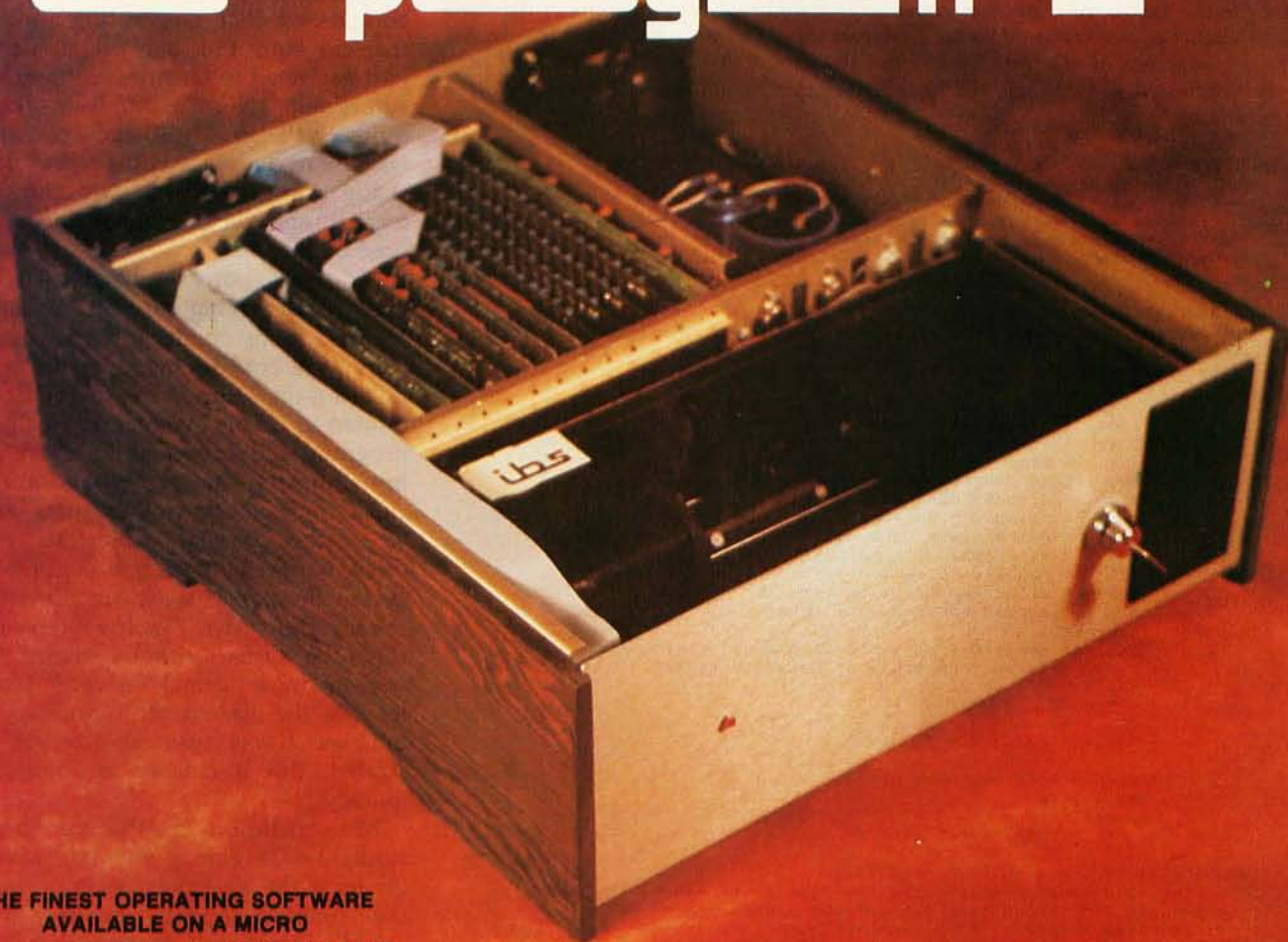
The day before the eclipse, Norm



Photo 4: A view of the equipment set up at the Tsavo West National Park campsite on the shores of Lake Jipe. Norm was using a 500 mm reflex lens with his camera; I was using my 1000 mm reflex lens. The two Nikon cameras were mounted on the equatorial telescope mount carted to Africa along with the 110 VAC generator in Norm's homebrew plywood shipping trunk. The Apple Pascal system is shown sitting in the bottom of its carrying case on top of a trunk.

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Listing 1: This is the final version of my Pascal Eclipse Control Program as used in Kenya, February 16, 1980. Major changes from the previously published version include filling in the details of real-time execution and modifying the exposure table to provide twenty-five shots instead of ten. Also added was an interactive option to reenter the the exposures allocation phase so that different combinations of diamond ring and totality exposures could be tried. Initialization now puts in a symmetrical rising and falling sequence of exposure times from 1 ms to 10,000 ms. All interactive texts have been adjusted so that they will fit the 40-character width of the Apple's built-in video display.

```
(
  NOTES ABOUT THE DESIGN PROCESS
)
(
  Step 1: High Level Description - begun November 22, 1979
  This is a first cut at a program to simulate the eclipse
  photography process, and define some of the necessary global
  data of the problem.
  COMPLETED 11/24/79
)
(
  Step 2: Fill in allocation details -
  Achieve a complete allocation of the eclipse camera con-
  trol function as evidenced by calculation of a detailed time
  line for the eclipse event given various conditions:
  Given:
    n = number of totality exposures
    m = number of diamond rings exposures
    t = totality time
    s = slack in allocated totality time
  Then let us seek the followings...
    * d2 = diamond rings time at 2nd contact
    * d3 = diamond rings time at 3rd contact
    * z = extra slack (one half of diamond rings total)
    * P = anticipation time (half first diamond rings)
    * A = required time for exposures during totality
    * a = allocated totality time for exposures
    * x = margin per frame in totality
  Theorems:
    d2,d3 derived from table of diamond rings frames
    A derived from table of totality frames
    z = (d2 + d3)/2
    P = d2 / 2
    a = t - s - z
    x = (a - A) / n
  PROCEDURES Detailed Here Are...
    initialize
    normalize
  COMPLETED 12/16/79
)
(
  Step 3: Fill in the simulated details...
  Create a program which uses the results of step 3 to
  go through a detailed time line of the experiment on paper
  (or terminal screen). Each event (shutter transition
  open-->close or close-->open will be marked by a report of
  its nature and time of execution relative to <start> signal
  PROCEDURES Detailed Here Are...
    await_cue
    diamond_rings_burst
    totality
)
(
  Step 4: Adapt to real time control -
  Put in asmentations of the software to actually demon-
  strate operation with the Nikon F2A camera via a relay
  plugged into the APPLE II Game Paddle Socket
  THIS IS THE FINAL FORM OF THE PROGRAM TO BE USED IN THE
  FIELD CONTROLLING THE EXPERIMENT...
  Necessary step: determining a method of measuring time
  intervals from the CPU clock which is consistent with UCSD
  Pascal. Possibly use assembly language subroutine.
)
PROGRAM eclipse_monitor_simulation;
```

```
CONST
  minimum_pulse_width = 20 (milliseconds);
  overhead_duration = 210 (milliseconds);
  open_shutter_address = -16295 (sets ANO output to "1");
  close_shutter_address = -16296 (resets ANO output to "0");
  post_rings_delay = 500 (milliseconds);

TYPE
  seconds = INTEGER;
  milliseconds = INTEGER;
  absolute_time =
    RECORD
```

Listing 1 continued on page 58

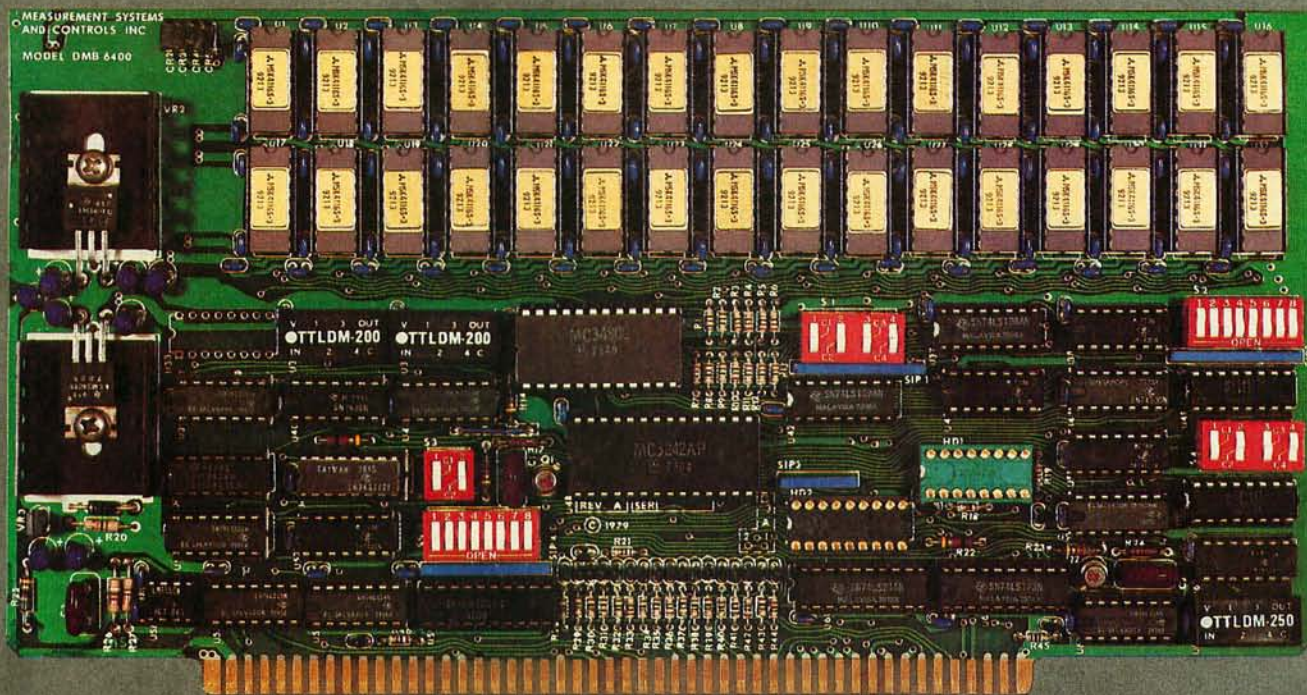
fired up the generator to supply power. We then set up our respective Apples. We naively thought that final programming details could be accomplished that day sitting in the tropical sun. But our preparations had neglected to include a canopy or sun shade. Norm's Apple worked quite well in the heat, perhaps because he had rigged up a sort of sun shade using his towel, two camera tripods, and a large piece of gaily colored cloth.

My Apple, however, had been baking in its carrying case all morning before I set it up. Its integrated circuits were hot to touch even before I turned it on. I turned it on and Pascal booted as usual. I entered my eclipse program and proceeded to check it out. But after one or two allocation runs, the operation of the program was rather unusual and erratic. As often happens in such situations, I cycled the power switch in order to reboot the system's software. With this, the system simply refused to operate in a normal fashion! After leaving the system off for about 2 minutes, I was again able to get it started. But it crashed again more quickly.

My conclusion was that the direct sunlight was baking my computer, giving it the electronic equivalent of the sunburn I was so carefully avoiding for myself. It seems that Apples do not work too well when temperatures are elevated to the point where components are too hot to touch. I estimate that the surface temperature of the main board at this time was in the range of 150° to 180°Fahrenheit (66° to 82° Celsius). Noting the excessive heat, I just turned off the system and thought about strategies for keeping it cool and out of sunlight until the eclipse happened. That evening after sunset and before the nightly parade of hippos began, I verified that the computer was still functional.

As it turns out, heat was not a problem the next day, February 16, 1980. The day of the eclipse broke with a solid overcast, not an auspicious beginning. If first contact were to have occurred at 8:30 in the

Text continued on page 66



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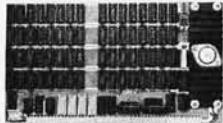
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Listing 1 continued:

```

units          : seconds;
thousandths   : milliseconds;
END;
exposures      = INTEGER;
an_exposure_detail =
RECORD
duration      : milliseconds;
wait_after    : milliseconds;
END;
strings_pointer = ↑STRING;
    
```

```

VAR
s              : STRING[128];
crash_ahead    : BOOLEAN;

an_integer    : INTEGER;

x,n           : INTEGER;
sima         : INTEGER;
which_rins    : (second,third);

a,b,c        : absolute_time;
rins_time    : absolute_time;
second_contact_rins : absolute_time;
third_contact_rins : absolute_time;
tot_time     : absolute_time;
time_totality : absolute_time;
margin_time  : absolute_time;
current_time : absolute_time;
half_time    : absolute_time;
quarter_time : absolute_time;
slack_in_totality : absolute_time;
dummy       : absolute_time;
total_elapsed_time : absolute_time;
total_duration : absolute_time;

maximum      : exposures;
total_eclipse : exposures;
rins_frames  : exposures;
current_shot : exposures;
    
```

```

twenty_five_shots : PACKED ARRAY[0..24] OF an_exposure_detail;
transient_shots   : PACKED ARRAY[0..1] OF an_exposure_detail;
    
```

<<<< opening "EUTILS.TEXT">>>>

```

( Miscellaneous routines used throughout the program )
( ----> new_Page )
( ----> set_Parameter )
( ----> error_abort )
( ----> subtract_time )
( ----> divide_time )
( ----> add_time )
( ----> print_time )
( ----> )
( ----> )
( ----> )
( ----> )
( ----> )
    
```

PROCEDURE new_Page;

```

VAR
stuff : STRING[24];
clear_screen : CHAR;
BEGIN
stuff := ' ';
clear_screen := CHR(24);
WRITELN(clear_screen,stuff);
WRITELN(' ');
WRITELN(' ');
WRITELN(s);
END (new_Page);
    
```

PROCEDURE set_Parameter(VAR time : absolute_time);

```

VAR
a_string : STRING[128];
i : INTEGER;
period : BOOLEAN;
decimal_count : INTEGER;
factor, result : INTEGER;
    
```

PROCEDURE add_a_disit(position : INTEGER);

```

VAR
disit : INTEGER;
BEGIN
disit := (ORD(a_string[position]) - ORD('0'));
IF period THEN
BEGIN
    
```

Listing 1 continued on page 60

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330	331	332	333	334
325	326	327	328	329
320	321	322	323	324
315	316	317	318	319
310	311	312	313	314
305	306	307	308	309
300	301	302	303	304
295	296	297	298	299
290	291	292	293	294
285	286	287	288	289
280	281	282	283	284
275	276	277	278	279
270	271	272	273	274
265	266	267	268	269
260	261	262	263	264
255	256	257	258	259
250	251	252	253	254
245	246	247	248	249
240	241	242	243	244
235	236	237	238	239
230	231	232	233	234
225	226	227	228	229

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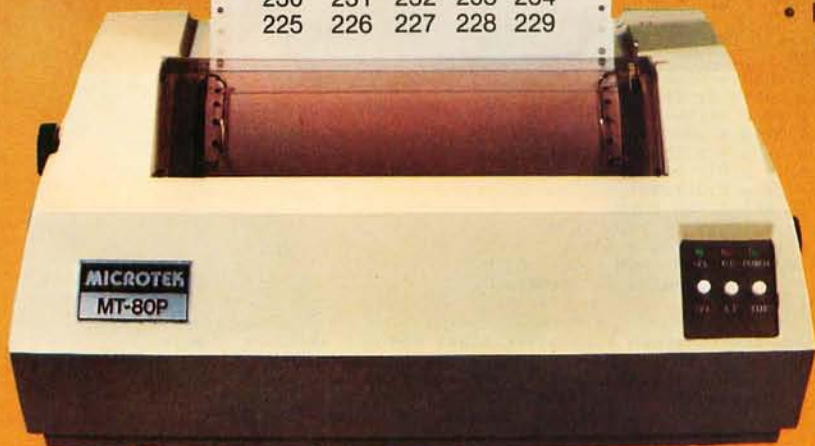
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Listing 1 continued:

```

decimal_count := decimal_count + 1;
IF decimal_count < 4 THEN
  BEGIN
    time.thousandths := time.thousandths
      + ((1000 * disit) DIV factor);
    factor := 10 * factor
  END
END
ELSE (before period)
  time.units := (time.units * factor) + disit
END;

BEGIN (set_parameter)

PAGE(OUTPUT);
time.units := 0;
time.thousandths := 0;
WHILE ((time.units=0) AND (time.thousandths=0)) DO
  BEGIN
    factor := 10;
    decimal_count := 0;
    period := FALSE;
    WRITELN(s);
    READLN(a_string);
    FOR i := 1 TO LENGTH(a_string) DO
      BEGIN
        CASE a_string[i] OF
          '0','1','2','3','4','5','6','7','8','9':
            add_a_disit(i);
          ',':
            period := TRUE
        END
      END
    END (WHILE);
  END (set_parameter);

PROCEDURE error_abort;
BEGIN
  maximum := 250;
  total_eclipse := 200;
  rind_frames := 25;
  WRITELN('Unrecoverable error in data');
  crash_ahead := FALSE
END;

PROCEDURE subtract_time(a,b : absolute_time; VAR c : absolute_time);
BEGIN
  c.thousandths := a.thousandths - b.thousandths;
  sisma := 0;
  IF c.thousandths < 0 THEN
    BEGIN
      c.thousandths := c.thousandths + 1000;
      sisma := -1
    END;
  c.units := a.units - b.units + sisma
END;

PROCEDURE divide_time(
  VAR a : absolute_time;
  b : absolute_time;
  n : INTEGER
);
( a <-- b DIV n )
VAR
  p,q : INTEGER[16];
BEGIN
  a.thousandths := 0;
  a.units := 0;
  q := b.units;
  q := q * 1000;
  q := q + b.thousandths;
  q := q DIV n;
  p := q DIV 1000;
  IF p < 32768 THEN
    a.units := TRUNC(p);
    p := q - (1000 * p);
  IF p < 32768 THEN
    a.thousandths := TRUNC(p)
  END;

PROCEDURE add_time(a,b : absolute_time; VAR c : absolute_time);
BEGIN
  sisma := a.thousandths + b.thousandths;
  c.thousandths := sisma MOD 1000;
  c.units := a.units + b.units + (sisma DIV 1000)
END;

PROCEDURE print_time(a : absolute_time);
VAR
  z1000,z100 : STRING[1];
BEGIN
  IF a.thousandths < 100 THEN z1000 := '0' ELSE z1000 := '';
  IF a.thousandths < 10 THEN z100 := '0' ELSE z100 := '';
  IF LENGTH(s) > 25 THEN s := COPY(s,1,25);
  WRITELN(s,a.units,',',z1000,z100,a.thousandths)

```

Listing 1 continued on page 62

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Listing 1 continued:

```

END;
<<<< opening "ENORMAL.TEXT">>>>
PROCEDURE normalize_timings;
VAR
    i          : INTEGER;

PROCEDURE sum_up_rins(rins: INTEGER; VAR rins_total : absolute_time);
VAR
    index,i : INTEGER;
    this_rins : absolute_time;

BEGIN
    rins_total.units := 0;
    rins_total.thousandths := post_rins_delay;
    FOR i := 1 TO rins_frames DO
        BEGIN
            this_rins.units := 0;
            this_rins.thousandths := transient_shots[rins].wait_after;
            add_time(this_rins,rins_total,rins_total);
            this_rins.thousandths := transient_shots[rins].duration;
            add_time(this_rins,rins_total,rins_total)
        END
    END;

PROCEDURE sum_up_eclipse(VAR eclipse_total : absolute_time);
VAR
    this_shot : absolute_time;
    index,i,j : INTEGER;
BEGIN
    eclipse_total.units := 0;
    eclipse_total.thousandths := overhead_duration;
    ( this compensates for the minimum wait after one )
    ( frame started and ended during the slack time period )
    FOR i := 1 TO total_eclipse DO
        BEGIN
            this_shot.units := 0;
            index := (i-1) MOD 25;
            this_shot.thousandths := twenty_five_shots[index].wait_after;
            add_time(this_shot,eclipse_total,eclipse_total);
            this_shot.thousandths := twenty_five_shots[index].duration;
            add_time(this_shot,eclipse_total,eclipse_total)
        END
    END;

PROCEDURE preliminary_allocation;
BEGIN
    s := 'Allocation of Eclipse Times...';
    new_page;
    s := 'Total time of eclipse = ';
    print_time(time_totality);

    WRITELN('-----');
    which_rins := second;
    sum_up_rins(ORD(which_rins),second_contact_rins);

    s := 'Second contact time = ';
    print_time(second_contact_rins);

    which_rins := third;
    sum_up_rins(ORD(which_rins),third_contact_rins);

    s := 'Third contact time = ';
    print_time(third_contact_rins);

    add_time(second_contact_rins,third_contact_rins,rins_time);
    s := 'Tot. diamond rins time = ';
    print_time(rins_time);
    divide_time(quarter_time,second_contact_rins,2);
    s := 'Anticipation time = ';
    print_time(quarter_time);

    WRITELN('-----');
    sum_up_eclipse(tot_time);
    s := 'Totality time = ';
    print_time(tot_time);
    s := 'Margin at end totality = ';
    print_time(slack_in_totality);

    divide_time(half_time,rins_time,2);
    s := 'Diamond rins slack = ';
    print_time(half_time);

    add_time(tot_time,slack_in_totality,total_duration);
    add_time(total_duration,half_time,total_duration);
    s := 'Total time initially = ';
    print_time(total_duration);

    WRITELN('-----');
    subtract_time(time_totality,total_duration,margin_time);
    s := 'Margin for allocation = ';
    print_time(margin_time)
END (preliminary_allocation);

```

Listing 1 continued on page 64



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Listing 1 continued:

```

PROCEDURE marsin_dispersal;
VAR
  marsin_per_frame : absolute_time;
  i : INTEGER;
BEGIN
  divide_time(marsin_per_frame,marsin_time,total_eclipse);
  FOR i := 0 TO 24 DO
    twenty_five_shots[i].wait_after :=
      twenty_five_shots[i].wait_after +
      (1000 * marsin_per_frame.units) +
      marsin_per_frame.thousandths;
  s := 'Marsin per tot. frame = ';
  print_time(marsin_per_frame)
END (marsin_dispersal);

PROCEDURE final_allocation;
BEGIN
  sum_up_eclipse(tot_time);
  s := 'Adjusted total phase = ';
  print_time(tot_time);

  add_time(tot_time,slack_in_totality,total_duration);
  add_time(total_duration,half_time,total_duration);
  s := 'Adjusted commitments = ';
  print_time(total_duration);

  add_time(tot_time,slack_in_totality,total_elapsed_time);
  add_time(total_elapsed_time,rins_time,total_elapsed_time);
  s := 'Total elapsed time = ';
  print_time(total_elapsed_time);

  WRITELN('-----');
  subtract_time(time_totality,total_duration,marsin_time);
  s := 'Marsin after allocation = ';
  print_time(marsin_time)
END (final_allocation);

PROCEDURE alloc_exposures;
BEGIN
  rins_frames :=
    (maximum - total_eclipse) DIV 2;
  IF rins_frames < 2 THEN error_abort;
  sisma := maximum - (total_eclipse + (2 * rins_frames));
  total_eclipse := total_eclipse + sisma;
  WRITELN('');
  WRITELN(' Exposures map:');
  WRITELN('First diamond rins = ',rins_frames);
  WRITELN('Totality = ',total_eclipse);
  WRITELN('Second diamond rins = ',rins_frames);
  WRITELN('-----');
  WRITELN(' TOTAL = ',maximum);
  WRITELN('');
  WRITELN('');
  WRITELN('Press return to continue');
  READLN(s)
END (alloc_exposures);

BEGIN (normalize_timing)

  alloc_exposures;

  preliminary_allocation;

  marsin_dispersal;

  final_allocation

END (normalize_timing);

PROCEDURE milli(time : INTEGER);
EXTERNAL;

PROCEDURE ref_memory(address : INTEGER);
( This procedure uses the variant record technique to
reference an address passed to it as a 16 bit signed
INTEGER. The Apple-II hardware will set or reset the
annunciator outputs of the Game I/O connector if the
appropriate addresses are simply referenced by a program.
)

TYPE
  ptr = ^CHAR;

  memory_access = (pointer,number)
( This is a dummy statement required by the syntax of
Pascal variant records such as "memory" below. The
variant record "trick" is not the most elegant way
to reference an absolute hardware address, since it
requires an implementation-dependent assumption about
variant records, ie: that a 16 bit signed two's complement
INTEGER type maps bit for bit into the 16 bit positive
integer value of an address stored in a Pascal pointer
data type.
);

```

Listing 1 continued on page 66



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Text continued from page 56:

morning as was the case in Montana last year, we would have missed the eclipse. But by the time of first contact, about 10 AM, the clouds had dissipated somewhat in the hot sun, to the point where maybe 50% of the time the sun was obscured. What this early cloudiness did, however, was keep my Apple from getting too hot too soon.

As the eclipse progressed, the air cooled off. Whether this lack of insulation due to the early phases of the eclipse affected the weather or not, it certainly helped guarantee the performance of my Apple during the total phase of the eclipse. At 11 AM when I turned on the power to my computer, it was delightfully cool in comparison with the previous afternoon. The weather had also improved considerably. We seemed by this time to be in a beautiful bowl of clear blue sky with the nearest clouds perhaps 5 to 10 miles away. This perfect eclipse-viewing weather lasted until well after the end of the event.

The Pascal system booted properly, and I proceeded to set up the final allocation I would use. Because I wanted to take a few partial phase shots manually, I had decided earlier that morning to limit the shots of totality to 200 exposures, with 120 taken during actual totality and the balance of 80 split equally between the two diamond-ring events. A slack time of 40 seconds was chosen to allow for the extra long exposure toward the end of the eclipse. Just to keep verifying the operation of the computer, I kept reentering the allocation phase of the program every few minutes.

Finally, at 11:21 AM, totality was heralded by a beautiful set of "shadow bands." After watching these last glimmers of direct sun, I removed the filter from my camera and gave the first manual cue to my eclipse program. I then had four enjoyable minutes of direct viewing of the eclipse, its effects on the local animal life, a glimpse of sunlight still illuminating the upper part of Kilimanjaro, and the incredible colorations of the distant clouds on the

Listing 1 continued:

```

memory =
  RECORD
    CASE memory_access OF
      pointer : (a_pointer : ptr);
      number  : (a_number : INTEGER)
    END;
  END;

VAR
  anybyte : memory;
  anychar : CHAR;

BEGIN
  anybyte.a_number := address;
  anychar := anybyte.a_pointer;
END (ref_memory);

PROCEDURE take_picture(photograph : an_exposure_detail);
BEGIN
  ref_memory(open_shutter_address);
  milli(photograph.duration);
  ref_memory(close_shutter_address);
  milli(photograph.wait_after)
END (take_picture);

PROCEDURE initialize;
VAR
  running_index : INTEGER;
BEGIN (initialize)
  s := '';
  ref_memory(close_shutter_address);
  current_time.units := 0;
  current_time.thousandths := 0;
  current_shot := 0;
  twenty_five_shots[0].duration := 1 + minimum_pulse_width;
  twenty_five_shots[1].duration := 2 + minimum_pulse_width;
  twenty_five_shots[2].duration := 5 + minimum_pulse_width;
  twenty_five_shots[3].duration := 10 + minimum_pulse_width;
  twenty_five_shots[4].duration := 20 + minimum_pulse_width;
  twenty_five_shots[5].duration := 50 + minimum_pulse_width;
  twenty_five_shots[6].duration := 100 + minimum_pulse_width;
  twenty_five_shots[7].duration := 200 + minimum_pulse_width;
  twenty_five_shots[8].duration := 500 + minimum_pulse_width;
  twenty_five_shots[9].duration := 1000 + minimum_pulse_width;
  twenty_five_shots[10].duration := 2000 + minimum_pulse_width;
  twenty_five_shots[11].duration := 5000 + minimum_pulse_width;
  twenty_five_shots[12].duration := 10000 + minimum_pulse_width;
  twenty_five_shots[13].duration := 5000 + minimum_pulse_width;
  twenty_five_shots[14].duration := 2000 + minimum_pulse_width;
  twenty_five_shots[15].duration := 1000 + minimum_pulse_width;
  twenty_five_shots[16].duration := 500 + minimum_pulse_width;
  twenty_five_shots[17].duration := 200 + minimum_pulse_width;
  twenty_five_shots[18].duration := 100 + minimum_pulse_width;
  twenty_five_shots[19].duration := 50 + minimum_pulse_width;
  twenty_five_shots[20].duration := 20 + minimum_pulse_width;
  twenty_five_shots[21].duration := 10 + minimum_pulse_width;
  twenty_five_shots[22].duration := 5 + minimum_pulse_width;
  twenty_five_shots[23].duration := 2 + minimum_pulse_width;
  twenty_five_shots[24].duration := 1 + minimum_pulse_width;
  FOR running_index := 0 TO 24 DO
    twenty_five_shots[running_index].wait_after := overhead_duration;

  transient_shots[0].duration := 5 + minimum_pulse_width;
  transient_shots[1].duration := 50 + minimum_pulse_width;
  FOR running_index := 0 TO 1 DO
    transient_shots[running_index].wait_after := overhead_duration;

  s := 'Restarting the program';
  new_page;
  WRITELN('Enter 0 to end, 1 to continue');
  WRITELN(' ' then <return> ');
  READLN(an_inteser);

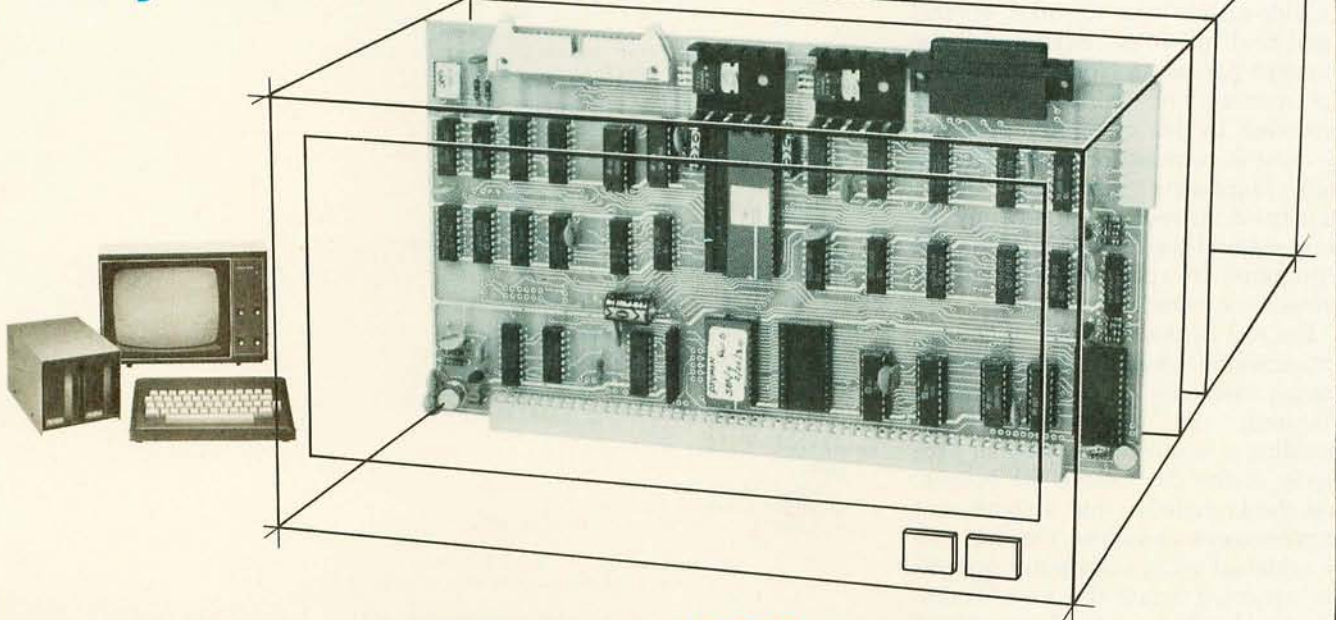
  IF an_inteser > 0 THEN
    BEGIN
      s := 'Preliminary data initialization';
      new_page;
      s := ' Enter number of exposures';
      set_parameter(dummy);
      maximum := dummy.units;
      s := 'Enter exposures in totality';
      REPEAT
        BEGIN
          set_parameter(dummy);
          total_eclipse := dummy.units
        END
    END
  END

```

Listing 1 continued on page 68

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Listing 1 continued:

horizon. I used a second camera with a wide-angle lens to take several hand-held pictures. Eventually the moment passed as Norm announced the coming of third contact as predicted by his computer program running in conjunction with a Mountain Hardware real-time clock. Perhaps a bit too late, I gave my second manual cue to my program, and I prepared to apply the lens cap to protect the camera and optics.

The rest of the trip was, of course, anticlimactic. I had the satisfaction of having had my program work as planned, the good fortune of avoiding a repeat of the thermal problems of the day before the eclipse, and the knowledge that a significant improvement in eclipse viewing can be achieved using a computer system. We returned home the next Thursday, and by Friday noon I was able to view the images photographed by my system during those 4 minutes in Tsavo the Saturday before. I don't know when I will next see a solar eclipse, but I am sure that whatever the state of the art of microcomputers at the time, I will be using one to improve my automation of photography of the 1980 eclipse.

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more formal description of procedures and requirements, potential authors should send a large (9 by 12 inch, 30.5 by 22.8 cm), self-addressed envelope, with 28 cents US postage affixed, to BYTE Author's Guide, 70 Main St, Peterborough NH 03458.

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

```

UNTIL
    (total_eclipse > 0)
    AND
    (total_eclipse < maximum);
s := 'Enter totality duration (sec)';
set_parameter(time_totality);
s := 'Enter slack time (sec)';
set_parameter(slack_in_totality);
END;
crash_ahead := TRUE;
END (initialize);

PROCEDURE await_cue;
VAR
    anychar : PACKED ARRAY[0..0] OF CHAR;
BEGIN (await_cue)
    WRITELN('');
    WRITELN('');
    WRITELN('');
    WRITELN('*****');
    WRITELN('Awaiting manual cue');
    WRITELN('*****');
    UNITREAD(2,anychar,1,0,0);
END (await_cue);

PROCEDURE diamond_rins_burst;
VAR
    i : INTEGER;
BEGIN (diamond_rins_burst)
    FOR i := 1 TO rins_frames DO
        BEGIN
            IF which_rins = second THEN
                take_picture(transient_shots[0]);
            ELSE
                take_picture(transient_shots[1]);
            END;
        milli(post_rins_delay);
    END (diamond_rins_burst);

PROCEDURE totality;
VAR
    exposure_count : INTEGER;
    cyclic_choice : INTEGER;
BEGIN (totality)
    WRITELN('Begin totality sequence');
    cyclic_choice := 0;
    FOR exposure_count := 1 TO total_eclipse DO
        BEGIN
            take_picture(twenty_five_shots[cyclic_choice]);
            cyclic_choice := (cyclic_choice + 1) MOD 25;
        END;
    WRITELN('End totality sequence');
END (totality);

PROCEDURE summarize;
BEGIN (summarize)
    WRITELN('Press return to end program');
    READLN(s);
END (summarize);

PROCEDURE perform_eclipse_dance;
BEGIN
    await_cue;
    diamond_rins_burst;
    totality;
    ref_memory(open_shutter_address); (sneak in one more exposure)
    await_cue;
    ref_memory(close_shutter_address);
    milli(overhead_duration);
    diamond_rins_burst;
END;

BEGIN (eclipse_monitor_simulation)
    an_integer := 100;
    WHILE an_integer > 0 DO
        BEGIN
            initialize;
            IF an_integer > 0 THEN
                BEGIN
                    normalize_times;
                    WRITELN('Is this an eclipse run? (Y = yes)');
                    READLN(s);
                    IF LENGTH(s) < 1 THEN s := ' ';
                    IF ((s[1] = 'y') OR (s[1] = 'Y')) THEN
                        perform_eclipse_dance;
                    END;
                END;
            summarize;
        END;
    END. (eclipse_monitor_simulation)

```

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Critique of Technique

This use of computer automation in photographing a solar eclipse provided a valuable improvement over manual methods. Computer automation allowed me to plan an exposure sequence which would be executed without relatively error-prone manual operations. This goal was achieved in the experiment described here. But by building on experience, one can always improve the techniques.

A relatively simple improvement would be to devote some automation to the partial phases of the eclipse. This would be accomplished by adding a loop to take photographs, for example, every five minutes, listening for the manual cue of imminent totality between partial phase shots. This would also assume cool enough temperatures for reliable operation over a 90-minute time span. I left this feature out because I had no idea of the proper exposure time to use and was too busy getting the main goal accomplished.

The problem of determining the mechanical overhead of the Nikon Motor Drive in the "bulb" position needs further attention. The shortest exposures in the 1980 eclipse were dictated by a fixed overhead time needed to ensure reliable triggering of the motor drive. If this time is too long, given the film used, then two options remain: using a slower film, or applying a filter to the lens during totality. The diamond-ring exposure times were much too long for a good photographic result. This problem would go away if a slower film or filters were applied. Since an equatorial telescope mount was tracking the sun during the eclipse, use of slower film would give a shorter effective minimum exposure time without sacrificing resolution with the long shots.

Two problems with my procedures during the 1980 eclipse will not go away given improvements

in computer systems techniques. The first problem is that of inadequate timing cues. While it would be possible to use a real-time clock to coordinate with universal time, such an open-loop operation would not necessarily guarantee better timing of the start of the sequences of totality photographs due to imprecision in our knowledge of latitude and longitude at a remote site.

The second difficult problem is forgetting to verify focusing of the camera during the automatic sequence. In this eclipse, I was lucky, because I did not jar the camera while removing the filter. But, quite frankly, I forgot to even look through the viewfinder while the automatic programming sequence was in operation. Had I twisted the barrel of the lens while removing the filter I could have had a real disaster of unfocused results.

And of course, the next time I go to the tropics with a computer, a sun shade of some sort will accompany me.

High-Level Conference

A key part of the success of this application of a personal computer to eclipse photography was the use of a high-level language system for nearly all of the programming. Listing 1 shows the final version of the eclipse camera-control program with an additional month's development from the state shown in listing 1 of the March 1980 editorial. This very successful use of Pascal in a relatively sophisticated engineering application helps emphasize the importance of the high-level-language design approach.

The importance of high-level languages in design extends far beyond any particular application. To help provide our professionally oriented readers with an intensive exposure to the design philosophy of modern software tools for small computers, we have created a

seminar on the subject. The seminar is organized in conjunction with the McGraw-Hill Conferences and Seminars group. It will be held at the McGraw-Hill building in New York City, June 16 and 17, 1980. The sessions of "The BYTE Conference on Languages and Tools for Microcomputing" will include six important talks on several essential high-level-language systems concepts for small computers.

Dr Fred Martin of Intermetrics Incorporated will talk about the high-level language-oriented software tools developed for the real-time systems programming of the NASA Space Shuttle flight computers. Dr Peter Grogono, author of *Programming in Pascal*, will present the philosophy of Pascal, the predominant block-structured, strongly typed language of contemporary microcomputer usage. Dr Ken Bowles, the driving force behind UCSD Pascal, will provide a fascinating talk entitled "After Pascal, What?" which concerns proposed microcomputer implementations of the US Defense Department's Ada language. John Morse of Digital Equipment Corporation will set Bell Laboratories' C language into a microcomputer context, describing its value as a systems and applications program implementation language. Dr Charles Moore of Forth Incorporated will describe the characteristics of Forth as a programming tool appropriate for small computers. Dr Henry Baker of the University of Rochester will complete this suite of language-oriented tools for microcomputers by presenting information on LISP and its applications. This 2-day intensive conference will end with a panel session in which all the speakers will participate.

For further information, contact The McGraw-Hill Conference and Exposition Center, 1221 Avenue of the Americas, Rm 3677, New York NY 10020, or see the advertisement in this issue. ■

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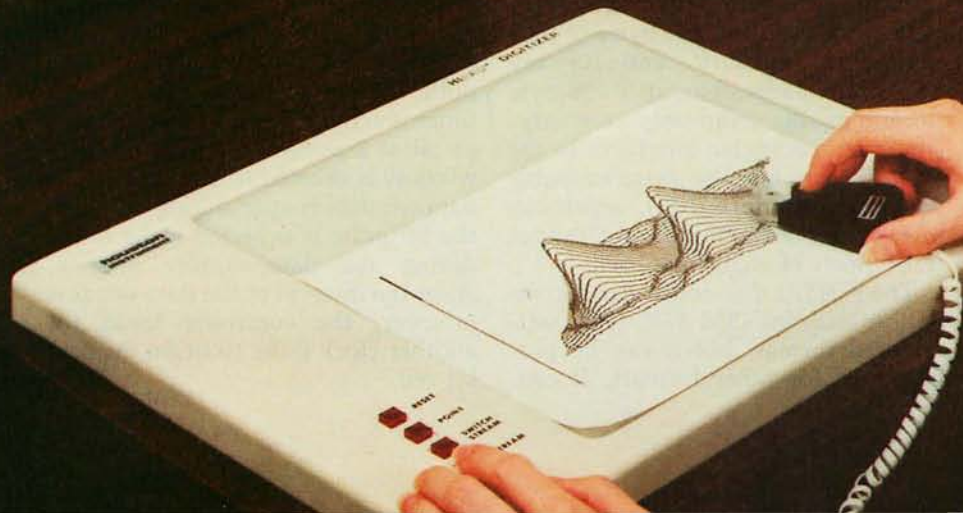
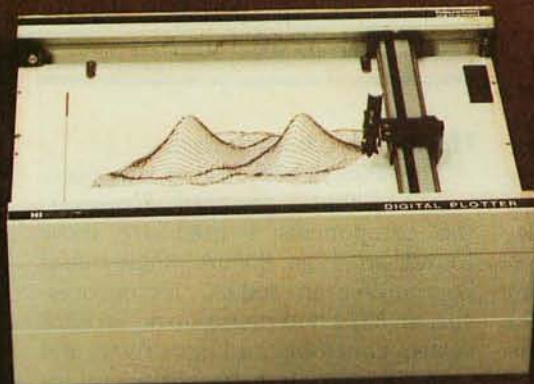
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Interface a Floppy-Disk Drive to an 8080A-Based Computer

John Hoepfner
Shugart Associates
415 Oakmead Pky
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The audio cassette has been used by most of us for off-line storage of programs and data. It has two advantages: it is inexpensive, and it is easy to implement because of the wide variety of cassette interfaces available.

However, I grew tired of waiting for the BASIC interpreter and all my data to be loaded every time I powered up my system. Even then, I sometimes had to load and reload the data until the interpreter and my programs were transferred correctly. I decided to try an alternative.

On one hand, the Shugart minifloppy 5-inch disk drive, which costs about \$350, was a little more expensive than my cassette recorder; but, on the other hand, the 5-inch floppy disk it uses costs about the same as a quality cassette tape — around \$4. And, despite a higher initial investment, the floppy disk is more reliable, and it can transfer programs and data as much as thirty times faster than the audio cassette. It seemed the more programs that were developed, the more worthwhile the additional investment would be. Also, with a recently introduced integrated circuit from Western Digital, the FD1771 floppy-disk formatter/controller, I could design a controller myself that could be interfaced to my

Minifloppy is a registered trademark of Shugart Associates used to describe their 5-inch floppy-disk drives.

8080A-based microcomputer system.

This article describes the hardware developed to connect a Shugart floppy-disk drive to an 8080A-based system using the Western Digital FD1771 chip, as well as the software routine necessary to drive the FD1771.

The FD1771 disk formatter/controller device is compatible with the IBM 3740 format.

Hardware Characteristics

The 8080A-based microcomputer was one that I designed. However, the components I used are those found on most 8080A single-board computers: an 8080A microprocessor, an 8224 two-phase clock, an 8228 system controller and bus driver, and an 8255 programmable peripheral interface. (See figure 1.) For temporary data storage, I used 2 K bytes of programmable memory, and for my bootstrap loader, I used a 256-byte programmable read-only memory. The microcomputer interfaces to the FD1771 through the programmable peripheral interface (PPI), which can be programmed as three input/output (I/O) ports of eight lines each.

The FD1771 disk controller is compatible with the IBM 3740-type, soft-sectored format, but it can be programmed for other formats. It con-

tains five registers: data, command, sector, track, and status. These registers hold the data and commands transferred from the 8080A processor. The FD1771 has a cyclic redundancy check (CRC) generator for performing a validity check on data transfers. It is also equipped with an internal data separator for separating clock and data bits from the disk into two separate streams. I chose not to use the internal data separator for the following reason.

Each bit of data on the disk is stored during a time interval called a *bit cell*. The bit cell is the space between two of the clock pulses that are recorded on the disk; the beginning of the bit cell is defined by the clock pulse. If the bit is to be recorded as a 1, a pulse is written in the center of the bit cell. If the bit is to be recorded as a 0, no pulse is written in the cell.

The bit pulse must be written on the disk inside certain boundaries. When the pulse is read by the disk drive, the pulse is presented to the controller within a certain time frame called the *data window*. The length of the bit cell is 8 μ s. When the clock pulse is detected by the controller, a timer is activated. This timer counts 2 μ s; after 2 μ s have elapsed, the data window is deemed to be "open." The data window is open during 4 μ s, and the bit pulse is expected to be found during the data-window interval. After the interval of the data window in over, the controller looks for another clock pulse to begin the next bit cell.

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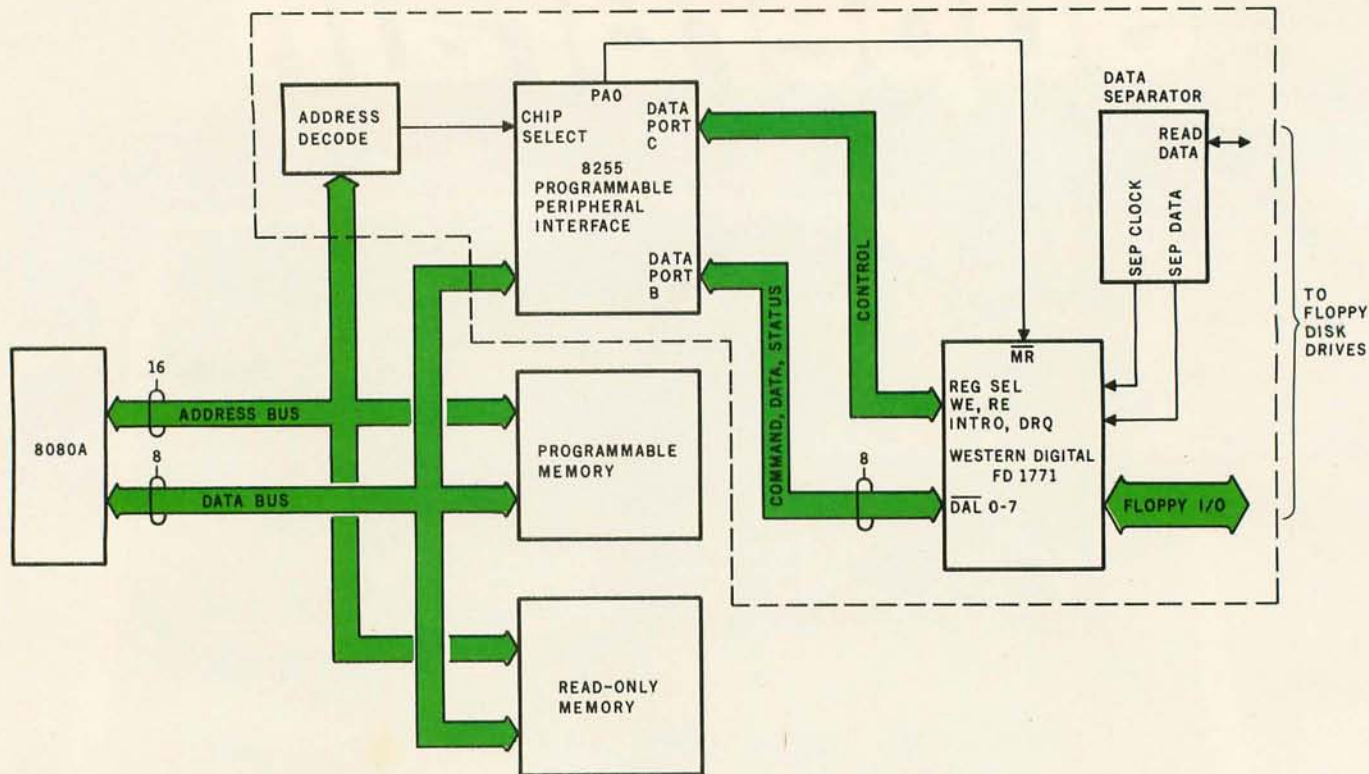


Figure 1: Block diagram of 8080A-based computer and interface to Shugart SA400 floppy-disk drive. The Western Digital FD1771 disk-controller circuit is illustrated here as the area within the dotted lines.

The problem with the FD1771 internal data separator arises from the counting after the clock pulse to find the beginning of the data window. The counter in the FD1771 is synchronous with the system clock pulses (at 1 MHz) that are fed into the FD1771. However, the pulses from the disk arrive at the controller *asynchronously*; the variation in the arrival intervals of the pulses is caused by a host of factors. Therefore, the data window as determined by the FD1771 can occupy varying positions within the bit cell. The position may vary by as much as 1 μ s (ie: 1 clock cycle) within the 8 μ s bit-cell interval.

In worst-case data patterns, this problem may lead to errors and loss of data. Therefore, I provided a data separator of my own design to replace the internal data separator of the FD1771. My data separator was built using a number of discrete logic gates of the 7400 family, as presented in figure 2.

The 5-inch floppy-disk drive I used was a Shugart SA400 minifloppy drive. It is organized to store data in thirty-five independent tracks. Each track contains 3125 unformatted bytes for a total unformatted capacity of 109.4 K bytes per disk. The for-

matting method I used results in an actual capacity of 71.68 K bytes per disk. The track-to-track access time of the data-transfer (ie: read/write) head is 40 ms. Once the read/write head is positioned above the correct track, another 10 ms of settling time must be allowed before a read or write operation can be performed. The basic data-transfer rate of the drive is 125 K bits per second, which translates to 15.6 K bytes per second. This compares to the audio cassette recorder's transfer rate of about 500 bytes per second.

Connecting the 8255 PPI

The 8255 programmable peripheral interface provides a universal means of interfacing peripheral devices to the 8080 microprocessor. It interfaces to the data bus through the 8228 system controller and bus driver. Three address lines (A0, A1, and A15) of the 8080A are connected to the 8255. Line A15 is connected to the chip select (CS) line of the 8255, giving the PPI a memory address of hexadecimal 8000. Lines A0 and A1 directly access registers in the 8255. This method of I/O addressing is called memory mapping, because it makes certain memory addresses act

as registers for communication between the computer and the peripheral device: it was necessary because the conventional I/O instructions were too slow.

The FD1771 interfaces to the processor through eight data lines (PB0 thru PB7) and seven control lines (PA1, PC0, PC1, PC2, PC3, PC6, and PC7), as shown in figure 2 (page 78). Ports A and B of the PPI, each providing eight lines for transfer of data, interface with the data lines of the FD1771. Three lines of port A also connect directly to the disk drive. Port C of the PPI handles the FD1771 control lines. The eighth control line of the FD1771 is not used, so it is tied to ground.

Six of the outputs of the PPI (PA0 thru PA3, PC2, and PC3) are logically inverted. Because the outputs of *all* ports on the 8255 go low when *any* port is commanded to change direction (from input to output, or vice versa), this inversion is necessary to prevent false signals from going to the FD1771, deselecting the drive and turning off the motor.

Due to total system-timing constraints, disk read and write routines must be performed within 56 μ s.

Text continued on page 80



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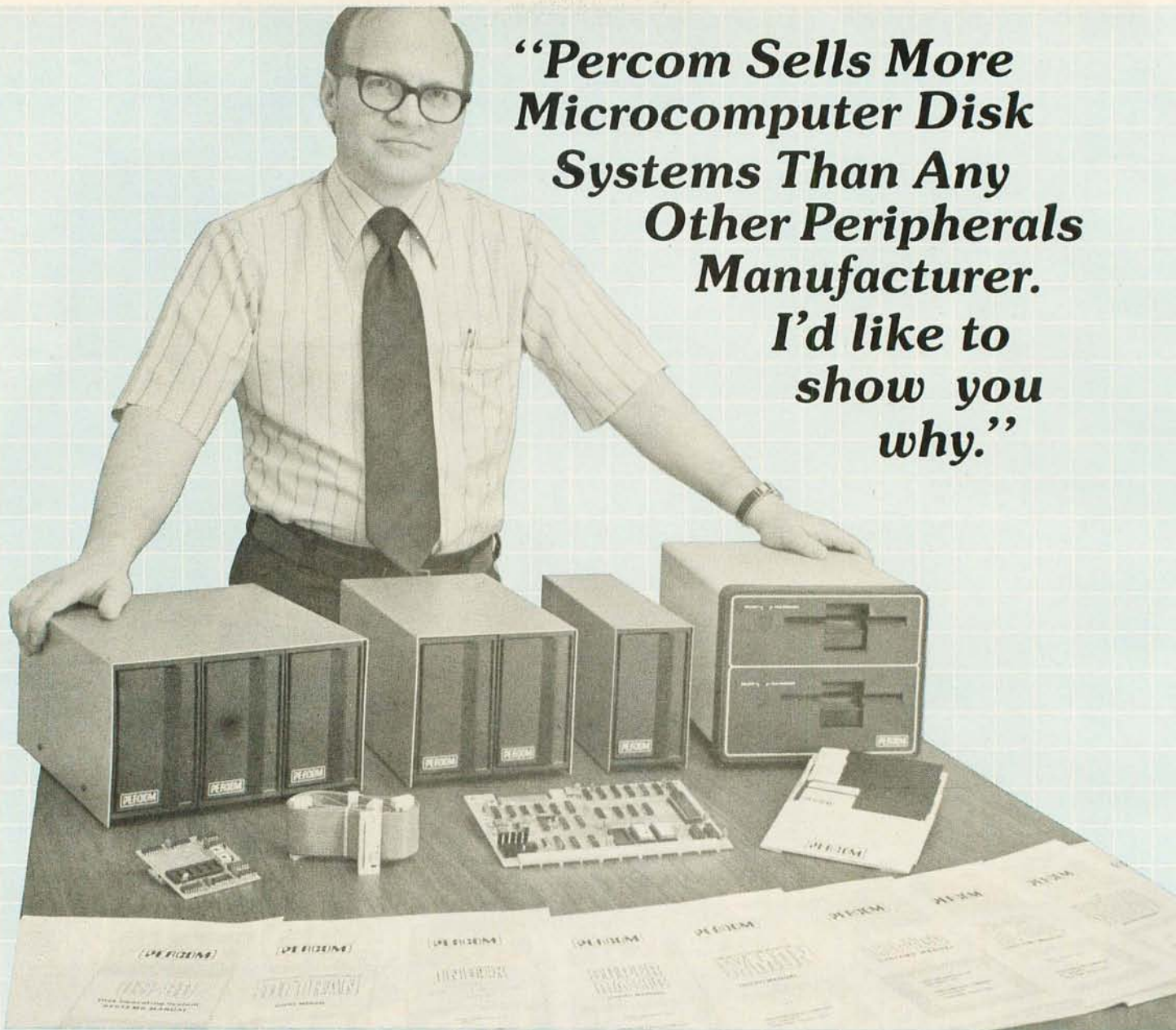
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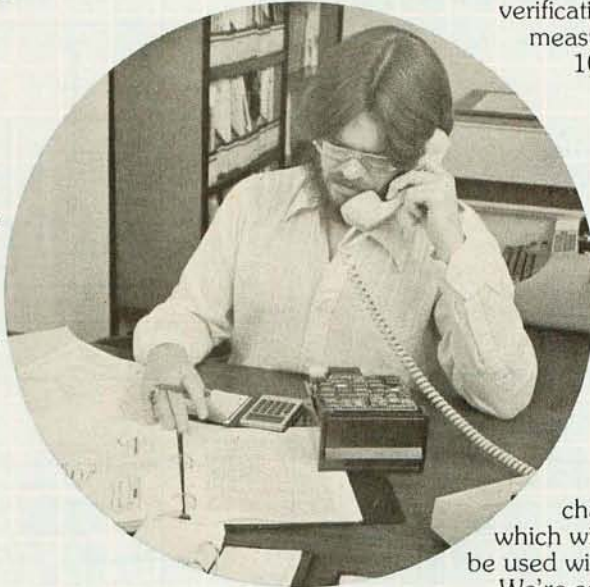
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IC2	8228	28	14		
IC3	8255	26	7		
IC4	FD1771	21	20	1	40
IC5	8224	16	8		9
IC6	7404	14	7		
IC7	7404	14	7		
IC8	9602	16	8		
IC9	9602	16	8		
IC10	7414	14	7		
IC11	7414	14	7		
IC12	7438	14	7		
IC13	7438	14	7		
IC14	7474	14	7		
IC15	7474	14	7		
IC16	9602	16	8		
IC17	7400	14	7		
IC18	7400	14	7		
IC19	7404	14	7		

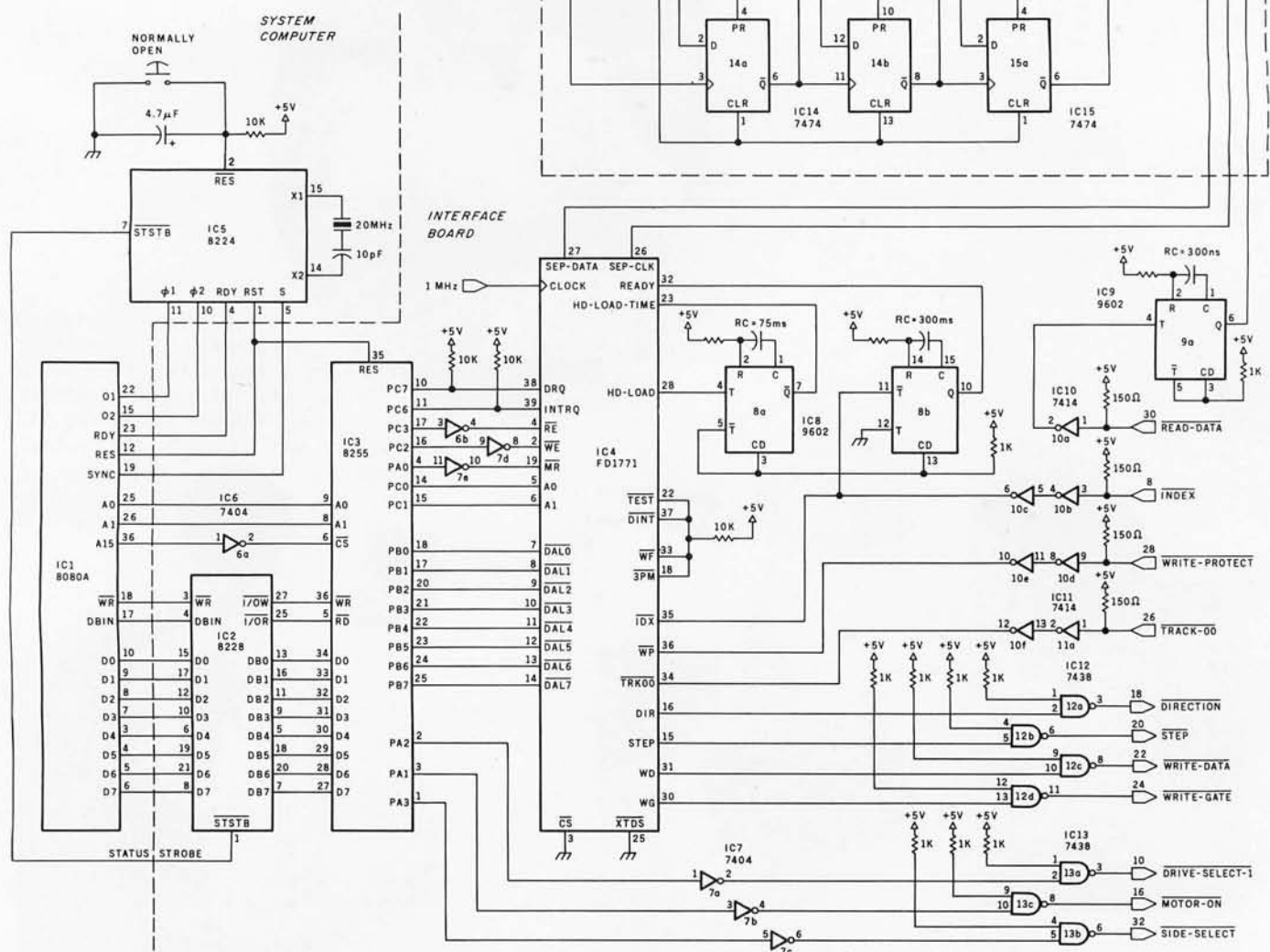
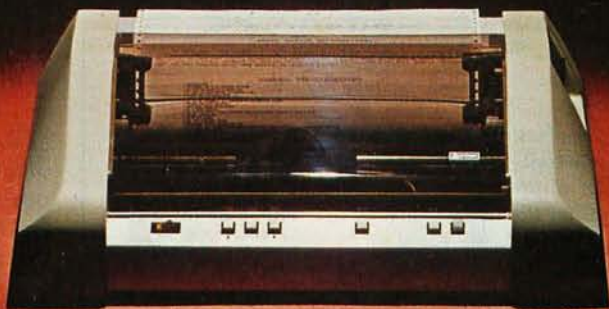


Figure 2: Disk-controller board. The circuit to the left of the dotted line is part of the computer being interfaced; the part to the right is the interface to the floppy-disk drive. The area in the dotted box is a data separator made from 7400-series TTL devices. It separates the clock bits from the data bits as they come from the disk drive.

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Text continued from page 74:

Therefore, it was necessary during the design process to shorten the time for checking the status of the drive. To allow fast status checking, bit 7, the most significant bit, of port C is tied to the FD1771's data-request line (DRQ). The value of the DRQ is brought into the accumulator by performing a memory-access instruction. It is then possible to perform an inclusive-OR of the accumulator with itself (ORA A), which results in the

sign bit being set to 1 if there is a data request (ie: if DRQ is high). Based on the status of the sign bit, control can branch to the appropriate routine. This arrangement eliminates the need to perform a separate check on the status bits using one of the logical instructions, thereby saving a significant amount of time.

Interfacing to the SA400

The SA400 drive has connections for twelve transistor-transistor logic

(TTL) compatible signal lines. Seven of them connect directly to the FD1771 lines through type-7414 Schmitt-trigger inverters used as line drivers and 7438 open-collector NAND buffers used as line receivers.

The WRITE-DATA line transmits digitized serial data to be written on the floppy disk. The WRITE-GATE signal, when activated, causes the data to be written on the disk. The WRITE-PROTECT line, when active in a low state, indicates that a write-protected disk has been inserted in the drive. The STEP line, when pulsed, causes the read/write head to move radially a distance of one track. The DIRECTION-SELECT line defines the direction that the read/write head moves when the STEP line is pulsed. The TRACK-00 line, when low, indicates when the read/write head is positioned over the outermost track, track 0. The INDEX line transmits the pulse that occurs once for every revolution of the floppy disk to indicate the beginning of a track. (The pulse comes when the index hole passes the photodetector.)

Three drive-select lines, which assign the logical drive address, are connected to port A of the 8255 through 7414 and 7438 circuits used as line drivers and receivers. A MOTOR-ON line, also tied to the 8255, controls the spindle-drive motor. The READ-DATA line is tied to the monostable multivibrator (commonly known as a one-shot) that shortens the pulse width from the drive to 300 ns before sending it to the data separator.

The FD1771 has nine other control lines, which control head positioning and data transfers, but which do not interface directly to the disk drive. Four of the lines to the FD1771 are not used. Lines TEST, DINT, WF and 3PM are therefore tied to +5 V through a 10 k-ohm resistor.

Of the remaining five control lines for the FD1771, the SEPARATED-CLOCK and SEPARATED-DATA lines transmit the clock and data bits from the data separator. (Clock pulses are used in frequency modulated (FM) encoding to signal the beginning of a bit cell.)

The READY line, which signals that the drive is ready for a read or write operation, must be active for the FD1771 to perform any function.

Text continued on page 84

A1	A0	Register Affected During Read (RE = 0, WE = 1)	Register Affected During Write (RE = 1, WE = 0)
0	0	Status Register	Command Register
0	1	Track Register	Track Register
1	0	Sector Register	Sector Register
1	1	Data Register	Data Register

Table 1: Access to registers within the Western Digital FD1771 disk formatter/controller device. The FD1771 has five internal registers: command, data, sector, status, and track. A given register is read or written by placing the appropriate values on lines A1 and A0 and pulling down either the READ-ENABLE (RE) line for a read operation, or the WRITE-ENABLE (WE) line for a write operation. The sector and track registers specify the sector and track when these parameters are needed by a given command byte. The command register, when filled, causes one of eleven high-level instructions to be executed (see table 2). Data passes between the computer and the disk drive through the data register. After a command has been executed by the FD1771, the status register must be read before another command can be executed.

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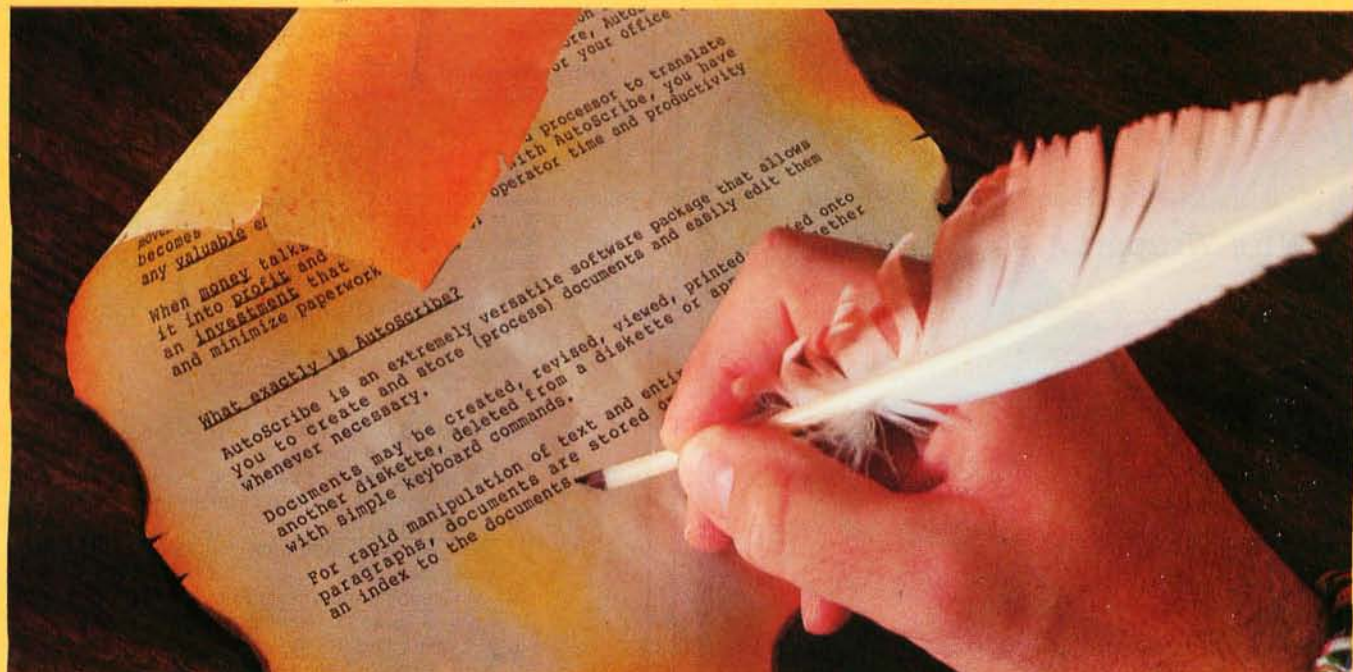
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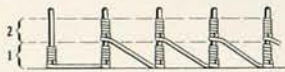
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TYPE	COMMAND	BITS							
		7	6	5	4	3	2	1	0
I	Restore	0	0	0	0	h	V	r ₁	r ₀
I	Seek	0	0	0	1	h	V	r ₁	r ₀
I	Step	0	0	1	u	h	V	r ₁	r ₀
I	Step In	0	1	0	u	h	V	r ₁	r ₀
I	Step Out	0	1	1	u	h	V	r ₁	r ₀
II	Read Command	1	0	0	m	b	E	a ₁	a ₀
II	Write Command	1	0	1	m	b	E	a ₁	a ₀
III	Read Address	1	1	0	0	0	1	0	0
III	Read Track	1	1	1	0	0	1	0	0
III	Write Track	1	1	1	1	0	1	0	0
IV	Force Interrupt	1	1	0	1	l ₃	l ₂	l ₁	l ₀

(a)

BIT VALUES FOR TYPE 1

h = Head Load flag (Bit 3)

h = 1, Load head at beginning

h = 0, Do not load head at beginning

V = Verify flag (Bit 2)

V = 1, Verify on last track

V = 0, No verify

r₁, r₀ = Stepping motor rate (Bits 1 thru 0)

r₁, r₀ = 11 gives 40 ms step time

u = Update flag (Bit 4)

u = 1, Update Track register

u = 0, No update

(b)

BIT VALUES FOR TYPE II

m = Multiple Record flag (Bit 4)

m = 0, Single record

m = 1, Multiple records

b = Block length flag (Bit 3)

b = 1, IBM format (128 to 1024 bytes)

b = 0, Non-IBM format (16 to 4096 bytes)

a₁, a₀ = Data Address Mark (Bits 1 thru 0)

a₁, a₀ = 00, FB (Data Mark)

a₁, a₀ = 01, FA (User defined)

a₁, a₀ = 10, F9 (User defined)

a₁, a₀ = 11, F8 (Deleted Data Mark)

(c)

BIT VALUES FOR TYPE III

s = Synchronize flag (Bit 0)

s = 0, Synchronize to Address Mark

s = 1, Do not synchronize to Address Mark

(d)

BIT VALUES FOR TYPE IV

l₀ thru l₃ = Interrupt Condition flags (Bits 3 thru 0)

l₀ = 1, Not Ready to Ready transition

l₁ = 1, Ready to Not Ready transition

l₂ = 1, Index pulse

l₃ = 1, Immediate interrupt

E = Enable HLD and 10 ms Delay

E = 1, Enable HLD, HLT and 10 ms delay

E = 0, Head is assumed engaged and there is no 10 ms delay.

(e)

Table 2: The high-level instructions of the FD 1771 disk formatter/controller device. When one of the instructions as defined by table 2a is loaded into the command register of the FD1771, the FD1771 executes one or a series of actions. Bits represented by a letter within a command are defined in the bit value tables for that type instruction, tables 2b thru 2e.

Text continued from page 80:

Since the Shugart SA400 floppy-disk drive has no "ready" signal, the drive's index signal is used to determine a ready condition.

The disk drive transmits the index pulse only when the drive door is closed, the disk is inserted, and the spindle motor is turning. Because the index pulse is transmitted once for each rotation of the disk, the speed of rotation may be determined by measuring the interval between pulses. When the drive spindle has reached final speed, the index pulse is transmitted at intervals of 200 ms.

I used the index pulse to trigger a monostable multivibrator, which generates a one-shot pulse with a length slightly greater than 200 ms. When the drive is up to speed, the one-shot is continuously activated, since the index pulse retriggers it at 200 ms intervals. This one-shot pulse is connected to the ready line on the FD1771, and the derived "ready" signal remains true as long as the drive is ready.

The HEAD-LOAD and HEAD-LOAD-TIME lines are related in func-

tion. When the FD1771 issues a command to the drive, the drive may have to first load the head. The head-load time for a Shugart SA400 drive is 75 ms. Since the FD1771 is designed for use with drives having a shorter head-load time, a time-out signal to indicate that the head is loaded must be generated externally. To insure that the head is loaded, the HEAD-LOAD signal from the FD1771 is tied to a monostable multivibrator having a pulse duration of 75 ms. The output is fed back to the FD1771 as its HEAD-LOAD-TIME input to force the FD1771 to wait for 75 ms before sending a read or write command to the drive.

The FD1771 controls the floppy-disk drive with one of several 8-bit command words; these command words are high-level in the sense that each initiates a series of operations that define the function requested. Generally, each command requires some type of parameter. So, before the 8080A microprocessor sends a command, it must first load the necessary parameter in the form of an 8-bit byte into the appropriate

register of the FD1771, whether the destination is the data, sector, or track register.

To place the necessary data in a register, address lines A0 and A1 are set according to the data in table 1, the READ-ENABLE (RE) line is held high and the WRITE-ENABLE (WE) line is pulled low. To implement a command, lines A0 and A1 must address the command register. An 8-bit byte representing the appropriate command is placed on the data lines of the FD1771 (via the B port of the 8255) and is sent to the command register as the WRITE-ENABLE line is toggled from high to low.

FD1771 Commands

The FD1771 recognizes eleven high-level commands; these are illustrated in table 2 with their binary representations. They can be divided into four types. Type I commands are used to move the drive's read/write head. Type II commands are read- and write-sector commands. Type III commands are read-address, read-track and write-track or formatting

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TRACK #	SECTOR C	SLOT 6	DRIVE I
00	0123	4567	89AB CDEF LBME
10	FOR	----	----
20	LLO	----	----
30	----	----	B-OL
40	RCOP	Y	----
50	-JLE	FINA	NCE I O
60	----	----	----
70	----	XLDU	FOAT E 3
80	----	----	----
90	ARCA	DE	JRPE NNY
00	ONAD	E	2+TL BLEM
10	----	----	+/LO
20	CHAI	N	----
30	----	----	C-

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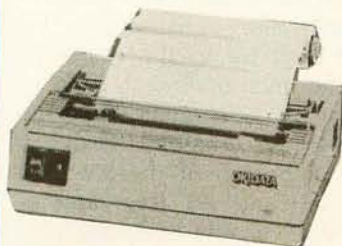


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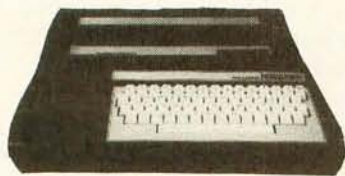
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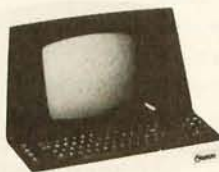
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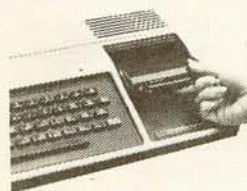
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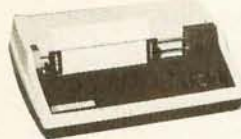
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commands. Type IV includes a class of command that raises the FD1771 interrupt line on a given condition.

The *restore* command causes the addressed drive to move the head to (or *seek*) track 0. When the *seek* command is executed, the addressed disk drive positions the read/write head over the track specified by the 8080A. The *step* command causes the drive to step the head one track in the direction previously selected. The *step-in* command causes the head to step one track toward track 35, the innermost track. With the *step-out* command, the head steps one track toward track 0.

A *read* command transfers a full sector of data, 1 byte at a time, from the disk to the 8080A. A *write* command transfers data for one sector from the microprocessor to the drive. A *read-track* command transfers all bytes of data on a track to the microprocessor. A *read-address* command transfers the next-encountered identification (ID) field to the microprocessor, places the sector address into the sector register, and checks the 2-byte cyclic-redundancy-check (CRC) field. During a *write-track* (format) command, the microprocessor must supply all gap, ID-field, and data bytes except for address marks and CRC bytes.

Data transfers between the 8080A and the floppy-disk drive can be performed using either direct memory access (DMA) or programmed I/O, both of which are supported by the FD1771. I chose programmed I/O, because it is the simpler method of the two, and because it is fast enough for single-density disk drives. With single-density recording, 1 byte is transferred every 64 μ s. An average 8080A instruction takes 5 to 6 μ s to execute, so that about ten instructions can be executed during the transfer time. This is enough time to gather the data and perform the required housekeeping functions.

Initializing the FD1771

Before the FD1771 can execute commands, it must be initialized. The program shown in listing 1 sets up the control ports of the 8255 PPI so that port A controls certain aspects of disk selection (as well as the MASTER-RESET (MR) pin of the FD1771); port B transmits the command, data, and status words for communication

between the 8255 and the FD1771; and port C controls data exchanges between the two devices. All commands and parameters come from the computer to the FD1771 through port B of the 8255. All data and status information from the disk to the computer uses the same path.

Data transfers can be performed with either direct memory access (DMA) or programmed input/output.

The initialization routine of listing 1 also checks the status of the FD1771 and initializes all the registers. The stack pointer is set to memory location hexadecimal 0BEF. For large applications, code for a disk-file library could be established in this routine as well.

Formatting the Disk

Formatting the disk is a matter of loading the track-address register with the point at which formatting is to begin, issuing the seek command which moves the head to that location, loading the data register with the format values, and issuing the write-track command to place that format on the disk.

Assuming that the formatting is to begin at track 0 on the disk, for example, a seek routine (such as the one given in listing 2) is executed. First, the seek routine places the track address (which is 0) on port B of the 8255. Then, holding line A0 high and A1 low (see table 1), the routine causes a write operation to the FD1771 to take place by holding the READ-ENABLE line (RE) high and pulling the WRITE-ENABLE line (WE) low. (See line 2 of table 1.) Similarly, the command code for a seek operation (hexadecimal 10) is placed on port B of the 8255 and is deposited into the command register of the FD1771 by holding both A0 and A1 low and causing a write operation to take place. When the FD1771 receives the command byte, it executes the seek command, ending with the read/write head in position over the appropriate track (here, track 0).

At the end of the operation, the FD1771 automatically raises the logic state on the interrupt line. At the same time, a byte of status information that indicates whether the command operation was successful is made available to the 8080A. Although the byte of status information does not *have* to be interpreted, the status register *must* be read before another operation can be performed. This is the purpose of the code marked "status handshake" in listing 2.

To format each track, the write-track command must be issued. This is done by placing the command byte for the write-track command (hexadecimal F4) on port B of the 8255, setting lines A0 and A1 low, and strobing the write-enable line with a high-to-low transition. Once this command is received, the FD1771 waits for an index pulse from the disk. The data register must then be filled with the contents of the entire track, 1 byte at a time. At the end of the track the disk drive sends the next index pulse, which causes an interrupt. To write the next track, a seek-to-track-1 operation is performed and another write-track command is issued.

Floppy Disk Format

Although the FD1771 permits non-IBM data-storage formats, I chose to use a modified version of the standard IBM format illustrated in figure 3. This is a 16-sector-per-track, 128-byte-per-sector format. In other words, each of the thirty-five tracks of the floppy disk contains sixteen records (see figure 3).

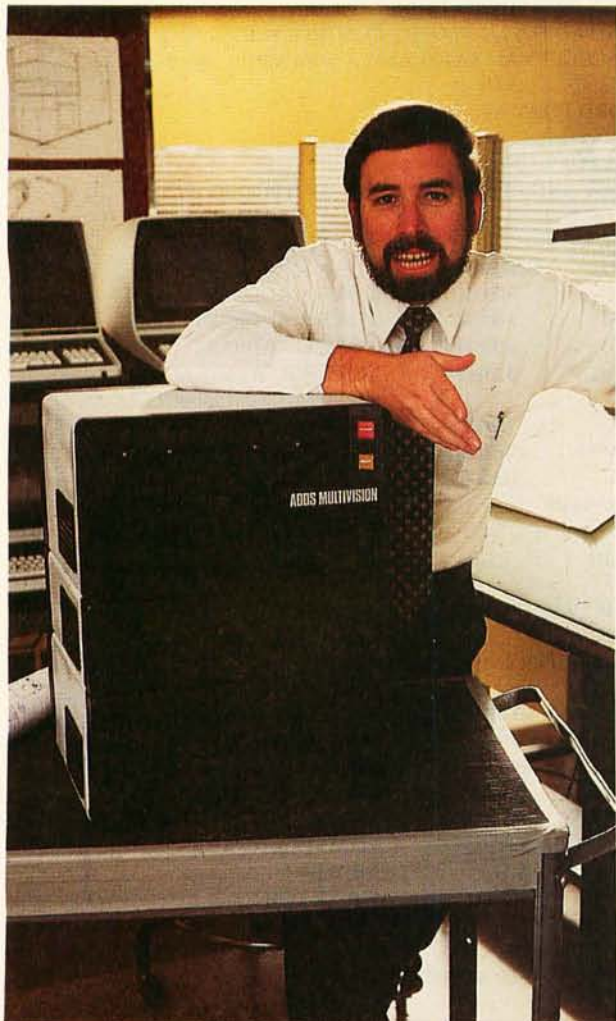
Each track starts with a gap, called G1, of 16 bytes, each containing the value hexadecimal FF. Next come sixteen records, each of which contains an identification (ID) field, a second gap (G2), a data field of 128 bytes, and an inter-record gap, G3, of 26 bytes. The track is finished with approximately 101 bytes of a final G4A gap field.

A 6-byte synchronization, or sync, section begins the identification field and is included to insure that the data separator is in phase with the data. The single-byte address mark (abbreviated as AM) field contains a unique character that defines the beginning of the ID2 section; here, it has a value of hexadecimal FE. The ID2 section

Text continued on page 100

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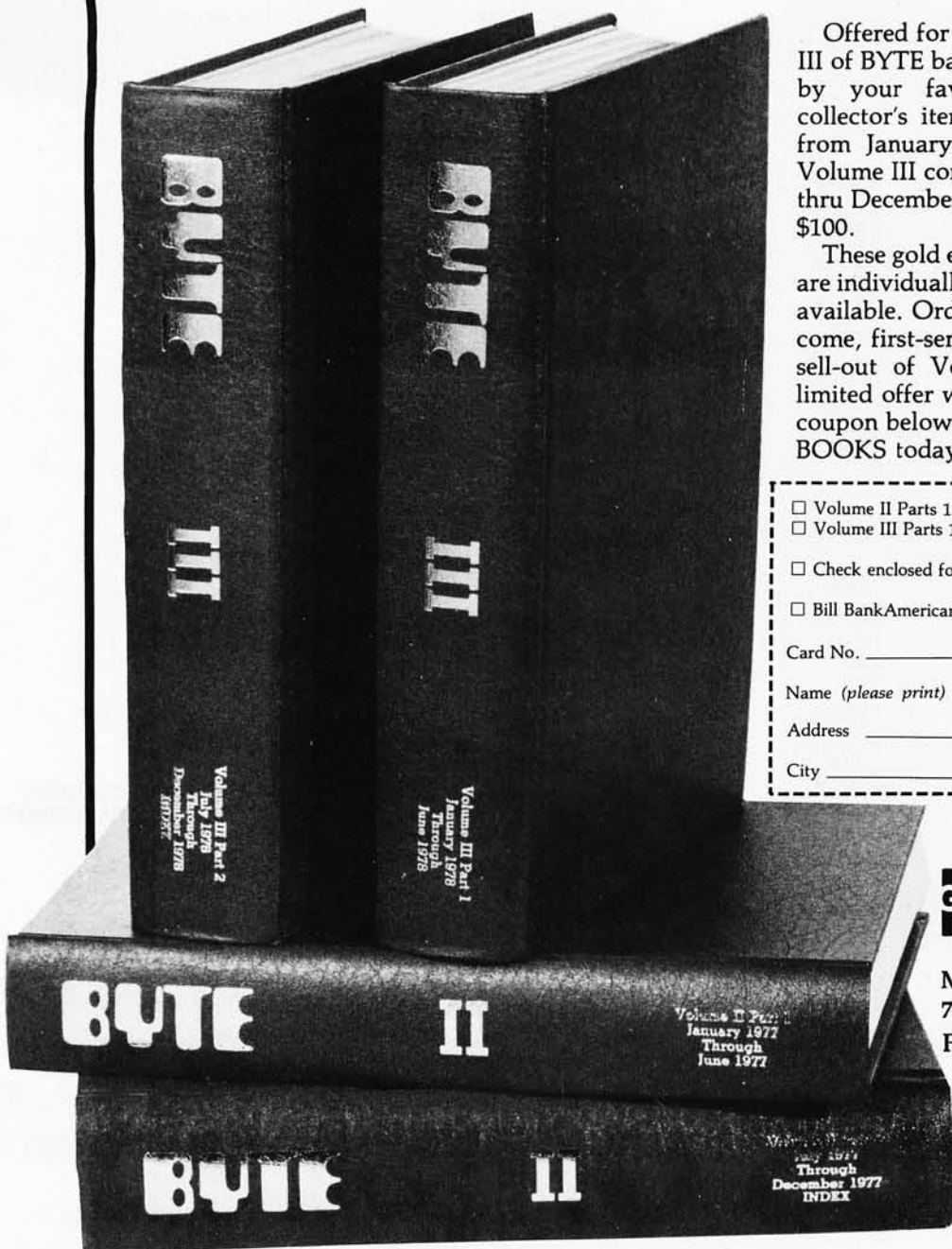
ADDS MULTIVISION

Listing 1: Program header and initialization routines. This routine initializes the 8255 programmable peripheral interface and sets the read/write head in the floppy-disk drive to track 0.

Hexadecimal Address	Hexadecimal Code	Label	Instruction Mnemonic and Operand	Commentary
		: INIT		
		:		
		:		;THIS PROGRAM IS DESIGNED TO PERFORM SEEKS,
		:		;READS, WRITES AND FORMATS USING THE
		:		;WESTERN DIGITAL FD1771 FLOPPY CONTROLLER
		:		;CHIP INTERFACED TO AN SA400 AND A 8080 MPU
0091		CTRL EQU 91H		
		:		;CONTROL WORD FORMAT:
		:		;MODE=0
		:		;PORTA=DATA PORT (INPUTS)
		:		;PORTB=STATUS AND COMMAND LINES (OUTPUTS)
		:		;PORTC=INPUTS, 0-3
		:		;PORTC=OUTPUTS, 4-7
8000		PORTA EQU 8000H		;PORT A ADDRESS
8001		PORTB EQU 8001H		;PORT B ADDRESS
8002		PORTC EQU 8002H		;PORT C ADDRESS
8003		CWR EQU 8003H		;CONTROL WORD ADDRESS
0520		CHARS EQU 520H		;COMMAND CHARACTERS
		:		ENTERED VIA CONSOLE
07D0		SEEK EQU 7D0H		;SEEK TRACK ROUTINE
0B10		READ EQU 0B10H		;READ SECTOR ROUTINE
0B80		WRITE EQU 0B80H		;WRITE SECTOR ROUTINE
0798		PIN EQU 798H		;PORT B SET AS INPUTS
		:		ROUTINE
		ORG 600H		
0600		:		
		:		;INITIALIZE THE PPI (POWER UP)
		:		
		:		;MR ALWAYS=1 AFTER INITIALIZATION
		:		
0600	31FF0B	INIT	LXI SP,0BFFH	;SET THE STACK
0603	CD9807		CALL PIN	;PORTB INPUTS
0606	210080		LXI H,PORTA	;PORTA ADRS
0609	3E01		MVI A,01H	;MR=0,DR SEL,MOT ON
060B	77		MOV M,A	;WRITE PORTA
060C	110280		LXI D,PORTC	;LOAD PORTC ADRS
060F	3E00		MVI A,0	;RE,WE=1
0611	12		STAX D	;WRITE PORTC
		:		
		:		;PPI INITIALIZATION DONE
		:		;RESTORE TO TRACK 0 IS AUTOMATIC
		:		
		TRK0		
0612	3E00		MVI A,00H	;MR=1
0614	77		MOV M,A	;WRITE PORTA
0615	3E08		MVI A,08H	;READ ENAB-STAT REG
0617	12		STAX D	;(RE=0) WRITE PORTC
0618	3A0180		LDA PORTB	;READ PORTB—GET
				STATUS
061B	4F		MOV C,A	;SAVE STAT REG
061C	3E00		MVI A,00H	;RE=1 (MR,WE=1)
061E	12		STAX D	;WRITE PORTC
061F	79		MOV A,C	;MOV STATUS TO A
0620	E604		ANI 4H	;GET TRAK 0 STATUS
0622	FE04		CPI 4H	;TRAK 0?
0624	CA1206		JZ TRKO	;NO
		:		
		:		;DRIVE NOW AT TRACK 0 — TEST READY
		:		
0627	79		MOV A,C	;RESTOR STATUS IN A
0628	E680		ANI 80H	;GET READY STATUS
062A	FE80		CPI 80H	;READY?
062C	CA3506		JZ INTERP	;YES GO TO IDLE LOOP
062F	010000		LXI B,0H	;ERROR CODE
0632	CD0007		CALL ERROR	

} PPI
INITIALIZE

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Listing 2: Seek routine. This routine causes the read/write head to go to (or seek) the track specified by a 2-digit number entered from the system console.

Hexadecimal Address	Hexadecimal Code	Label	Instruction Mnemonic and Operand	Commentary
				;THIS ROUTINE IS DESIGNED TO SEEK THE ;DRIVE TO A TRACK SPECIFIED BY THE 3RD & 4TH ;CHARACTERS ENTERED BY AN OPERATOR.
	8000	PORTA	EQU 8000H	;PORT A ADDRESS
	8001	PORTB	EQU 8001H	;PORT B ADDRESS
	8002	PORTC	EQU 8002H	;PORT C ADDRESS
	0793	POUT	EQU 793H	;PORT B SET AS OUTPUTS ROUTINE
	0798	PIN	EQU 798H	;PORT B SET AS INPUTS ROUTINE
	0769	STATUS	EQU 769H	;ROUTINE, CONVERTS STATUS TO ASCII PRINTABLE DATA
	0520	CHARS	EQU 0520H	;COMMAND CHARACTERS ENTERED VIA CONSOLE.
				;
	07D0		ORG 7D0H	;
				;
				;FORM THE TRACK ADDRESS FROM THE 3RD & 4TH ;CHARACTERS. 4TH CHARACTER MIGHT BE NEGATIVE ;IF ONLY ONE CHAR WAS ENTERED.
				;
07D0	2A2205	SEEK	LHLD CHARS+2	;GET BOTH CHARS
07D3	7C		MOV A,H	;XFR LS CHAR
07D4	B7		ORA A	;TERM ?
07D5	F2DC07		JP TWO	;NO
07D8	7D		MOV A,L	;LOAD SINGLE CHAR
07D9	C3E207		JMP NEWTRK	;YES
07DC	7D	TWO	MOV A,L	;XFR MS CHAR
07DD	07		RLC	;SHIFT TO MS POSITION
07DE	07		RLC	
07DF	07		RLC	
07E0	07		RLC	
07E1	84		ADD H	;MERGE CHARS
				;NOW PUT NEW TRACK ADDRESS IN FDC DATA REGISTER
				;
07E2	322008	NEWTRK	STA TRACK	;SAVE TRACK ADDRESS
07E5	CD9307		CALL POUT	;PORTB=OUTPUTS
07E8	210280		LXI H,PORTC	;GET PORT C ADRS
07EB	0603		MVI B,03H	;A0,A1=1
07ED	70		MOV M,B	;WRITE PORTC
07EE	3A2008		LDA TRACK	;TRAK ADRS
07F1	2F		CMA	;INVERT FOR WD BUS
07F2	320180		STA PORTB	;WRITE PORTB
07F5	0607		MVI B,07H	;WRITE TO DATA REG
07F7	70		MOV M,B	;WRITE PORTC
07F8	0600		B,00H	
07FA	70		MOV M,B	;WRITE PORTC
				;
				;INITIATE SEEK COMMAND
				;
07FB	3E1F		MVI A,1FH	;SEEK 40 MS STEP
07FD	2F		CMA	
07FE	320180		STA PORTB	;WRITE PORTB
0801	0604		MVI B,04H	;WRITE TO CMD REG
0803	70		MOV M,B	;WRITE PORTC
0804	0600		MVI B,00H	;RE,WE = 1
0806	70		MOV M,B	;WRITE PORTC
				;
				;WAIT FOR END OF SEEK — THEN REPORT STATUS
				;

**COMMAND
HANDSHAKE**

Listing 2 continued on page 92

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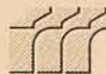
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BASIC COMPILER	●	●	□	●	
FORTRAN-80 COMPILER	●	●	□	■	●
COBOL-80 COMPILER	●	●		●	
muMATH/muSIMP muLISP	●		□		
MICROSEED DBMS	●				
EDIT-80 TEXT EDITOR	●		□	■	
MACRO-80 ASSEMBLER	●	●	□	■	●

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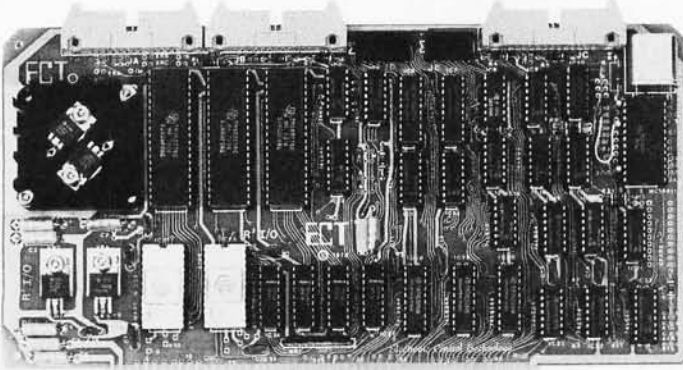
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Listing 2 continued:

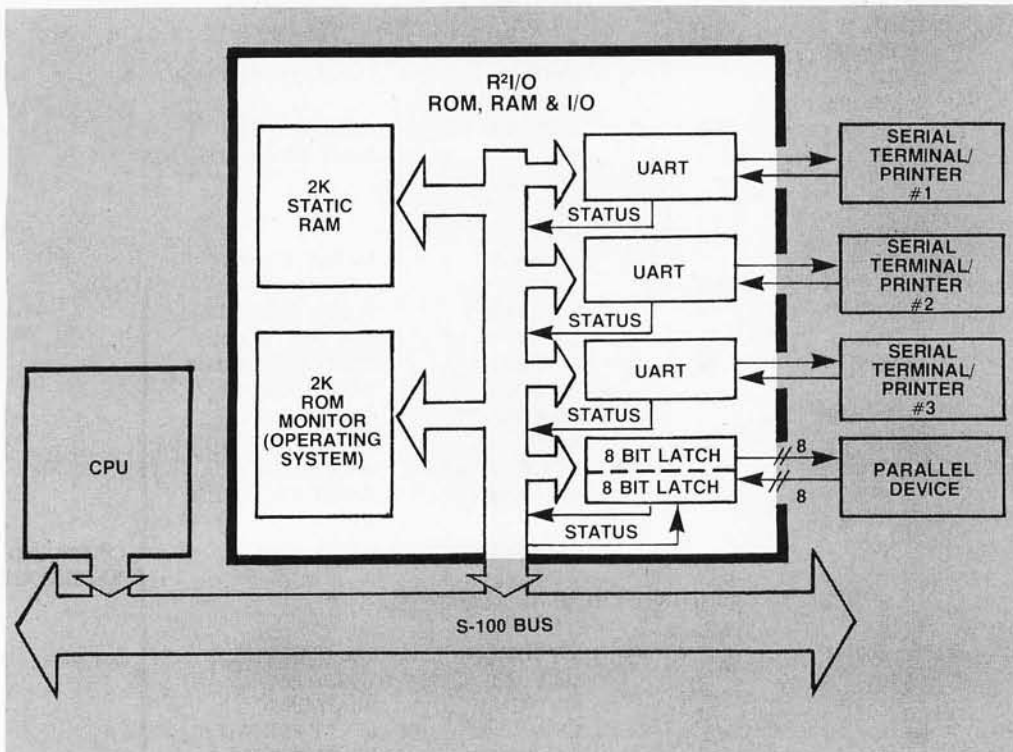
0807	CD9807		CALL PIN		
080A	7E	WAIT	MOV A,M	;WAIT FOR END OF SEEK	}
080B	E640		ANI 40H		
080D	CA0A08		JZ WAIT		
0810	3E08		MVI A,08H	;STAT REG READ	
0812	77		MOV M,A	;WRITE PORTC	
0813	3A0180		LDA PORTB	;BRING STATUS	
0816	0600		MVI B,00H	;RE,WE= 1	
0818	70		MOV M,B	;WRITE PORT B	
0819	2F		CMA	;INVERT	
081A	E618		ANI 18H	;SEEK AND CRC BITS	
081C	CD6907		CALL	;REPORT TO CONSOLE	}
081F	C9		STATUS		
			RET		
0820	00	TRACK	BYTE 0		
	07D0		END SEEK		

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- S-100 BUS
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- 2K RAM
- ROM Monitor (Operating System)
- 3 Serial I/O Ports
- 1 Parallel I/O Port
- 4 Status Ports

ELECTRONIC CONTROL TECHNOLOGY's R²I/O is an S-100 Bus I/O Board with 3 Serial I/O Ports (UART's), 1 Parallel I/O Port, 4 Status Ports, 2K of ROM with Monitor Program and 2K of Static RAM. The R²I/O provides a convenient means of interfacing several I/O devices, such as - CRT terminals, line printers, modems or other devices, to an S-100 Bus Microcomputer or dedicated controller. It also provides for convenient Microcomputer system control from a terminal keyboard with the 8080 Apple ROM monitor containing 26 Executive Commands and I/O routines. It can be used in dedicated control applications to produce a system with as few as two boards, since the R²I/O contains ROM, RAM and I/O. The standard configuration has the Monitor ROM located at F000 Hex with the RAM at F800 Hex and the I/O occupies the first block of 8 ports. Jumper areas provide flexibility to change these locations, within reason, as well as allow the use of ROM's other than the 2708 (e.g. 2716 or similar 24 pin devices). Baud rates are individually selectable from 75 to 9600. Voltage levels of the Serial I/O Ports are RS-232.



8080 APPLE MONITOR COMMANDS

- A - Assign I/O
- B - Branch to user routine A-Z
- C - Undefined
- D - Display memory on console in Hex
- E - End of file tag for Hex dumps
- F - Fill memory with a constant
- G - GOTO an address with breakpoints
- H - Hex math sum & difference
- I - User defined
- J - Non-destructive memory test
- K - User defined
- L - Load a binary format file
- M - Move memory block to another address
- N - Nulls leader/trailer
- O - User defined
- P - Put ASCII into memory
- Q - Query I/O ports: QI (N)-read I/O; QO(N,V)-send I/O
- R - Read a Hex file with checksum
- S - Substitute/examine memory in Hex
- T - Types the contents of memory in ASCII equivalent
- U - Unload memory in Binary format
- V - Verify memory block against another memory block
- W - Write a checksummed Hex file
- X - Examine/modify CPU registers
- Y - 'Yes there' search for 'N' Bytes in memory
- Z - 'Z END' address of last R/W memory location

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Listing 3: Read-sector routine. This routine causes the contents of a given sector of the current track (specified by a 2-digit number entered from the system console) to be transferred from the disk drive to an area of memory starting at the location given by the value of DATBUF, using decreasing memory addresses.

Hexadecimal Address	Hexadecimal Code	Label	Instruction Mnemonic and Operand	Commentary
			;READ READ SECTOR ROUTINE	
			;	
			;READ SECTOR ROUTINE INITIATES THE READ	
			;COMMAND AND TRANSFERS ALL THE DATA FOR A	
			;SELECTED SECTOR TO THE BOTTOM OF MEMORY	
			;BEGINNING AT LOCATION 5FF	
			;R,XX READ SECTOR, SECTOR ADRS	
	8000	PORTA	EQU 8000H	;PORT A ADDRESS
	8001	PORTB	EQU 8001H	;PORT B ADDRESS
	8002	PORTC	EQU 8002H	;PORT C ADDRESS
	0793	POUT	EQU 793H	;PORT B SET AS OUTPUTS ROUTINE
	0798	PIN	EQU 798H	;PORT B SET AS INPUTS ROUTINE
	0769	STATUS	EQU 769H	;ROUTINE CONVERTS STATUS TO
				ASCII PRINTABLE DATA
	05FF	DATBUF	EQU 5FFH	;BEGINNING ADRS OF "READ"
				DATA BUFFER
	0520	CHARS	EQU 520H	;COMMAND CHARACTERS ENTERED
				VIA CONSOLE
			;	
	0B10		ORG 0B10H	
			;	
0B10	2A2205	READ	LHLD CHARS+2	;GET BOTH CHARS
0B13	7C		MOV A,H	;XFER LS CHAR
0B14	B7		ORA A	;TERM?
0B15	F21C0B		JP TWO	;NO
0B18	7D		MOV A,L	;LOAD SINGLE CHAR
0B19	C3220B		JMP SECTOR	
0B1C	7D	TWO	MOV A,L	;XFER MS CHAR
0B1D	07		RLC	;SHIFT TO MS POSITION
0B1E	07		RLC	
0B1F	07		RLC	
0B20	07		RLC	
0B21	84		ADD H	;MERGE CHARS
0B22	327C0B	SECTOR	STA SECSTR	;STOR SECTOR
0B25	CD9307		CALL POUT	;PORTB OUTPUTS
0B28	210280		LXI H,PORTC	;GET PORTC ADRS
0B2B	0602		MVI B,02H	;SECTOR REGISTER
0B2D	70		MOV M,B	;WRITE PORTC
0B2E	3A7C0B		LDA SECSTR	;SECTOR ADRS
0B31	2F		CMA	;INVERT FOR WD BUS
0B32	320180		STA PORTB	;WRITE PORTB
0B35	0606		MVI B,06H	;WRITE TO SECTOR
			REG	
0B37	70		MOV M,B	;WRITE PORTC
			;	
			;INITIATE THE READ COMMAND	
			;	
0B38	0600		MV B,0	;SEL CMD REG
0B3A	70		MOV M,B	;WRITE PORTC
0B3B	3E88		MVI A,88H	;READ CMD
0B3D	2F		CMA	;INVRT FOR WD BUS
0B3E	320180		STA PORTB	;WRITE PORTB
0B41	0604		MVI B,04H	;ISSUE READ TO
				CMD REG
0B43	70		MOV M,B	;WRITE PORTC
			;	
			;WAIT FOR END OF READ — THEN REPORT	
			;	

**COMMAND
HANDSHAKE**


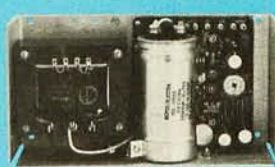

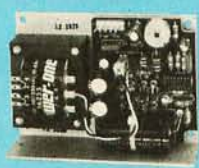

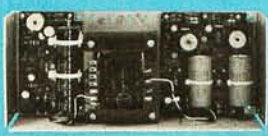

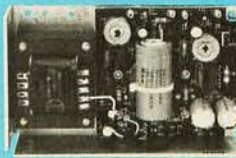
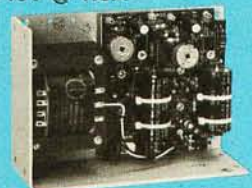
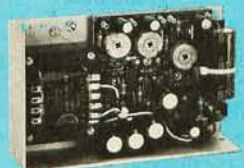
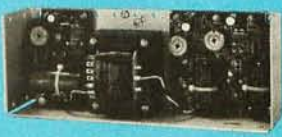
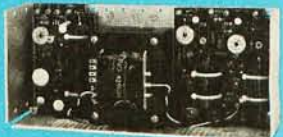
Listing 3 continued on page 96

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Listing 3 continued:

0B44	0603		MVI B,03H	:SEL DATA REG	} DATA TRANSFER SEQUENCE
0B46	70		MOV M,B	:WRITE PORTC	
0B47	CD9807		CALL PIN	:PORTB = INPUTS	
0B4A	11FF05		LXI D,DATBUF	:FWA OF DATA	
0B4D	0603		MVI B,03H	:RE,WE=1	
0B4F	C35C0B		JMP DLOOP		
0B52	3E0B	GD	MVI A,0BH	:RE=0	
0B54	77		MOV M,A	:WRITE PORTC	
0B55	3A0180		LDA PORTB	:GET DATA	
0B58	2F		CMA	:INVERT DATA	
0B59	12		STAX D	:SAVE IT	
0B5A	1B		DCX D	:BUMP INDEX	
0B5B	70		MOV M,B	:RE=1,PORTC	
0B5C	7E	DLOOP	MOV A,M	:GET STATUS PORTC	
0B5D	B7		ORA A	:DRQ=1?	
0B5E	FA520B		JM GD	:YES	
0B61	E640		ANI 40H	:INTRQ SET?	
0B63	CA5C0B		JX DLOOP	:NO	
			:		
			:READ DONE — GET STATUS		
			:		
0B66	3E00		MVI A,0	:ADRS STAT REG	} STATUS HANDSHAKE
0B68	77		MOV M,A	:WRITE PORTC	
0B69	3E08		MVI A,08H	:STROBE RE=0	
0B6B	77		MOV M,A	:WRITE PORTC	
0B6C	EB		XCHG		
0B6D	227E0B		SHLD ISAVE	:SAVE INDEX TO DATA	
0B70	EB		XCHG	:RESTOR PORTC ADRS	
0B71	3A0180		LDA PORTB	:GET STAT BYTE	
0B74	0600		MVI B,0	:STAT HANDSHAKE	
0B76	70		MOV M,B	:WRITE PORTC	
0B77	2F		CMA	:INVERT STAT BYTE	
0B78	CD6907		CALL STATUS	:REPORT STATUS	
0B7B	C9		RET		
			:		
0B7C	0000	SECSTR	WORD 0	:SECTOR ADRS	
0B7E	0000	ISAVE	WORD 0	:DATA INDEX STORAGE AREA	
	0B10		END READ		

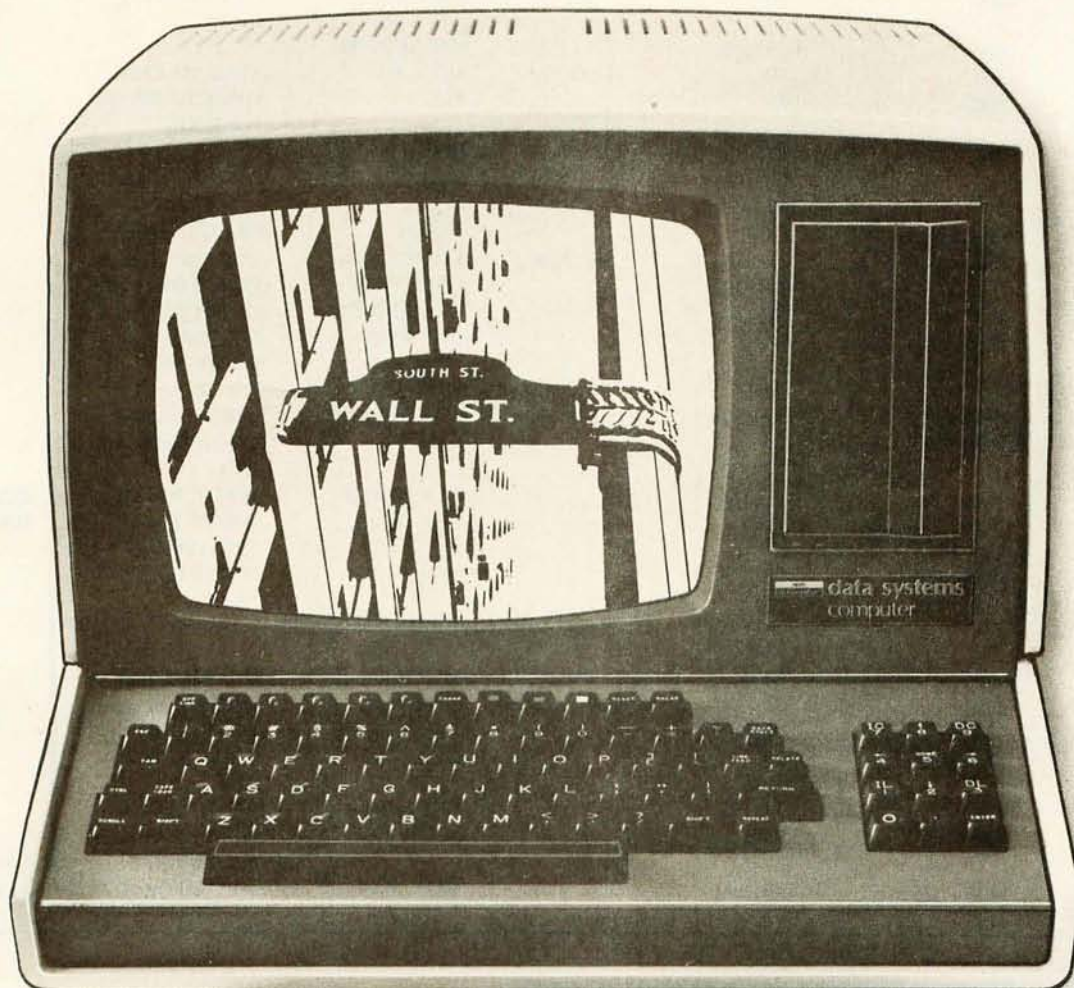
Listing 4: Write-sector routine. This routine causes a section of memory to be written to a given sector on the disk. The sector number is specified by a 2-digit number entered from the system console.

Hexadecimal Address	Hexadecimal Code	Label	Instruction Mnemonic and Operand	Commentary
			:WRITE WRITE SECTOR ROUTINE	
			:	
			:WRITE SECTOR ROUTINE INITIATES THE WRITE	
			:COMMAND AND TRANSFERS ALL THE DATA FOR A	
			:SELECTED SECTOR	
			:	
			:W,XX = WRITE SECTOR,SECTOR ADRS	
8000	PORTA		EQU 8000H	:PORT A ADRS
8001	PORTB		EQU 8001H	:PORT B ADRS
8002	PORTC		EQU 8002H	:PORT C ADRS
0793	POUT		EQU 793H	:PORT B SET AS OUTPUTS ROUTINE
0798	PIN		EQU 798H	:PORT B SET AS INPUTS ROUTINE
0769	STATUS		EQU 769H	:ROUTINE CONVERTS STATUS TO ASCII PRINTABLE DATA
0520	CHARS		EQU 520H	:COMMAND CHAR-

Listing 4 continued
on page 98

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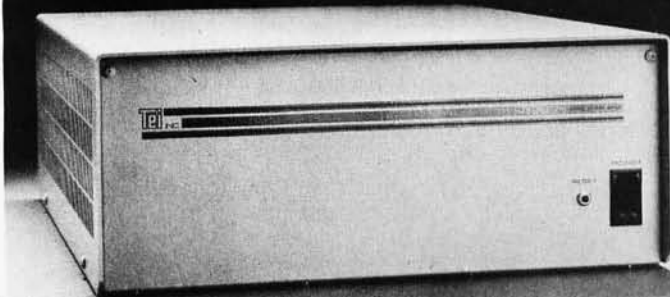
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				ACTERS ENTERED VIA CONSOLE	
			ORG 0B80H		
0B80	2A2205	READ	LHLD CHARS +2	;GET BOTH CHARS	
0B83	7C		MOV A,H	;XFER LS CHAR	
0B84	B7		ORA A	;TERM?	
0B85	F28C0B		JP TWO	;NO	
0B88	7D		MOV A,L	;LOAD SINGLE CHAR	
0B89	C3920B		JMP SECTOR		
0B8C	7D	TWO	MOV A,L	;XFER MS CHAR	
0B8D	07		RLC	;SHIFT TO MS POSITION	
0B8E	07		RLC		
0B8F	07		RLC		
0B90	07		RLC		
0B91	84		ADD H	;MERGE CHARS	
0B92	32E50B	SECTOR	STA SECSTR	;STOR SECTOR	
0B95	CD9307		CALL POUT	;PORTB OUTPUTS	
0B98	210280		LXI H,PORTC	;GET PORTC ADRS	
0B9B	0602		MVI B,02H	;SECTOR REGISTER	
0B9D	70		MOV M,B	;WRITE PORTC	
0B9E	3AE50B		LDA SECSTR	;SECTOR ADRS	
0BA1	2F		CMA	;INVERT FOR WD BUS	
0BA2	320180		STA PORTB	;WRITE PORTB	
0BA5	0606		MVI B,06H	;WRITE TO SECTOR REG	
0BA7	70		MOV M,B	;WRITE PORTC	
				} COMMAND HANDSHAKE	
			;INITIATE THE READ COMMAND		
0BA8	0600		MVI B,0		;SEL CMD REG
0BAA	70		MOV M,B		;WRITE PORTC
0BAB	3EA8		MVI A,0A8H		;WRITE CMD
0BAD	2F		CMA		;INVRT FOR WD BUS
0BAE	320180		STA PORTB		;WRITE PORTB
0BB1	0604		MVI B,04H		;ISSUE READ TO CMD REG
0BB3	70		MOV M,B		;WRITE PORTC

Listing 4 continued
on page 100

The Mainframe .

(or how to get a good night's sleep)



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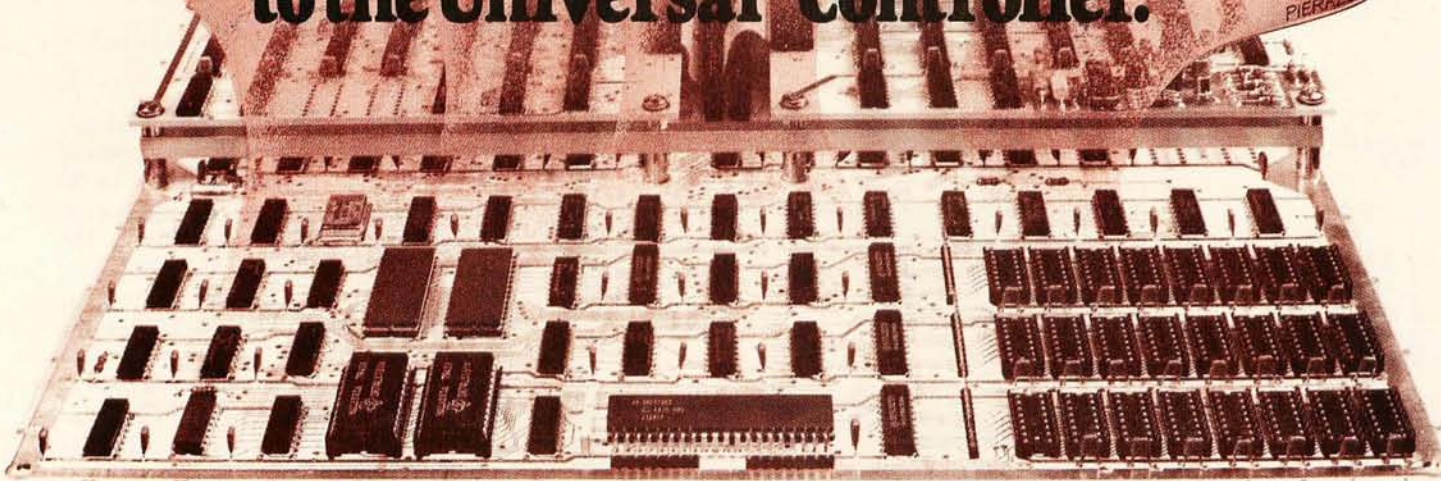
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And this little pluggy
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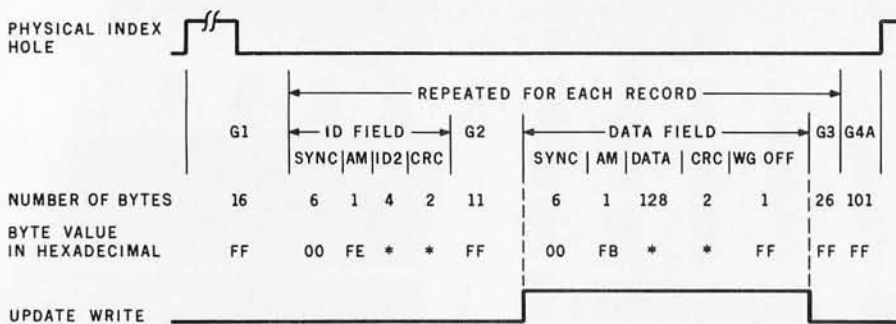
                                WAIT FOR END OF READ — THEN REPORT

0BB4          0603          MVI B,03H          ;SEL DATA REG
0BB6          70           MOV M,B            ;WRITE PORTC
0BB7          110180      LXI D,PORTB      ;PORTB ADRS
0BBA          0603          MVI B,03H          ;RE,WE=1
0BBC          C3C70B      JMP DLOOP
0BBF          3E8D        GD      MVI A,8DH      ;LOAD DATA
0BC1          2F          CMA              ;INVRT DATA
0BC2          12          STAX D            ;WRITE PORT B
0BC3          3E07        MVI A,07H      ;WE=0
0BC5          77          MOV M,A            ;WRITE PORTC
0BC6          70           MOV M,B            ;RE=1,PORTC
0BC7          7E          DLOOP      MOV A,M      ;GET STATUS
                                PORTC
0BC8          B7          ORA A              ;DRQ=1
0BC9          FABF0B      JM GD              ;YES
0BCC          E640        ANI 40H          ;INTERQ SET
0BCE          CAC70B      JZ DLOOP      ;NO

                                READ DONE — GET STATUS

0BD1          CD9807      CALL PIN        ;PORTB INPUTS
0BD4          3E00        MVI A,0         ;ADRS STAT REG
0BD6          77          MOV M,A         ;WRITE PORTC
0BD7          3E08        MVI A,08H      ;STROBE RE=0
0BD9          77          MOV M,A         ;WRITE PORTC
0BDA          3A0180      LDA PORTB      ;GET STAT BYTE
0BDD          0600        MVI B,0         ;STAT HANDSHAKE
0BDF          70           MOV M,B         ;WRITE PORTC
0BEO          2F          CMA              ;INVERT STAT
                                BYTE
0BE1          CD6907      CALL STATUS    ;REPORT STATUS
0BE4          C9          RET

0BE5          0000        SECSTR      WORD 0         ;SECTOR ADRS
                                0B80        END READ
    
```



LEGEND:

- ID IDENTIFICATION
- AM ADDRESS MARK
- CRC CYCLIC REDUNDANCY CHECK FIELD
- WG OFF WRITE-GATE-OFF BYTE

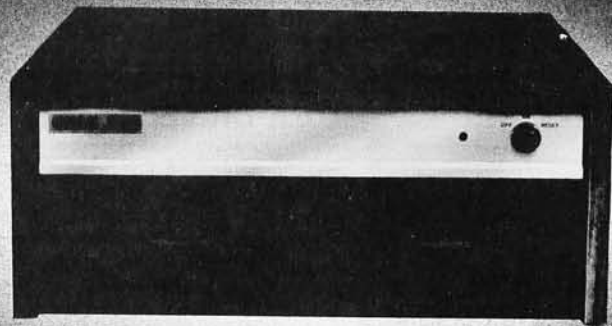
Figure 3: Format of data as recorded on one track of the disk drive. Each track contains sixteen records, each of which contains 128 bytes. Each record consists of an identification (ID) field followed by a data field. The columns marked with an asterisk represent fields with contents that vary from record to record.

Text continued from page 86:

contains the following: track address, side-select byte (set to 00 here), sector address, and sector length (set to 00 here because the sector length is constant); each field is 1 byte long. The cyclic-redundancy-check (CRC) section contains a 2-byte value that serves to check the accuracy of the previous bytes as written onto the disk. A command byte of hexadecimal F7 sent to the FD1771 controller causes it to generate and write the CRC bytes.

The data field also begins with a sync section. The address mark for this section, hexadecimal FD, is a different value than for the sync section in the identification field. A data section of 128 bytes follows and can be filled with any desired data. The last section within the data field is the write-gate-off (WG-off) byte, which allows the head an area in which to be

25MB



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- RS232 or TTY serial port for system console.
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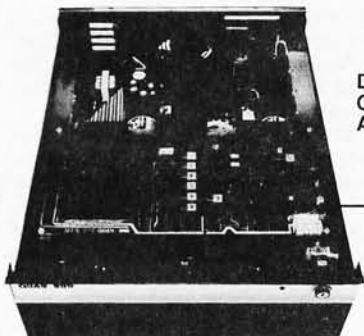
OPTIONS FOR THE 900 SERIES:

- Disk expansion: up to 5 Mb formatted capacity.
- Serial I/O expansion: two additional RS232 ports (serial printer, modem, etc.)
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- Multi-user operation
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- Application packages include: Inventory, Word Processing, GL, AR, AP and Payroll.

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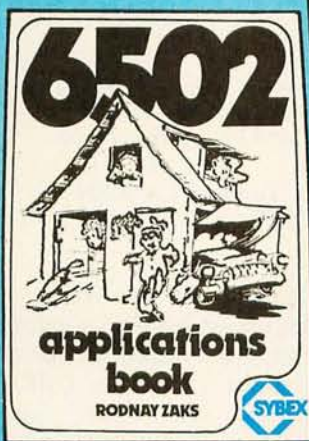
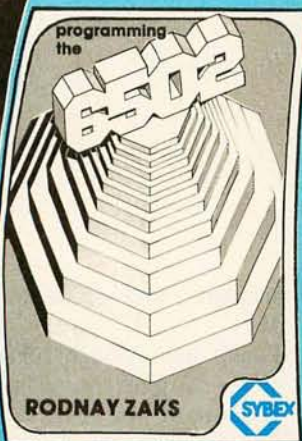
However, the read and write commands differ from commands like the seek command in the following one respect: data must be transferred. For example, a write command, in a data-transfer routine like that presented in hexadecimal locations 0BB4 thru 0BCE of listing 4, places a byte of data in port B and points the address pointers (lines A0 and A1) to the data register. When the FD1771 raises the DRQ line, the WRITE-ENABLE line is brought low. The byte of data, which is placed in the FD1771 data register, is transferred from the FD1771 to the disk. The 8080A places another byte in the port and pulls the WRITE-ENABLE line low again when the FD1771 signals that it is ready to accept another byte of data. A similar procedure is followed for a read command (see listing 3), except that this command uses the READ-ENABLE line.

This concludes our discussion of the hardware and software necessary to interface a Shugart SA400 disk drive to an 8080A-based microcomputer system. Additional application information is given in the application notes available from the companies listed in the references. ■

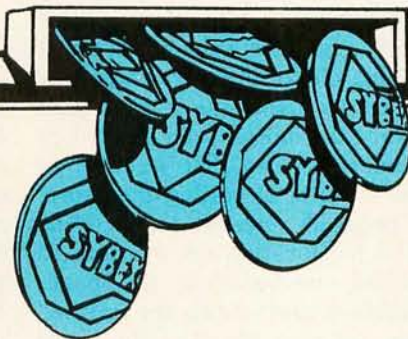
References

1. SA400/450 Minifloppy Diskette Storage Drives with an 8080A/FD1771 Single Density System Application Bulletin, Shugart Associates, 415 Oakmead Parkway, Sunnyvale CA 94086
2. FD1771 Floppy Disk Formatter/Controller Data Sheet, Western Digital Corporation, 3128 Red Hill Ave, POB 2180, Newport Beach CA 92663
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The Commands

With what commands should the editor provide the user in order to make the program easy to use, and how does the nature of these commands affect the structure of the program?

Mode Commands

We begin to answer this question by distinguishing three major ways in which the user will use the program. The first is when the user creates a score of music. Here the editor must establish a file for the score and allow the user to overwrite the default values for the music, such as the key and time signatures. The second major use consists of editing the score. The program needs to provide facilities for locating the measure to be edited, reformatting the pages after editing, and writing the finished version out to a file. The third and hardest facility the editor must provide is the ability to display the score on the screen.

A multitude of problems must be handled automatically by the editor in adjusting the format of the score as

it will appear on the screen. The above discussion leads to a definition of three separate modes of operation for the editor called the CREATE, EDIT, and DISPLAY modes. Switching between modes is done by issuing a command through the graphics tablet as discussed in part 1. The editor also switches modes automatically to display the contents of a measure while the user creates or edits the score.

Location Commands

Commands must be provided to allow sequential passage through the score. In order to do this, the user must first set a symbolic-operation mode which determines the units to be used as increments in moving through the score. These units are pages, lines, measures, or characters, and are set via commands on the template. For example, suppose you are located on page two, line one, measure three, and character twenty-one of the score, and you wish to edit page five, line four, measure one, and character three. The following sequence of commands will accomplish this:

1. Touch page. This sets the increments to pages, and sets the line, measure, and character values to one.
2. Touch forward three times. This positions you on the first line,

measure, and character of page five.

3. Touch line. Touch forward three times. You are now at the first measure of line four.
4. Touch character and touch forward two times.

If you are editing the end of a unit, it is often faster to back up. If you were editing the last character, number thirty-seven, of measure one above, you could go to measure two and then back up one character rather than going forward from measure one, thirty-seven times. If the program is to provide this flexible location scheme to the user, it should be easy to determine the location of the page, line, measure, and character at any place in the score. A look back at the data structures indicates that this was accomplished using doubly-linked pointers between the score area arrays.

Edit Commands

The program must support all editing features that allow easy text manipulation. Commands to insert, delete, replace, or move pages, measures, lines, or characters must be provided, as well as methods of searching the text for patterns of music. These facilities require a set of routines that will automatically adjust the paging of the music after editing.

Note

The figure numbering sequence is continued from part 1 which appeared in the April 1980 BYTE.

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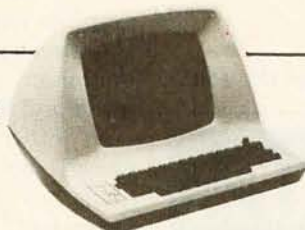


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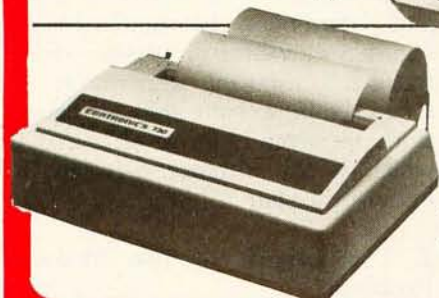


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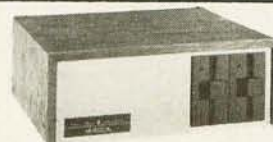
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Exit Commands

After editing a measure, the user either wants the version to become a permanent part of the score, or wishes to inform the program to ignore any changes made. This is the function of the EXIT and NULL-EXIT commands on the template. Note that the exit command must transfer the contents of the work area to the score area and make the necessary format changes while the NULL-EXIT simply does nothing.

Symbols

Music abounds with symbols. The

template shown in part 1 indicates only a few. The actual design allows for one hundred different symbols. In order to avoid cluttering the template you would have to cull the necessary symbols for the type of music that is being scored. To transfer from one notational style to another is not a difficult task, since only the template and interface program would have to be changed. The main portion of the editor is protected from such alterations.

Output

The hardest problems of the editor

are related to displaying the musical score on the screen in a pleasing and useful format. I will touch on three classes of problems, and outline their solutions in this section.

Dimension Problems

This set of problems is caused by the physical dimensions of the screen output. The actual physical dimensions of the height and length of the screen are fixed, and you must work around their limitations. Since most graphics screens represent points in a coordinate system, the maximum and minimum absolute coordinates for the X and Y axis are set.

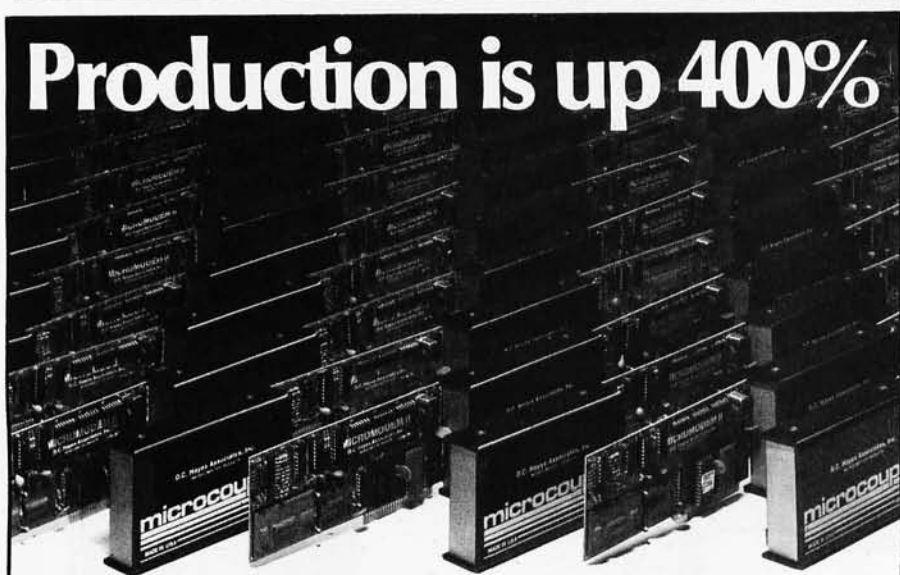
In order to achieve a flexible design, no commitment should be made to any of these machine-dependent characteristics. Instead, you should work in a virtual coordinate space controlled by the editor, and write another interface program to handle the conversion of coordinates in the virtual space to the actual screen coordinates. Every dimension that is given will then represent a dimension of the virtual space in the editor. Since the option of determining the size of a score of music should be left to the user, you must understand that all dimensions are subject to scaling factors that will be set by the user on entrance to the program. With these considerations in mind, I will now discuss three problems and their solutions.

1. The Spacing Problem for the Staff

How are the dimensions for the staff, notes, and symbols determined? The solution was found by taking measurements from scores of music and determining the standard sizes. Figure 5 shows the dimensions of the staff and lists the dimensions for other symbols. Note that all dimensions are given in terms of LSPACE, which is the distance between the lines of the staff.

2. The Length of the Measure Problem

How do you assign a virtual length to a measure? Although each measure has the same number of beats, their lengths can differ radically. Observe in figure 7 that the length between notes of the same value is not always equal. This eliminates a simple method in which you would assign virtual lengths to specific note values



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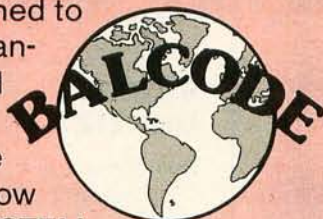
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Figure 5: Dimensions of the musical staff, notes, and symbols. All dimensions are given in terms of LSPACE, the distance between the lines of the staff.

and determine the total length of the measure by summing their values. A modified approach to this simple scheme can be adopted, however. You must first determine the minimum distance between notes that allows sharps and flats to be inserted, while still preserving readability. This distance can be fine-tuned to the eye of the user, but it is approximately nine-fourths the distance between the lines of the staff, or $(\frac{9}{4}) \times \text{LSPACE}$. This dimension will be called the *internote distance*, denoted by INTER. Second, a *beaming group* is defined as a set of notes that are connected by beams. Later I will discuss a routine that determines beaming groups in the measure. Assume here that the job has been done. Next, a code for

each possible note value is determined (this code was actually developed much earlier and is used throughout the program in most of the data structures). This information is shown in table 5. Notice that all the values are integer quotients of 20160. There are several reasons for this particular encoding scheme. First, the editor allows for twenty-six different note values. In order that the subgroupings of these notes add up to correct total values, each note must have the same common denominator. The value 20160 fulfills the requirement. The code for one beat is 5040. Other reasons for this encoding concern the eventual placement of the notes in their proper screen locations. The total length of the measure is

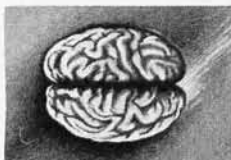


Figure 6: An example of a rarely occurring musical symbol. Of the many thousands of symbols which are used to communicate different forms of expression, some are used only infrequently. This particular symbol is found in piano music. It directs the performer to reach inside the instrument and strike the string corresponding to the indicated note with a mallet.

now the sum of the lengths of all of the beaming groups of that measure plus the lengths of the rests. The algorithm for determining the length for the beaming groups can now be stated:

1. Determine the total number of beats for the beaming group. This can be done by summing the codes for all the notes in the group and dividing by 5040, the value for one beat. Let this value be NUM.
2. Find the minimum value for the beaming group. Call this MIN.
3. Determine the number of notes required if the total number of beats were to be taken up by the minimum note. This is simply NUM / MIN .
4. Multiply this number by the internote distance. Thus you finally get the length, which is equal to $(\text{NUM} / \text{MIN}) \times \text{INTER}$.

You can now perform the above routine for all of the beaming groups of the measure and sum up the lengths, with rests included. The total value represents the virtual length of

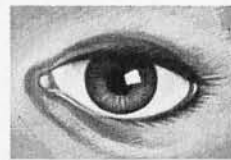


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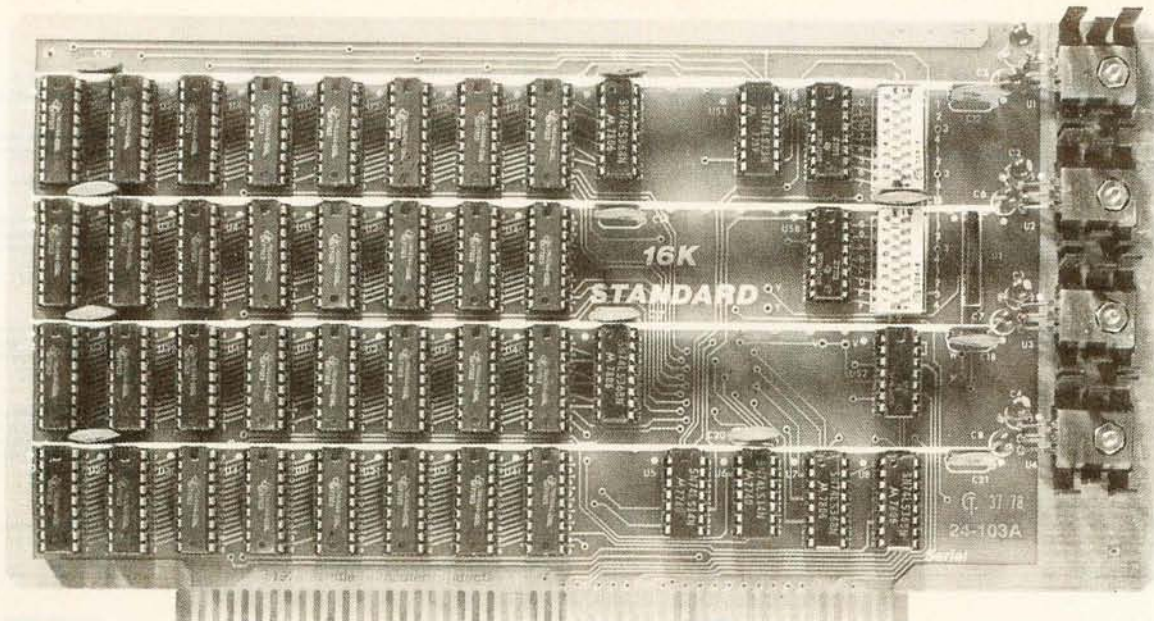
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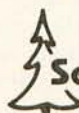
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Others: Fifth 1008, Seventh 720, Ninth 560, Tenth 504, Eleventh 458, Twelfth 420, Thirteenth 387, Fourteenth 360, Fifteenth 336.

Table 5: Additional musical symbols.

the measure. This is stored in the character array of the score area.

3. The Line Length Problem

With different sized measures, how do you determine the number of measures that will fit on each line, thus assuring that the bar lines at the end of each line are aligned? The difficulty of this problem is increased by the fact that not all of the space in a line is used. Each line of music starts with a clef, key signature, and time signature. Every bar line of every measure is bounded by empty space. (Refer to figure 5.) All of these spaces must be accounted for in determining the number of measures that can fit on each line.

Assume that the total length of the line in virtual space is LLINE. The first part of that space must be allocated to the clef and signatures; this will be called LWASTE. The total usable virtual space, LUSABLE, is then equal to LLINE - LWASTE. The wasted space around each measure will be called LMSRWST. If N

measures are on the line, then $N \times LMSRWST$ space has been wasted in these measures. Now suppose that you are positioned at the first measure that will go on the line. You know the virtual lengths of this measure and all that follow. Denote the sum of the lengths of these first N measures as SUMN. The problem is then to find the largest N such that:

$$LUSABLE \geq SUMN + N \times LMSRWST$$

This says that you want to find the greatest number of measures that can be put on the line before going past the end of the line. In general, the measures will not fit perfectly on the line; therefore there will be excess space at the end. This excess must be distributed equally among the measures, and to do this you must find a scaling factor to transform each X coordinate of the measure into a new coordinate. This scaling factor can be easily determined. Let EXCESS be the excess space at the end of the line. It is equal to $LUSABLE -$

$SUMN - N \times LMSRWST$. The scaling factor then is simply $LUSABLE / (LUSABLE - EXCESS)$. The solution to the line length problem is shown in algorithmic form in listing 1.

Beaming

Before this problem can be formulated I will review some of the questions that must be answered when writing music on the page. These are various conventions used for writing music. The following lists a few of these problems.

Stems Up or Down?

You must first decide if a group of eighth or sixteenth notes will be underbeamed or overbeamed (ie: whether the ligature is placed at the top or bottom of the note stems which point up or down, respectively). The easiest solution to this problem consists in finding the maximum note displacement from the center line of the staff and then drawing the note stems in that direction. There are

several exceptional cases for this simple algorithm. For example, if the previous group of notes was underbeamed and the maximum displacement of the next group is above the middle line of the staff (but not by much), the score will read easier if the group is underbeamed rather than overbeamed.

Determining Beam Inclination

Note in figure 7 that the ligature inclination of beaming groups is not always the same. To determine the angle of the beam, you must find the height difference between the stems of the maximum note and the minimum note. For each octave of this difference, increase the height of the tilt by one unit. Notice that the tilt can be

either up or down. In the following discussion I will talk about one of the four cases: underbeamed and tilting upward. The other three cases are easy modifications to the algorithms.

Determining the Stem Lengths

The length of the stems from the notes depends on several factors. Suppose you have an underbeamed, upward-inclined beaming group. The shortest note stem must be at least a certain minimum length for readability. Once this distance is set, determine the lengths of the stems for the other notes of the beaming group. These distances depend on the location of the note and the angle of the beam. Although the algorithms are quite involved, they basically consist

of solving equations to find the intersection point for the lines of the stems and the beam. A complete description of an example with all the equations is given in figure 8.

The algorithms for each of these problems are not difficult, and for the most part they consist of only a few instructions. However, the exceptional cases which make the music more readable are complex and tedious. Given the ad hoc nature of musical notation there seems to be no mechanical way to eliminate these exceptional cases. Let me briefly outline the basic algorithms. Once again, you assume that you have a routine that provides the beaming groups and that you are dealing only with an underbeamed upward-inclined group.

The beam-characteristic algorithm is shown in listing 2.

Next I will discuss how to determine the beaming groups. The basic strategy is to collect notes with flags until one either goes past a beat or encounters a rest. Then output a beaming group, and if a rest is encountered, continue within the beat to collect the remaining notes of the beat. Only in cases of syncopated rhythms will beaming groups cross over a beat. I might add that this is the reason for the strange initialization:

```
BEATCOUNT =
BEATCOUNT + 5040
```

in step 2 of the algorithm, for if BEATCOUNT comes back negative from step 4, a beat has been crossed over. The algorithm is shown in listing 3.

Symbol Problems

Several ways are presented for routines that draw the notes and symbols on the screen. You must keep in mind that the eventual size of the symbols is left to the discretion of the user, and the program must therefore allow for scaling. Scaling sometimes distorts characters, so the editor must have procedures to keep this distortion within a readable limit. I found that for symbols consisting mostly of straight lines, simply storing a set of relative points and drawing lines between them is sufficient. For symbols that are curves, such as the G clef, a better approach is to use a spline-fitting routine to draw the symbol.

Listing 1: Solution to the line-length problem in algorithmic form.

1. LUSABLE = LLINE - LWASTE
2. N = 1 SUMN = Virtual length of first measure
3. VALUE = SUMN + N × LMSRWST
IF LUSABLE < VALUE THEN GO TO 4
N = N + 1
SUMN = SUMN + VALUE of virtual length of Nth measure
GO TO 3
4. EXCESS = LUSABLE - VALUE
LSCALE = LUSABLE / (LUSABLE - EXCESS)
5. Store scale into the scale portion of the line array for future use when displaying the measure.

Listing 2: Algorithm used to determine whether a group of notes should be under or overbeamed.

1. Find the minimum note in the beaming group. MINX, MINY
Find the maximum note in the beaming group. MAXX, MAXY
Let OCTAVE be the height of an octave.
Let MID be the height of the middle note of the staff.
Let STEM be the minimum length of a stem.
Let LENGTH be the virtual length of the beaming group.
2. IF (MAX - MID) ≥ (MID - MIN) then overbeam, ELSE underbeam.
Assume underbeam.
3. TILT = (MAX - MIN) / OCTAVE (integer division)
4. For each note in beaming group:
Get coordinates into NOTEX, NOTEY
M = TILT / LENGTH
B = (MINY - STEM) - MINX × M
The height of the stem for this note is then equal to NOTEY - M × NOTEX - B.

Listing 3: Algorithm to determine the beaming groups.

1. BEATCOUNT = 0
MEASURECOUNT = Number of beats to a measure times 5040.
2. BEATCOUNT = BEATCOUNT + 5040
IF MEASURE ≤ 0 GO TO 5
3. Get value of next note into NOTEVAL
BEATCOUNT = BEATCOUNT - NOTEVAL
MEASURECOUNT = MEASURECOUNT - NOTEVAL
4. IF BEATCOUNT ≤ 0 THEN output group and GO TO 2.
IF encountered a rest THEN output group and go to 3
5. Finished with measure, either continue or stop.



Figure 7: Sample of a musical score, in this case part of a bourrée by J S Bach. Note the difference in note spacing and in angles of beams.

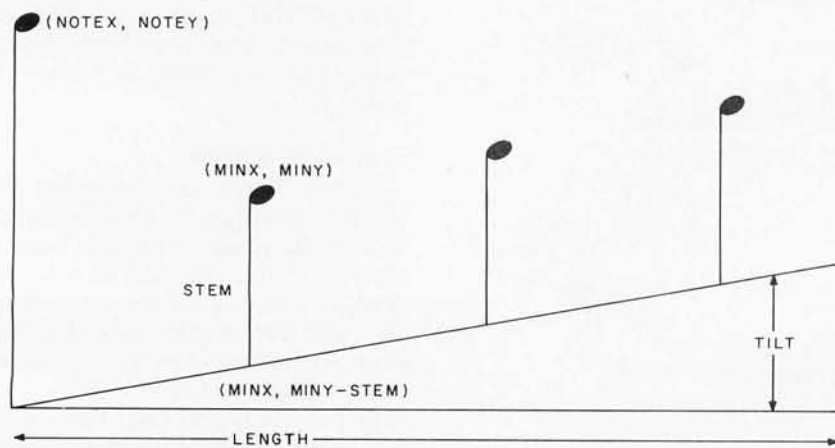


Figure 8: Calculating the equation of the line segment forming a beam. The standard slope intercept equation $Y = mX + b$ is used. We know that the slope is $M = \text{TILT}/\text{LENGTH}$, and that the value of one point on the line is $(\text{MINX}, \text{MINY} - \text{STEM})$. Fitting this to the equation of the line, we can find $b = (\text{MINY} - \text{STEM}) - M \times \text{MINX}$. The heights for all the other stems can then be calculated. For each note, put the X and Y coordinates in *NOTEX* and *NOTEY*. The height for this stem is then $\text{HEIGHT} = \text{NOTEY} - M \times \text{NOTEX} - b$.

Although this requires much more computation time on the computer, it does produce an aesthetically pleasing symbol and allows the user to fine-tune the form of the symbol by simply moving a few of the interpolation points.

Other Points

Now that the basic design of the editor has been presented, I will discuss some of the finer points of the design.

Patterns and Sequences

Although the input format is satisfactory for most music, the use of the current template becomes taxing, if not impossible, when creating a score of complex music. There is no facility that allows the user to input complex rhythms. In order to provide this ability, the concept of a pattern

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Look for good people, team spirit, and top-notch facilities:

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- Will my accomplishments be acknowledged, appreciated, rewarded? YES ? NO
- Will I be encouraged to seek more challenge and responsibility? YES ? NO
- Will the company pay for advanced training in technology and management? YES ? NO
- Can I pursue my own career goals within the company framework? YES ? NO

THE LONG RANGE PICTURE

Where will you be professionally in 5 years? ... in 10 years?

- Are there plenty of opportunities for rapid advancement within the company? YES ? NO
- Does the company encourage engineers to assume positions of authority? YES ? NO
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- Can I choose my own career path—into technological leadership or executive management? YES ? NO

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HALF 	QUARTER 	EIGHTH 	SIXTEENTH 	THIRTY-SECOND 	TRIPLET 	SEXTUPLET 
DOTTED HALF 	DOTTED QUARTER 	DOTTED EIGHTH 	DOTTED SIXTEENTH 	DOTTED THIRTY-SECOND 	DOTTED TRIPLET 	DOTTED SEXTUPLET 
WHOLE 	SIXTY-FOURTH 	5TH	7TH	9TH	10TH	11TH
SET	END	DISPLAY	12TH	13TH	14TH	15TH
PAT	1	2	3	4	5	6
SEQ	1	2	3	4	5	6

Figure 9: Extensions to the musical template for more advanced editing.

of rhythm is created. Here the user can establish any rhythmic pattern with a code number. When this code number is touched on the template, the interface program organizes the notes which are entered after it according to that rhythm. The template must now have more fields on it to accommodate this ability, and the interface program must be expanded to perform these computations. The extensions to the template are shown in figure 9. In order to create a rhythmic pattern the user must issue the following commands:

1. Push SET and PAT. This informs the interface program that a pattern is to be created.
2. Push a number on the PAT row. This will be the number of the pattern, and any existing pattern with this number is overwritten.
3. Push the series of note values which determines the pattern.
4. Push END. This signifies the end of the pattern.

To use the pattern the user issues the following commands:

1. Push the number of the pattern.
2. Push the pen onto the correct pitch positions on the staff, preceding them with any attached symbols such as sharps, dots, slurs, etc. Note that the order of the notes and symbols is now important, but the X locations on the staff are immaterial.

The end of the pattern occurs when the number of notes of the pattern is pushed onto the screen. If more notes are entered before another pattern number is pushed, the interface program issues a warning to the user signifying that the pattern is ended. If an insufficient number of notes is entered before another command is issued, the user is warned and the incomplete input is discarded.

A sequence, as used here, is simply a series of patterns. Suppose that sequence 1 consists of the patterns 2, 5, 1. The use of sequence 1 will cause the notes pressed to follow the rhythm of pattern 2. When all of its notes are used up, it will follow the rhythm of pattern 5, and when that is finished, it will follow pattern 1. Setting a sequence is similar to the setting of a

pattern. The steps are:

1. Push SET and SEQ.
2. Push a number in the SEQ row. This is the sequence number.
3. Push a series of numbers in the PAT or SEQ row.
4. Push END.

Sequences can cross over measures and can consist of other sequences. To clarify these concepts, input the music in figure 7, using patterns and sequences. There are many ways to input that section of score. Break up the rhythms into their smallest components and then form sequences from them. Thus, three patterns are defined first: one consisting of a quarter note only, the other of two eighth notes, and the last of four sixteenth notes. The following commands do this:

1. Push SET, PAT, and 1.
2. Push QUARTER.
3. Push END.
4. Push SET, PAT, and 2.
5. Push EIGHTH twice.
6. Push END.

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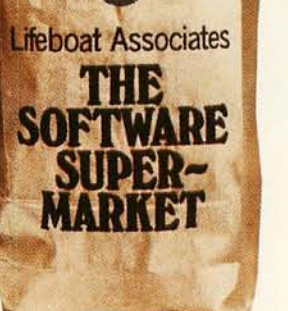
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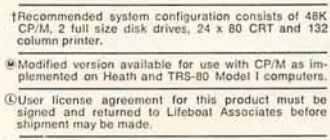
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†Recommended system configuration consists of 48K CP/M, 2 full size disk drives, 24 x 80 CRT and 132 column printer.

‡Modified version available for use with CP/M as implemented on Heath and TRS-80 Model I computers.

§User license agreement for this product must be signed and returned to Lifeboat Associates before shipment may be made.



7. Push SET, PAT, and 3.
8. Push SIXTEENTH four times.
9. Push END.

Note that there are now four sequences that can be defined. They are labelled on the score. I will create the commands for the first one only, since the others are similar:

1. Push SET, SEQ, and 1.
2. Push 3,1,2,1,2,1,1,1 on the PAT row.
3. Push END.

The other sequences consist of:

#2 - 3,1,3,1,1,2,2,1
 #3 - 3,1,3,1
 #4 - 2,2,2,2,2,1,1,1

The different ways of ordering sequences and patterns are numerous. The above score in particular could have been entered in several ways.

Using a scheme like this, any score of music can be entered into the editor. Other schemes could be devised to tailor the input form to the type of music being edited. The only changes to the program, however, would occur in the input-interface program; the main part of the editor would remain unchanged.

Symbols That Cross Over Measures

I have not yet approached the problem of symbols that cross over measures and, thus, over lines and pages. Nor have I discussed the placement of nested slurs or ties and how to draw them on the screen. These problems are complex; their solutions lie in keeping pointers in the character array to the locations where the symbol begins and ends. Any changes to these measures, such as deletion, must also change these pointers - for example, we do not have a beginning of a crescendo with no end. Thus these pointers must again be doubly-linked. Drawing the correct arcs for slurs and ties presents a problem because they can be separated by long distances. A routine must be called when the screen locations are known to fit a curve through these points.

Reformatting

After editing a page, the format of the pages from then on is usually different. If you simply added a

character in a measure, the paging will probably remain the same; however, if you add thirty notes to the measure, it is much longer, and might change the number of measures on the line and hence the format of the page. How far this change will carry depends upon the size of the change and the scaling factors of the measures. (If the scaling factors were all 1.0, then any change to a measure would cause a complete repaging of the score.)

Whenever the user wants to display or edit the score, a formatting program must be called to repage the score. This routine must execute the algorithms given previously, which determine the beaming groups of the measures and the measure lengths of all changed measures. It must then determine which measures will go on the lines. It needs to alter the existing paging only as far as the change propagates, but there is no way to predict this in advance. Thus a simple change could cause considerable computation.

Conclusion

I hope that the reader has begun to

appreciate the problems involved in creating a text editor for music. What is the utility of such a program? To anyone who has ever tried printing a score of music with india ink, the virtues of an editor with hard-copy facilities are obvious. A number of uses for the program present themselves. For example, very often music written in one key needs to be changed into one of the other keys. This is called *transposition*. A program can easily be written which takes the contents of the character array and performs the transformation.

You might wish to create computer music and display it on the screen. You could write a music-generation program and feed its output to a conversion routine that would convert its output into the format of the editor. If actual sounds were converted into pitches and durations with an electronic device, this could be placed in the editor, and you could see the music that was being played. If several scores by a composer are entered into the program and statistical analysis is performed on them to determine the probabilities of

certain patterns of music, the results could, in theory, be used to drive a music-generation program that would simulate the composer's style. This same approach could be applied to music from different historical periods, thus enabling the computer to create a classical symphony or a twelve-tone quartet. ■

Editor's note: The data-entry system for musical scores described in this article has a bias toward transcription of scores containing a single melodic line. Other types of musical scores contain elements which are not dealt with here. For instance, music for keyboard instruments, such as the piano, usually contain chords consisting of several notes to be sounded simultaneously. These chords are often written as several note heads sharing a single stem. It would be difficult at best to work with such music using this system. Enhancing the system to handle these elements would be a good project for the ambitious reader. . . . RSS

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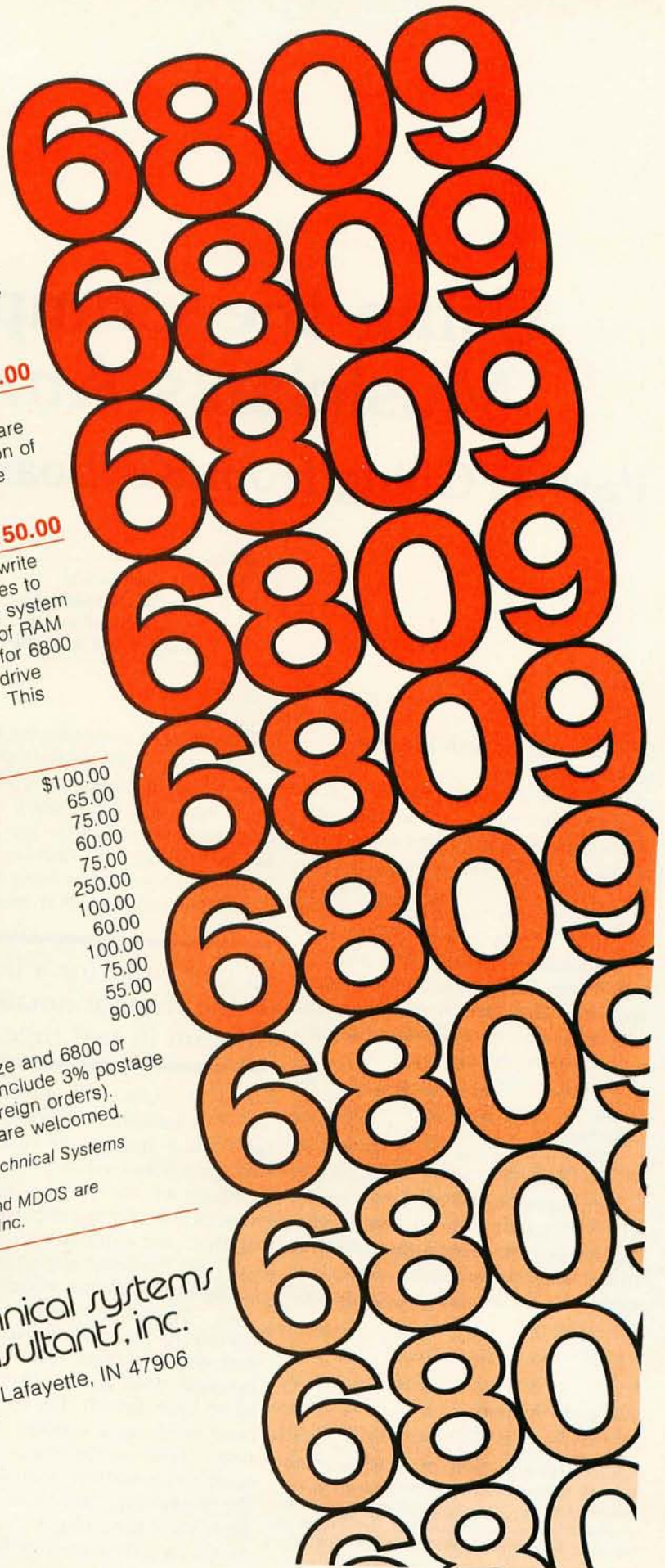
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Using the Computer as a Musician's Amanuensis

Part 2: Going from Keyboard to Printed Score

Jef Raskin
Apple Computer Co
10260 Bandley Dr
Cupertino CA 95014

More Problems with Rhythm and Tempo

The would-be Composer's Aid designer plummets into another pile of programming problems when tempo change. The beat, *sometimes* constant within a piece, may abruptly slow down, as may happen in a reflective refrain in a blues number, or gradually accelerate, as in a Greek folk dance. Changes of tempo present problems that are worse than the problems in transcribing rhythms that we have already seen.

It is not difficult to see that an abrupt change in tempo cannot be detected the instant that it happens, but only after a few notes have been played at the new speed, establishing, as musicians say, the new tempo. This brings up the concept that rhythm does not exist only in relation to the length of individual notes, but exists also in a much larger musical context.

About the Author

Jef Raskin's credentials in music include his years as a professional musician and a music teacher. He is presently the manager of Advanced Systems at Apple Computer Co. His personal music and computer equipment includes a piano, a harpsichord, an organ, a PDP-11, and three Apple II computers.

Therefore, a computer (or a human being) cannot notate rhythm in real time (ie: as it happens). The notator must wait and accumulate a significant sample (ie: listen for a while) before making any decision how to write down what has been heard. A computer program that must deter-

A computer (or a human being) cannot notate rhythm in real time.

mine rhythms will most probably have to backtrack through the data, perhaps a number of times, before deciding how to notate the music.

Much of the fun in listening to music comes from anticipation of the rhythm; the composer or performer can use rhythmic expectations as a background against which to introduce rhythmic novelties. This is similar to the use of harmonic and melodic "surprises" that cannot be assessed until some time after they have been heard. The fact that we hear music in a context of expectations built on previous experience stands as a sentinel, guarding against the possibility that there is an easy algorithm that might "understand" music on a note-by-note basis.

Further Consequences of Changes of Tempo

A gradual change of tempo is either *accelerando* (getting faster) or *ritardando* (getting slower). In *ritardando* (very common at the ends of pieces or sections of pieces), how is the computer to tell the difference between a gradual lengthening of the written note values on one hand, and the use of the word "ritardando" along with an actual constant note length, on the other? This is very easy for a human to do, but it is very difficult to tell a computer how we do it.

In many pieces that require this slowing down, there is no notation for a *ritardando* at all. In these cases, the *ritardando* is inherent in the nature of the music. The conventional notation is to write the score as if nothing at all happens to the tempo.

This last problem afflicts score-to-performance transforming programs more than it afflicts programs that transform performances to scores. It is one of the symptoms of "soulless" computer performances. The computer too often is programmed with only the notes, but not with the *style*—that part of the music which is indigenous to a culture or time. Without the proper style, music tends to sound "wooden" or "dead."

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Someone Tries to Sell the Author a "Notating Machine"

An entrepreneur tried to interest me in funding a device he was in the process of patenting. According to him, it would do the "simple" task of transcribing any rhythm tapped out on its surface into standard musical notation. It was to be the size of a hand-held calculator.

I asked him the questions that I have brought up in this discussion, and it soon became clear that he had not given the matter even as much thought as I have been giv-

ing the problem in this article. As an answer to the question of *accelerando* and *ritardando*, he suggested that the instructions would specify that the user must not slow down or speed up.

As happens too often in the world of computing, he was forced to lean toward a device that would—perhaps—write down the easy rhythms, leaving the difficult ones for the user to figure out. Most users, I suspect, would rather have a device to write down the difficult rhythms. The users can figure out the easy ones without

mechanical aid.

Incidentally, one of the most difficult problems for a beginner to solve is determining on which beat of a measure a piece begins. Pieces very often begin in the middle of a measure. This is also a vexing problem for anyone who would program a computer to notate rhythms.

Placing any restrictions not found in the music itself on the user seems inherently wrong to me. The system must accommodate the person, not the other way around.

There are many other problems with rhythm—for example, *rubato*, where one part momentarily goes faster or slower than accompanying parts. Another class of problems are rhythmic complexities such as triplets, grace notes (so short that their time value is not notated), and other groups of notes that break the simpler rhythmic patterns.

A *triplet* is a melodic phrase consisting of three notes of equal length,

three quarter notes, for instance. These three quarter notes are played in the same time interval that two quarter notes occupy in the normal rhythm of the piece. It is difficult to tell what has happened when a few triplets are introduced in a piece. When they first occur in a piece, you may ask yourself (if you are a trained musician), "Has the tempo suddenly changed, or have triplets been introduced?" The program will be hard

put to guess at the difference.

Another problem occurs when very long notes occur in a piece which previously consisted only of relatively short notes. You must decide, for instance, whether to write them as tied shorter notes or as longer note forms. Of course, they might be written as the *same* note-length notations as the earlier, shorter notes, but with a tempo change!

All of this judgment of tempo must be done in the face of the first problem, that the note lengths and inception times are not coming in precisely, but with considerable variation. Often, the amount of this variation may mask tempo or rhythmic changes. Consider, too, that the people who need the *Composer's Aid* most are those who may be least proficient at performing upon conventional instruments. The designer probably has a more difficult task to make the *Composer's Aid* accurately portray the muddled attempts at rhythmic regularity of a beginner, than to make it follow the (probably) more precise playing of a master.

Before leaving the subject of rhythm, I shall take the liberty to give the following advice to all would-be designers of automatic music-transcribing systems. First, build one that has but one key or button, and get it to determine rhythms correctly. By "correctly" I mean without unreasonable limitations. It should be able to handle any rhythm found in a Mozart or a Beatles' melodic line. If you cannot master that, then you certainly cannot transcribe more complex music, which might have a solo melody as a part of a piece.

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Figure 1: The same passage as written (1a) and as performed (1b). Both examples here are from the "St Louis Blues."

unexplored. Some of the algorithms that adaptively follow varying-rate Morse code may be useful. A number of moderately successful programs, all quite large and complex (using many techniques from artificial intelligence work, and *not* operating in real time), have been created. [The October 1976 issue of *BYTE* contained several discussions of Morse-code decoding problems. . . .RSS]

If you first succeed with rhythm, then you might have a chance at the rest of the problem. At least a good portion of the problem of transcribing a musical performance into a standard score will have been solved.

More and Less

It is clear that a performance of a piece often contains *more* information than is given in the score: things happen in the performance that are not specified in the written music. Jazz, usually played from sketchy "charts," is an especially good example. The lilting "dotted" rhythms of jazz are notated as equal notes on the page. But everyone "knows" how it should sound. Look at the example from W C Handy's "St Louis Blues" in figure 1.

It is clear that the performance in figure 1b is quite different from the written notation in figure 1a, as it must be in order to sound right. The figure shows just one possible way of singing the opening measure of the chorus to the "St Louis Blues" (and it is not an especially extreme example).

It is rare, if not unheard of, that two live performances are the same. Some of the changes are minor, such as changing two eighths to a dotted eighth and a sixteenth. More surprising is the modification of the opening two eighth notes into half notes (with a ritard, no less). But that is the way

it is done.

Strangely enough, the same convention about playing eighth notes with a certain uneven lilt occurs in much baroque music, in spite of the fact that the notes were written down as being of equal length. Many performances of Bach's music, for example, are marred by a "wooden" playing of such passages.

Many conductors and performers play baroque music exactly as it is notated. It sounds as if you tried playing jazz or rock exactly as written in songbooks and sheet music: the result is dull music. This may help to account for some of the comments about baroque music sounding like a melodic sewing machine—some performers play it as though their in-

INPUTS					OUTPUTS
Musical Idea	Score	Keypresses	Sound		
Inspiration	Plagiarization	Stimulation	Synthesized Music	Musical Idea	
Composition	Arranging, Copying	Transcription	Taking Dictation	Score	
Improvisation	Performance	Coupling	Playing By Ear	Keypresses	
"Science Fiction"	Automation	"Sonification"	Transmission	Perceived Sound	

Table 1: Musical transformations, representing the various ways of obtaining musical results. The table is read by starting at the top at a given input and proceeding downward and to the right to read the output. The shaded example illustrates that the term performance describes the connection between a printed score and the production of keypresses. (For simplicity's sake, the table deals only with keyboard instruments.) Similarly, to go from a musical idea (ie: input) to a score (ie: output) requires "composition." The term coupling refers to the mechanical addition of extra voices to an organ keyboard so that the organist can play more than one pipe with a single keystroke. Automation refers to the procedure by which mechanical musical instruments (such as music boxes and player pianos) take a score in machine-readable form and generate perceived sound. For want of a better word, sonification is used to describe the production of perceived sound from pressing a key on a keyboard. The terms in the row called "musical idea" are meant to be taken tongue-in-cheek.

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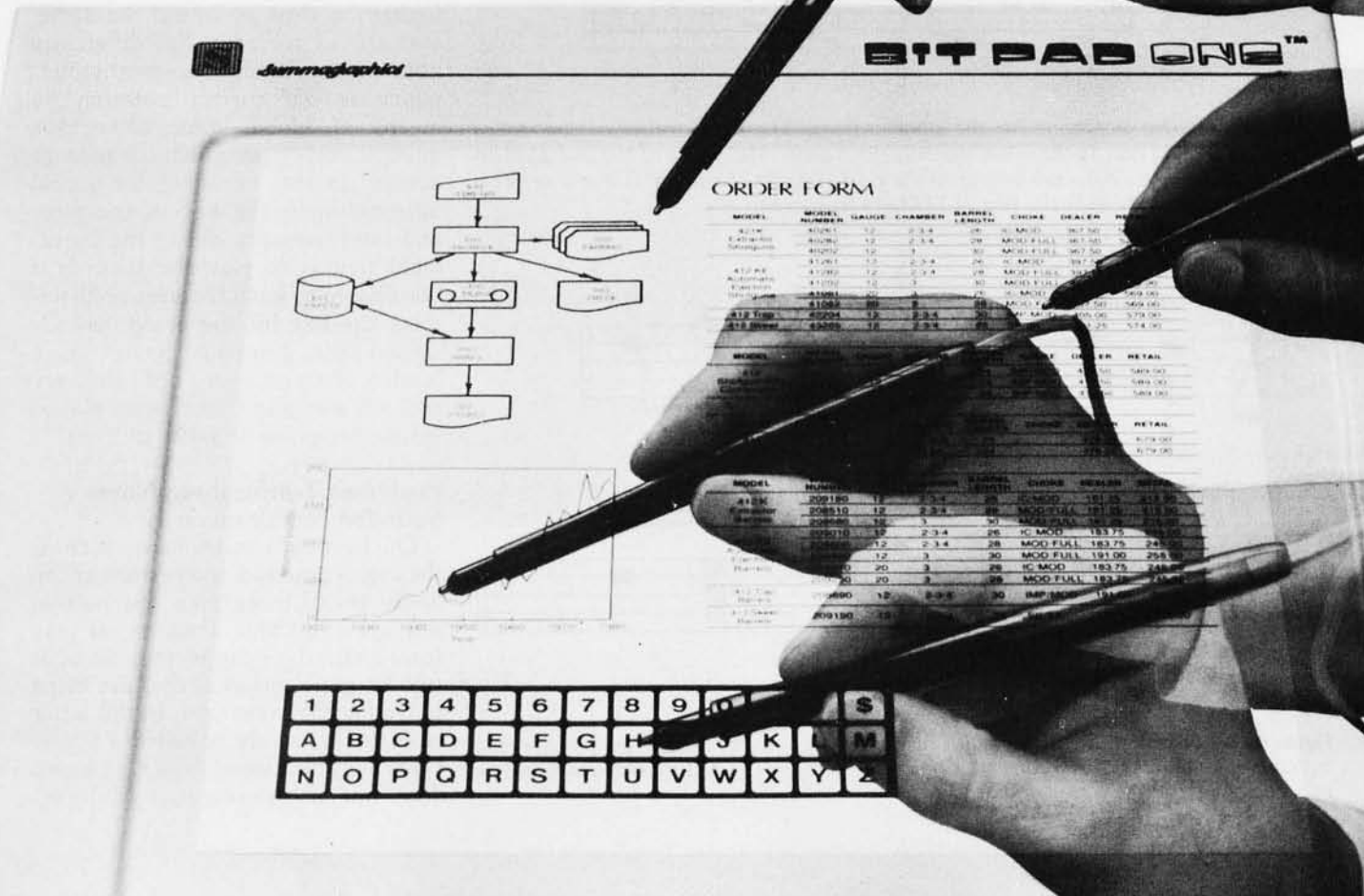
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struments *were* sewing machines, without any regard for the original stylistic intent.

Problems Caused by Repeats and Larger Musical Structures

Here is another dilemma: how can a computer (or a human) tell if a section of a piece being performed has been repeated (perhaps with embellishments), or if it is a new section

merely similar to the old one?

For example, in a Mozart rondo for the piano, almost all of the embellishments will be written out in full. In a Mozart sonata for the piano, there will usually be repeats marked and any variety will be at the performer's option. Does this mean that the computer must first be told the form of the piece before it can transcribe it? Knowing the form of a

piece beforehand certainly aids a human transcriber.

Again, there is vague and general information that must somehow find its way into the program. As in having the computer play chess, methods have been found for translating an imprecise notion (eg: control the center of the board) into algorithms. Chess is a rich field, rife with human invention and complexity. Music is a more complex environment.

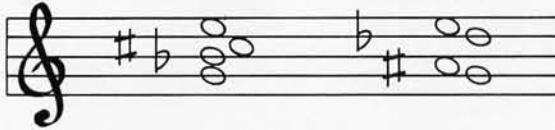


Figure 2: Example of the equivalence of two musical notations. The chords notated here are played the same way on a keyboard instrument and sound the same, but they are written in different ways. This difference, however small, subtly influences the way many musicians interpret the chord.



Figure 3: Different notations for the same sounds. The three melodies here, when played, will sound exactly the same; the only difference is the choice of clef and accidentals. The first two melodies are written in the keys of A-flat Major and G Major in treble clef; the third melody is in the key of D Major in soprano clef.



Figure 4: A musical phrase played with two different voicings. These two phrases may sound the same, but the two correct, differing notations convey different meanings to a musician.

Problems With Notating Pitch

Having shown that there is information in a performance that is not to be found in the score (this is always the case), I would like to show that often there is information in the score that cannot be gleaned from the performance. The "spelling" of chords is one example. The two chords in figure 2 sound exactly the same on our equal-tempered organ. Nevertheless, they would be thought of differently by a musician playing them.

The notes of the two chords actually represent different pitches if sung or played on violins (or any instrument which allows the performer to vary pitch continuously rather than in discrete steps, as with an organ or piano).

The three sets of melodic notes in figures 3a thru 3c sound the same, and are all correctly but differently notated. Again, a human might guess which is the correct notation by means of global information, the musical context in which the passage occurs. In this example, the global information is the key of the piece and the customary clef of the instrument that is to play the tune. Is it reasonable to have the user predetermine the key for the computer? Or should the computer wait, as a human often must do, until the very end of the piece has been played before beginning to write it down?

Problems Transcribing Notes Sounded Simultaneously

On keyboard instruments such as the organ or piano, the performer can easily sound more than one note at any given instant. These notes may form a chord, or can be thought of as two or more melodies that are being played at the same time. In this latter case, each melody is called a *voice*. (This use of the word "voice" in music does not imply singing.) Multiple,



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simultaneous voices bring another host of difficulties to the attempt for accurate transcription.

It is nearly impossible for even an expert musician to determine unambiguously, from listening alone, which note should be allocated to which voice. I realize that this portion of the discussion is delving heavily into the terminology of music, but the intricate details of music are what make this problem so fascinating. The two segments of music in figures 4a and 4b sound the same, and are both notated correctly. Nevertheless, the differences are significant and useful to the musician performing the music.

This is not the place to go further into the musical significance of these notational differences. Enough examples of problems have been amassed to give you a starting place at which to begin to think about having a computer "listen" to and "understand" music.

Problems in Determining Pitch With a Computer

If things were not difficult enough given direct input from a keyboard,

many people (eg: ethnomusicologists) would love to be able to play a recording into a computer and produce a written score. So would I. However, two new problems are introduced. Finding what pitch is being played is not easy. To be sure, a simple sine wave could be digitized by a frequency counter. Unfortunately, real musical sounds are far more complex, often having harmonics and overtones that make almost any frequency-determining method unsure. And what do you do when a note slides from one frequency to another (*portamento* in musical jargon)? Or when a chorus finishes singing a chorale a semitone lower than when they started—will the computer notate it as a sudden modulation in the middle?

Even determining how long a note lasts is difficult. Try playing a piano note; strike a key and hold it down. How long does it last? Just when does its gradual dying away cease? In a quiet room, with a good piano, it may take several minutes. You might as well ask where the rainbow changes colors. Musical sounds often do not have well-defined edges with

respect to time or pitch.

Summary

The point has been made, and it is possible to show many more examples than have been shown here that you cannot go from a performance to a score, or vice versa, in any easy fashion while preserving the qualities that make the notation of music readable to most musicians and the properties of a performance that make it worthwhile listening material.

A score is a highly idiomatic rendering of a piece of music, and a piece of music is a unique instance of the composition that the composer had in mind when the score was written.

These facts assure that the building of a perfect music transcriber is literally impossible. Whether it is possible to make the Composer's Aid good enough for most practical purposes remains to be seen. If we put low enough limits on the idea of "good enough," I am sure that it can be done quite easily. If it is to satisfy me (and musicians of like mind), it will probably not be easy at all.

A final suggestion: if you want to tackle any project of this sort, make sure that you know music well. Also make sure that you know your computing well or forge a partnership that can provide the needed experience. I have met many people who do not know the first thing about music trying to achieve difficult goals combining computers and music. I have also met musicians who imagined that they could get the computer to do some task that they found very easy—only to discover that they did not understand the difficulty of what they themselves could easily do.

The greatest benefit the computer confers upon mankind is that it forces us to truly understand what we are doing, for it is only through such understanding that we can instruct a computer. ■

Acknowledgments

I would like to thank the many people who have made useful suggestions about this article, and I would like to specially mention Doug Wyatt of the Xerox Palo Alto Research Center for many useful discussions about the nature of music, Brian Howard of Apple Computer Co for his excellent editing and criticisms, and both of them for the many hours of rehearsal, performance, and programming that they have shared with me.

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Comparing Floppy-Disk Drives by Software Simulation

Dennis Nendza
1622 W Ave de Maximillian
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Large companies learned long ago that preliminary performance specifications of systems can be predicted reasonably well by computer simulation. The National Aeronautics and Space Administration (NASA) saved much money and effort by simulating numerous systems that have been developed for the space program. In a somewhat smaller way, microcomputers can be used to simulate a variety of operational systems. Complex equations and analysis are not always required.

Here I shall present a practical simulation. I have chosen a topic of interest to myself and many small-computer enthusiasts: a comparison of the operating speeds of floppy-disk drives. This article will explain basic mechanical drive movements and illustrate the transformation of these physical events into the algorithmic steps of a computer program. Estimating one drive's performance in relation to others is the goal.

To do such a comparison, we need some knowledge of the operational parameters of floppy-disk drives. These parameters are the lengths of time required for a drive to perform a given function. All drives have at least these four parameters:

- head load
- seek
- rotational latency
- data-transfer rate

I shall look at each function in detail.

Head-Loading Motion

Before any data can be located or

transferred on some drives, the data-transfer head must be *loaded*; firm contact between the head and the disk surface must be assured. To accomplish this, a pressure pad is placed against the disk on the side opposite the head. This pressure pad movement is referred to as *loading the head*. The length of time required to move the pad into place and insure that all mechanical bouncing has stopped is termed *head-load time*. Look at figure 1 to see a diagram of the head-load mechanism.

Track-Seeking Motion

Once the head is loaded, it may be necessary to move the head to a position over another data track on the disk. In most drives, the track-to-track movement, or *seeking*, is accomplished by a *stepper motor*. This motor rotates in steps of fixed, discrete increments; a specific interval of time is required for each incremental movement. Thus, to move the head across X tracks takes an amount

of time equal to X intervals. Once we know the time interval required to perform a movement and the number of tracks to move across, we can predict how much time it will take the head to reach the desired track.

All stepper motors exhibit some vibration at the end of the last step in a given movement. There may be a settling time required before a read or write operation can begin.

Another type of motor is used in floppy-disk drives such as the PerSci Model 277. It is called a *linear motor* since it produces linear motion directly. The method is also called "voice-coil" positioning, due to the similarity to the action of a loudspeaker mechanism. Figure 2 depicts the stepper- and linear-motor positioning systems in simplified form.

The amount of time required per track for the linear motor to perform a seek operation varies according to the total number of tracks to be skipped. Unless the manufacturer supplies data describing the seek-time

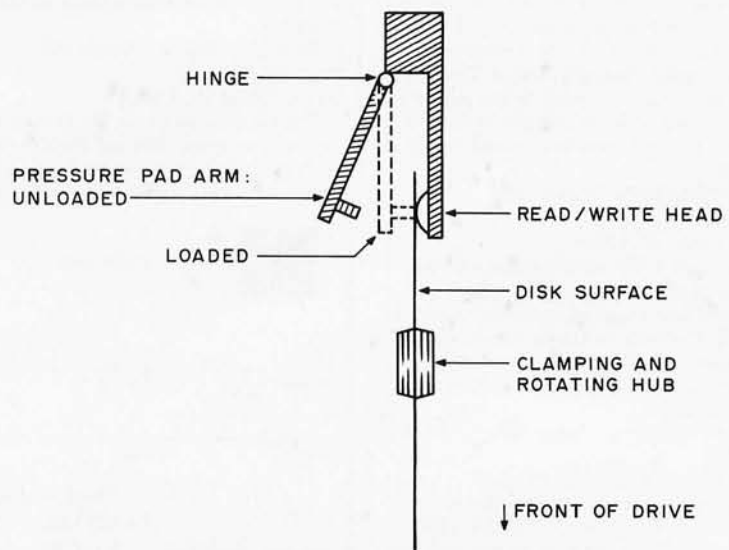


Figure 1: Diagram showing a side view of the floppy disk loaded in the drive. When loaded, the read/write head is pressed against the surface of the disk by the pressure pad.

About the Author

Dennis Nendza is 32 years old and is currently working as a computer systems consultant, after previous experience as a systems programmer, analyst, and data processing manager. He wrote his first computer program while in high school, using the ALGOL language.

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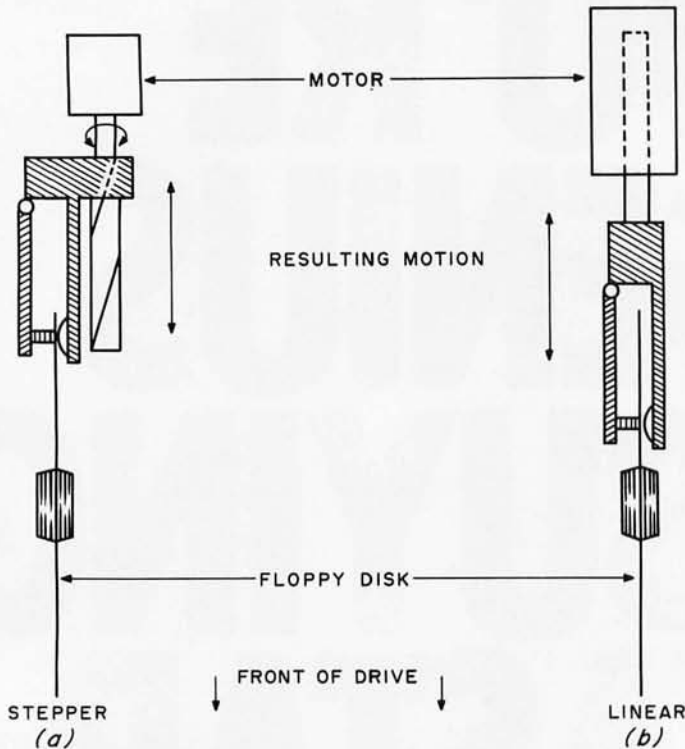


Figure 2: Two methods of moving the read/write head from track to track across the disk. A stepper motor is shown as (a); a linear or "voice-coil" motor is shown as (b). The rotary motion of the stepper motor must be converted into linear motion by a gear arrangement.

function, it must be derived from empirical measurements. This derivation, however, is not within the scope of this article.

Rotational Latency

Reading and writing operations are equivalent functions with respect to the actual time required for completion. With that in mind, the discussion will proceed as if a read operation is being executed. Assuming that the head is now loaded and positioned over the proper track, it remains for us to examine how long a delay may be expected in waiting for the desired record to spin past the head.

A look at figure 3 shows how most soft-sectored disk formats appear. Actually, the soft-sectored format contains 128 bytes of user data; the other data locations are used as address marks and gaps between certain fields. To determine the extent of the delay that must be endured before the desired sector is available, I will consider two cases.

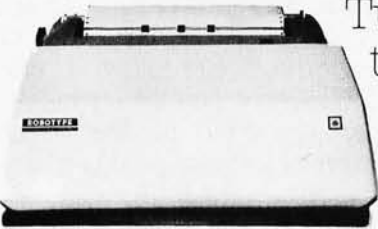
The first case occurs when we begin a read operation and find the correct sector just about to pass by the head. In this event, there is no wait or *latency*, as it is called, before starting the transfer of data. The second case shows that the beginning of the desired sector just went by an instant before the read operation was started. We must now wait for one full rotation of the disk, or the *maximum rotational latency*, for the record to appear at the head again. These two extreme cases show that there are well-defined minimum and maximum rotational latencies. Of course, most delays will be at some random point within this range for actual read operations. The absolute delay for a single read operation is not predictable, but the average for a group of read operations is predictable within limits.

Data-Transfer Time

Finally, there is the most obvious function of the disk drive, data transfer. Data-transfer time is dependent on three basic parameters: disk rotational speed, data density, and format. The faster the disk surface spins past the head, the faster the


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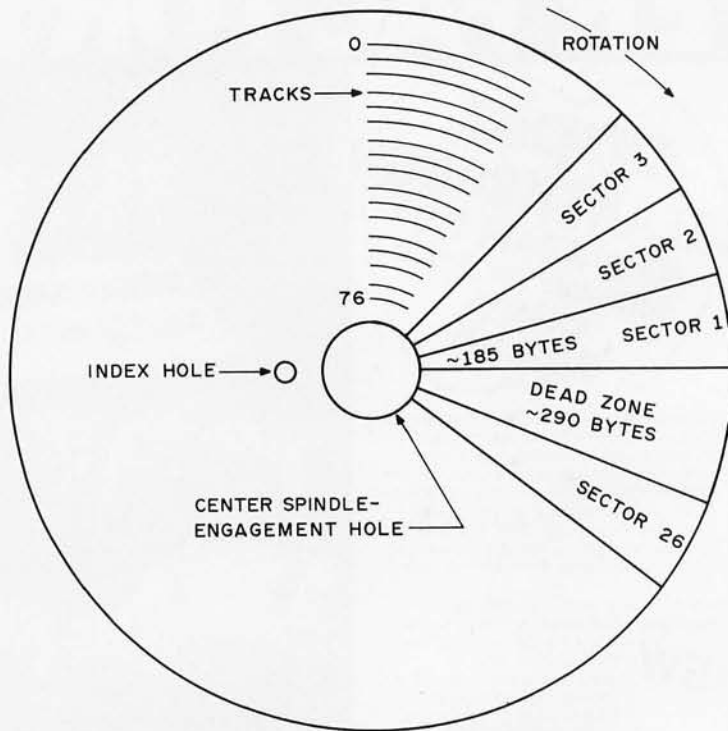


Figure 3: Format of data storage on a soft-sectored, 8-inch floppy disk, viewed from the side that faces the pressure pad.

head can read the data. (Large 8-inch disks spin faster than the smaller 5-inch disks.) The higher the density, the more data can be transferred in a given interval of time. Format differences can account for different effective transfer rates on large records, but will not be dealt with in this simulation. I will deal primarily with the standard IBM 3740 soft-sectored, 8-inch floppy-disk format.

Building the Simulation

We now have an understanding of what happens when a function of the floppy-disk drive is requested. We can now construct a program framework that will use this information. To read or write a record, we must pass through four distinct states: head-loading, track-seeking, rotational-latency waiting, and data-transferring. To compute the actual time required to pass through these states, we must get some information from the manufacturer's specifications for a given drive. Typically, the manufacturer will list the time for head load, track step, average latency, and sector transfer in milliseconds.

Head-load time calculation is easy. Each time that the head is loaded, a value corresponding to the head-load time is added to a total-time accumulator. As a matter of practice, most drives and control software leave the head loaded for a fixed-time interval following a disk operation. This reduces head-loading delays and acoustic noise, but it also increases disk surface wear slightly. For most programs (such as assemblers) that engage in almost continuous disk activity, the head will probably go through the load cycle only once during an execution of the program.

Computation of track-step time is not difficult in most cases. We merely figure the number of steps we must make from the current track to the desired track, and multiply that value by the specified track-step time. Do not forget to add the *settling* time, if the manufacturer gives it. (Remember that the settling time indicates the time taken by the head to stop vibrating from its track seeking and to start reading.)

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motors, the seek time is the absolute value of the distance from the current track to the desired track multiplied by the track-step time, all added to the settling time, or:

$$T_{seek} = \text{ABS}(P_{current} - P_{desired}) \times T_{step} + T_{settling}$$

where T is used for values of time, and P shows the position of the head in relation to data tracks on the disk.

But what should be done when the disk drive uses the linear-type motors to move the head from track to track? The specification sheets for the PerSci unit give only a single-track seek time of 10 ms. Is that the same as the stepper-motor drive timing? No—this timing is for a single-track step, and there is no settling time to be added. In fact, if the two-track seek time is measured, it is one and one-half times the single-track seek time. If a ten-track seek is measured, we find that it takes only three times as long as moving the head a distance of one track.

Well then, what can be done about this device? For this simulation, my plan of attack was direct. I merely

measured the time that it took for all possible seek distances (seventy-six values) and then computed an approximating function by using a least-squares polynomial curve-fit calculation. The concepts behind this computation are not simple. Fortunately, the routine is adaptable from a book that addresses such problems, *Data Reduction and Error Analysis for the Physical Sciences* by Philip R Bevington (McGraw-Hill Book Company Inc, 1969).

When the seek time for the PerSci drive is needed in my simulation, the number of tracks the head crosses is evaluated and is given as an argument to the empirically derived seek-time function. The result of the function evaluation is the number of milliseconds required to complete the seek. Thus, the PerSci drive becomes a special case in the simulation, but handling it is not so awkward.

To compute the rotational latency, one of two possible techniques is employed. For any large number of discrete read operations, the actual, average rotational latency experienced will approach one-half of the

maximum latency. This value can be used for each read operation as a typical latency. I prefer to calculate a random latency for each read operation. Approximately the same results will appear as in the first method for a large sampling of read operations. You will notice that the results from using random latency values are not likely to be the same each time the program is executed. This is due to the accumulation of random variability, which is an effect you would see if the simulation were carried out on real hardware as well as in a program. The function for randomly determining a latency time is simply: the value of the maximum latency multiplied by a random number between 0 and 1.

The final item which must be dealt with is the actual time it takes the drive to transfer the data to (or from) the disk. The time to transfer 128 bytes of data has been chosen for this simulation. The time values for each drive in this simulation were calculated based on the rotational speed and data density. Record overhead bytes and interrecord gaps were not considered. In the simulation program, the computed values are reflected in the appropriate field in DATA statements that describe the characteristics of each drive. Transfer time for n bytes is calculated by multiplying n by 8, and then dividing by the *transfer rate*, in bits per second.

About the Simulation Program

Now that we understand the basic drive mechanics, there should be no difficulty in comprehending how the simulation works. The program performs two simulations for each disk drive under consideration.

The first simulation is a set of 500 sequential-read operations, as you would find in a sequential file-copy operation. The second simulation involves a random reading of 500 records, as you might encounter in a program that reorganizes an indexed file according to an unordered secondary key field.

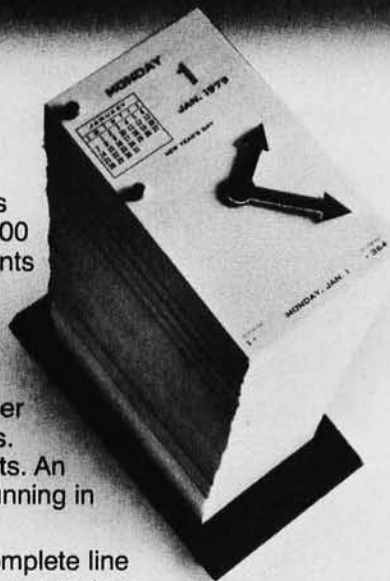
These two modes of access will exhibit the characteristics of general interest concerning floppy-disk drive performance. Briefly, the program steps through the DATA statements that supply the drive name and parameters for that drive. Both simulations are run for a given drive,

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and the results are printed. Look at the program shown in listing 1 to see the simple logic and computations.

Results and Notes

If this simulation were run using a true random-number generator, you would find that the resulting timings will vary on each run. As noted earlier, this is random variation that is to be expected. Do not expect to see exactly the same results as printed here; the values *will* be within a few percent on all runs.

Referring to the simulation output shown in listing 2, observe that, on sequential-read operations, the

transfer times for the 5-inch floppy-disk drives are about 25% slower than the times for the standard size (ie: 8-inch) drives. Allowing for random variation, this is very close to the 20% speed difference that might be predicted based on the different rotational rates of the two sizes of floppy disks. The 8-inch disk drives also outperform the 5-inch drives during random-access operations. Most, but not all, of the smaller drives are slower in seeking from track to track, and this really shows during random access.

The fastest-seeking drive of the group, the PerSci Model 277, does

not get a chance to show off while reading sequentially, but its capability becomes apparent during random-access operation. This device really moves the head fast! The second and third places go to the Memorex Models 552 and 550 respectively; these use fast stepper-motor drives.

Now that you have read this far, I can reveal some bad news concerning this simulation. The timings obtained are not likely to be a true indication of how long it would take to actually perform these operations on a running computer system. Accomplishing so realistic a simulation involves additional simulation of the interface

Listing 1: Program to simulate mechanical characteristics of various 8-inch and 5-inch floppy-disk drives, written in BASIC-E and running under the CP/M operating system. One step is the simulation of 500 sequential-read operations; the other is the simulation of 500 random-access read operations. Due to the use of random numbers, some variation of results is expected between different executions of this program.

```

REM PROGRAM TO COMPARE ACCESS TIMES OF VARIOUS FLOPPY-DISK DRIVES FOR
REM SIMULATED SEQUENTIAL AND RANDOM READING.
REM
REM THE FIRST TEST IS FOR 500 SEQUENTIAL READS, 128 BYTES PER READ.
REM STARTING TRACK IS 0. THE HEAD IS LOADED AND REMAINS LOADED.
REM WHERE A DRIVE HAS SECTORS GREATER THAN 128 BYTES, THE SECTOR TRANSFER
REM RATE HAS BEEN ADJUSTED IN THE DATA FOR THAT DRIVE.
REM
REM ALL TIMES ARE IN MILLISECONDS.
REM
READ DRIVES REM GET NUMBER OF DRIVES TO SIMULATE
INPUT "ENTER ANYTHING TO SEED THE RANDOM-NUMBER GENERATOR";A$
PRINT : PRINT REM UPSPACE A FEW LINES
PRINT TAB(30); "FOR 500 READ OPERATIONS"
PRINT TAB(25); "DRIVE SPEED COMPARISON SIMULATION"
PRINT TAB(30); "ALL TIMES IN MILLISECONDS"
PRINT
PRINT "DRIVE NAME"; TAB(25);"SEQUENTIAL";TAB(40);"RANDOM"
PRINT TAB(25);"-----+-----"
PRINT
RANDOMIZE REM SHAKE UP RANDOM-NUMBER GENERATOR
FOR D=1 TO DRIVES
READ DNAME$,TTRK,TSETL,HLOAD,LATENCY,SECREAD,NSECS,NTRKS
CURTRACK=0 REM STARTING TRACK
TOTALTIME=0 REM SET TIME ACCUMULATOR TO 0
REM LOAD THE HEAD ONCE FOR THIS SEQUENTIAL TEST
GOSUB 1000 REM GO ACCUMULATE HEAD-LOAD TIME
FOR I=1 TO 500 REM 500 SEQUENTIAL READS LOOP
GOSUB 2000 REM STEP TO NEXT TRACK IF NEEDED. ACCUMULATE TIME
GOSUB 3000 REM READ NEXT RECORD. ACCUMULATE TIME
NEXT I
REM PRINT RESULTS FOR TEST 1
PRINT DNAME$,TAB(28);INT(TOTALTIME*10)/10;TAB(40);
REM NOW FOR 500 RANDOM READS IN A FILE 35 TRACKS LONG
TOTALTIME=0 REM SET TIME ACCUMULATOR TO 0
LOWTRACK=0 REM LOWER FILE TRACK LIMIT
HIGHTRACK=34 REM UPPER FILE TRACK LIMIT
CURTRK=0 REM START AT TRACK 0
FOR I=1 TO 500 REM 500 RANDOM READS LOOP
NEXTRK=LOWTRACK+INT(RND*35) REM NEXT RANDOM TRACK
TRACKSTOMOVE=ABS(CURTRK-NEXTRK) REM NUMBER OF TRACKS TO TRAVERSE
GOSUB 2500 REM COMPUTE TIME TO DO SEEK. ACCUMULATE IT
GOSUB 3000 REM COMPUTE RECORD READ TIME. ACCUMULATE IT
CURTRK=NEXTRK REM NEXT TRACK HAS BECOME THE CURRENT TRACK
NEXT I
PRINT INT(TOTALTIME*10)/10 REM PRINT RANDOM READ RESULTS
NEXT D
STOP
REM SUBROUTINES FOLLOW
1000 REM ACCUMULATE HEAD-LOAD TIME

```

Listing 1 continued on page 140



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Credit card callers may phone us 24-hours a day at (202) 337-4691.

These programs, unless otherwise indicated, are for the 16k, Level II TRS-80.



Galactic Trilogy

by Douglas Carlston

This trilogy is one of "the hottest new games of the Eighties" says Softside. "Galactic Empire" is a sophisticated game of strategy and tactics of trying to unify the three dimensional universe. As in all the games, the universe is randomly created for a new challenge each time you take control of the Galactica.

After peace is declared, "Galactic Trader" starts. Now as an outcast you barter Microbes, Feelies and other commodities to gain riches and power. But, watch out for assassins and the energy cartel.

"Galactic Revolution" is a game of tactics, diplomacy, social manipulation, and Machiavellian ruthlessness. Unlike the other two in the series, you can play with more than one player and there are sound effects.

Start with any of the Galactic Trilogy today for \$14.95 each.

Dunjonquest

THE TEMPLE OF APSHAI
from Automated Simulations

This first in the DunjonQuest(tm) series, lets you take your hero into a magical and mythical labyrinth of over 200 rooms which is populated by over 30 kinds of fearsome monsters who guard over 70 varied treasures. Some of the treasures are magical and can help you in exploring the underground complex, but look out for monsters and traps that spring at you from the walls and shadows of the rooms and passages you traverse. The Book of Lore fills in the background and describes the appearance of the temple as you go. You combat monsters, move, and grab treasure in real-time. Bring in characters from other fantasy role playing games, or let the innkeeper find thee a hardy fellow. Test your mettle against the servants of evil! For D&D players, serious gamers. \$24.95 with Book of Lore. On disk, \$29.95 - "Temple of Apschai"

Also available are "Datestones of Ryn," the microquest which is the introduction to the Dunjonquest series and "Morloc's Tower," the deadliest of the series. \$14.95 on tape, \$19.95 on disk, each.



PACKER

by Cottage Software

This is the ultimate editing tool for BASIC program lines. There are five commands which allow easier reading of BASIC programs and more efficient execution by the computer.

The 'unpack' command breaks multiple statement lines into single statement lines with extra spaces for easier reading and editing. The 'short' command deletes any unnecessary words like LET and all REMarks.

The 'pack' command compresses lines into multiple statement lines up to the maximum length you specify while maintaining complete program logic. This can easily reduce the memory requirement by more than 33%! As you can imagine this also speeds up execution of a program, saves time in loading a program from either tape or disk and saves disk space.

And the 'move' command allows you to move any section of your program to a new location. With the 'renumb' command you can renumber your BASIC lines.

So if your programs need more memory, or you need more time, order your 'packer'! 16k, 32k and 48k versions supplied on two cassettes for \$29.95.

SYSTEM SAVERS

by Tom Stibolt from Acorn

If you ever use the SYSTEM command, you should buy this two program package. These programs allow you to save any system format tape on tape or disk, plus offer several features for machine language programmers. Many two part, protected system tapes like Sargon II are not system format.

With FLEXL, which is one of the two programs, you can make back-up copies of any system format tape. Most often a cassette that you make will load easier than an original. Plus you can find the filename on any system tape because it is displayed on the screen. And at any time you can stop the reading of the tape by pressing <BREAK>.

For any machine language programmer, FLEXL offers the advantage of producing more efficient tapes than the assembler. Also, it is written to interface directly with monitor programs. And you can merge machine language tapes into one file.

Disk drive owners can use TDISK to save any system format tape onto disk. Adventure, Airaid, Ting-Tong, Editor/Assembler and other programs cannot normally be loaded to disk using TRSDOS. Now, TDISK allows you to save these programs onto disk. After DOS READY you will be able to simply type the filename and be up and running. It even loads non-contiguous tapes. TDISK will greatly increase the benefit of owning a disk drive.

And as a FREE BONUS, Acorn provides instructions on how to load MicroChess 1.5 onto disk.

Complete your system with the routines not found in either Level II or DOS for only \$14.95. Order your System Savers, today!



TRS-80 DISK & OTHER MYSTERIES

by H.C. Pennington

We don't usually list books, but this one is so unique that we thought you would want to know about it. There are over 100 pages about how DOS works, how a disk is organized, and how to recover from errors. This is THE technical backup for NEWDOS+ with great illustrations. \$22.50.

DISK*MOD

by Roy Soltoff from Misosys

This machine language program modifies your copy of the Radio Shack Editor/Assembler for use with your minidisk and any disk operating system. You can save and load both text source and assembled object files. Unlike the NEWDOS+ version you can read the directory and the allocation of granules while in the EDTASM. You can also kill files. It is a complete disk modification for one or more drives.

Other capabilities are also added which are not found on NEWDOS+. The block move command relocates a section of text to any other area. The global change command permits, for example, changing a label throughout the text. The pagination feature provides hardcopy on 8 1/2 by 11 pages on either single sheets or continuous paper. In addition, high memory can be reserved, like in BASIC, for machine language routines like printer drivers. You can also display the amount of memory remaining.

The <CLEAR> key is functional, the symbol table is sorted alphanumerically and output 5-across, the scroll up/down allows 15 lines on the screen, and the 'DEFM' assembly is improved. Lower case input is now permitted and you can branch to any address. Plus, it also corrects the errors in the Radio Shack tape version. \$19.95

Also available for \$239.95 for the TRS-80 Model II is a similar Editor Assembler from Galactic Software. Write for a complete list of Model II software.

DISASSEMBLER

by Roy Soltoff from Misosys & Acorn

This two-pass Z-80 disassembler produces symbolic labels with output to either the video monitor, printer or tape. Radio Shack's Editor/Assembler can load the tapes. If you own the Editor/Assembler, complete the package with this program. Program on tape for two different memory locations. Cassette version NOW only \$14.95. Version which creates disk files \$19.95

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PO Box 9609 Dept B9
Washington, D.C. 20016



YES, please send me these TRS-80 programs:

title price

Listing 1 continued:

```

TOTALTIME = TOTALTIME + HLOAD
RETURN
2000 REM COMPUTE SEQUENTIAL TRACK READ-SEEK TIME
IF I/NSECS NE INT(I/NSECS) THEN RETURN      REM NO TRACK ADVANCE
2500 IF TTRK = 0 THEN 2800                    REM USE SPECIAL PERSCI FUNCTION
SEEKTIME = TRACKSTOMOVE * TTRK + TSETL      REM COMPUTED SEEK TIME
2600 TOTALTIME = TOTALTIME + SEEKTIME
RETURN
2800 REM PERSCI-277 DERIVED SEEK TIME FUNCTION
IF TRACKSTOMOVE = 0 THEN :                   REM NO MOVEMENT REQUIRED
SEEKTIME = 0:                                REM THEREFORE SEEKTIME IS ZERO
RETURN
X = TRACKSTOMOVE
SEEKTIME = 10.89605 + 2.178647 * X - 4.846975E - 2 * X * X + 7.936448E - 4 * X * X * X - 4.406022E - 6 * X * X * X * X
GOTO 2600
3000 REM COMPUTE RECORD READTIME INCLUDING ROTATIONAL LATENCY
RNDLATENCY = INT(RND * LATENCY)              REM RANDOM ROTATIONAL LATENCY
TOTALTIME = TOTALTIME + RNDLATENCY + SECREAD REM ACCUMULATE READ TIME
RETURN
REM FIELD ORDER IN DATA STATEMENTS
REM DRIVE NAME, TRACK-TO-TRACK TIME, SETTLING TIME, HEAD-LOAD TIME,
REM MAX LATENCY, TRANSFER TIME, SECTORS PER TRACK, TRACKS PER DISK
DATA 12                                       REM NUMBER OF DRIVES TO SIMULATE
DATA "PERSCI 277",0,0,40,166.7,4.096,26,77
DATA "REMEX RFD 1000A/B",6,24,50,166.7,4.096,26,77
DATA "SHUGART SA800",8,8,35,166.7,4.096,26,77
DATA "SHUGART SA400 MINI",40,10,75,200,8.192,18,35
DATA "SHUGART SA450 MINI",25,15,50,200,4.096,18,35
DATA "PERTEC FD200 MINI",25,10,35,200,8.192,16,35
DATA "ICOM FD3800 DUAL-DENSITY",10,0,40,166.7,2.048,26,77
DATA "ICOM MICROFLOPPY",40,10,75,200,8.192,16,35
DATA "MEMOREX 550",6,10,35,166.7,26,77
DATA "MEMOREX 552",3,15,35,166.7,26,77
DATA "MICRO PERIPHERALS B51 MICROFLOPPY",5,15,35,200,8.192,16,40
DATA "ALTAIR 88-DCDD",10,10,45,166.7,4.096,32,77
END

```

and software delay characteristics. However, the relative standing of the drives is unlikely to change if these factors are included.

The important elements to consider for additional simulation are: the record formats on the disk, the interface and controller characteristics, processor speed, and the algorithm of the program performing the access.

As an example of the discrepancy

between the simulation and the speed of the total system, I offer the following. My system uses a Z80 microprocessor running at a 2 MHz clock rate, and contains 24 K bytes of zero-wait-state memory. The drive controller, designed by George Morrow, connects to a PerSci Model 277 with the fast-seek option. The operating system is CP/M. The time to read 500 records sequentially using BASIC-E is

109 seconds; to read 500 records randomly takes 525 seconds. Compare these times with those in the results of the simulation for the PerSci drive. Beware of making system estimates based only on a part of the total operation. Does anyone want to write an article that describes operating-system timing simulation?

Two for One

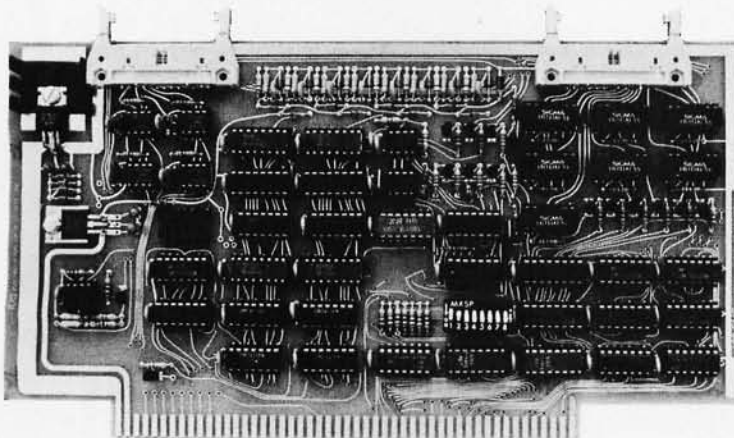
There are two basic lessons to be learned from this exercise. The first one concerns an elementary introduction to the motions that occur in floppy-disk drives and affect their speed of operation. The second lesson concerns derivation of mathematical functions that describe these mechanical motions; it also concerns putting the functions into a program for the purpose of obtaining an estimate of performance. Performance, for the purpose of this article, considers only the relative speed of operation of the various drives. In making a decision to select a particular floppy-disk drive, you must understand that overall performance, not just speed of operation, should be examined. ■

Listing 2: Output of simulation results produced by the program of listing 1.

FOR 500 READ OPERATIONS DRIVE SPEED COMPARISON SIMULATION ALL TIMES IN MILLISECONDS		
DRIVE NAME	SEQUENTIAL -----+-----	RANDOM
PERSCI 277	43107.6	57912.2
REMEX RFD1000A/B	43650.1	92281.9
SHUGART SA800	44163.1	94881.9
SHUGART SA400 MINI	53547.8	288397.1
SHUGART SA450 MINI	55153.2	198631.3
PERTEC FD200 MINI	52804.8	201703.6
ICOM FD3800 DUAL-DENSITY	43110.0	101456.6
ICOM MICROFLOPPY	55698.8	293376.0
MEMOREX 550	44821.1	77892.1
MEMOREX 552	44000.1	66670.3
MICRO PERIPHERALS B51 MICROFLOPPY	55287.8	89390.2
ALTAIR 88-DCDD	42634.1	108670.8

IDS Announces S-100 Energy Management Module

The 100-EMM Energy Management Module provides temperature measurement at four separate locations indoors or out; monitors eight (8) doors, windows, or fire sensors; controls six external devices via relay or optoisolator; and provides an intrusion alarm with battery backup (alarm operates even during primary power outages). Put the 100-EMM to use in your home or business and claim a 30% tax credit for the cost of your S-100 computer system including the 100-EMM. (Purchasing the 100-EMM can actually save you several times its cost in tax credits. Full instructions for filing are included in the 100-EMM manual.)



**BUY THIS S-100 BOARD
AND GET UP TO A 30%
TAX CREDIT BASED ON
THE COST OF YOUR
COMPUTER SYSTEM!**

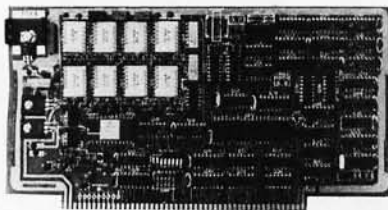
**100-EMM Energy Management Module
Assembled and Tested \$395.00
Kit \$345.00**

Options for 100-EMM:

CP-52 Cable Panel - Terminates two 26-conductor flat cables in 26 screwlugs. Use it for convenient interconnection of the 100-EMM to the "outside world". **\$45.00**

CABL-26-STD 26-Conductor Flat Ribbon Cable - Four feet in length with connectors for 100-EMM and CP-52 above. **\$35.00** Other lengths available on special order. Add **\$1.00** per foot.

OTHER PRODUCTS FROM IDS. The most complete source of S-100 compatible modules for process control, data acquisition, energy management, and data communications.



88-MODEM S-100 ORIGINATE/ANSWER MODEM WITH AUTO-DIALER. Software selectable baudrate provides any baudrate from 66-600 baud. Provides 1.5 stop bits when operated in 5-bit code mode. Auto-answer programs available for CROMEMCO CDOS, CP/M, North Star Horizon and MDS, and Alpha Micro.

Assembled and Tested \$395.00 Kit \$245.00

88-UFC UNIVERSAL FREQUENCY COUNTER

Four software selected inputs. Measure frequency from 0-650 MHz and period from .1µs to 1 Second. Extensive software included.

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The most versatile serial interface on the market. Computer access/control of all data and handshake lines and provision for masked interrupts, inversion of any input or output signal, and onboard baudrate generation for 110, 134.5, 150, 300, 600, 1200, 2400, 4800, 9600, and many other baud rates. Many more features.

Assembled and Tested \$299.00 Kit \$199.00

88-SPM TIME OF DAY CLOCK with battery backup. Set the clock with three out instructions: no delays! Programs included in North Star BASIC, CBASIC, and 8080 assembly language.

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88-RCB RELAY CONTROL BOARD

16 Relays on one board. Control appliances, production equipment, or even musical instruments (See BYTE Magazine Sept 1977 page 12)

Assembled and Tested \$299.00 Kit \$199.00

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ALLOS
COMPUTER SYSTEMS

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**CP/M and MP/M are registered trademarks of Digital Research, Inc.

ALTOS BREAKS THE MICRO BARRIER.

Yesterday, microcomputer meant micro performance. Once you outgrew it, you had to step up to a mini. Which meant a big step up in price.

Today, there's the new Altos ACS8000-6 single-board microcomputer system.

It's the first system for the OEM, small businessman and personal user, that offers minicomputer performance and minicomputer storage capacities—at a microcomputer price.

MULTI-USER, WINCHESTER STORAGE, FLOPPY BACK UP: \$14,260.

The new Altos ACS8000-6 is a highly advanced Z80* based microcomputer system with high-speed RAM, floppy disk and Winchester hard-disk controllers, DMA, six serial and two parallel I/O ports and the AMD 9511 floating point processor all on a single board. A typical four-user system configuration with two megabytes of Shugart floppy and 29.0 megabytes of Shugart Winchester storage, including CPU and 208K bytes of RAM, costs only \$14,260—compared to \$30,000 or more for a similar minicomputer system. And that adds up to mini performance at less than half the cost!

MULTI-USER EXECUTIVE SUPPORTS FOUR INDEPENDENT USERS RUNNING CP/M COMPATIBLE PROGRAMS.**

This revolutionary new microcomputer system features the MP/M** Multi-User Executive software program that's unique in two ways. It includes a multi-user CP/M capability and the ability to handle Winchester-type hard disks. The advanced Z80 operating program supports four independent CP/M

compatible programs in any of six popular languages: BASIC, FORTRAN, COBOL, PASCAL, APL, C, and a large assortment of additional business application packages. MP/M is compatible with both the 1.4 and 2.0 versions of Digital Research's CP/M, which means programs based on either version can run under MP/M without modification.

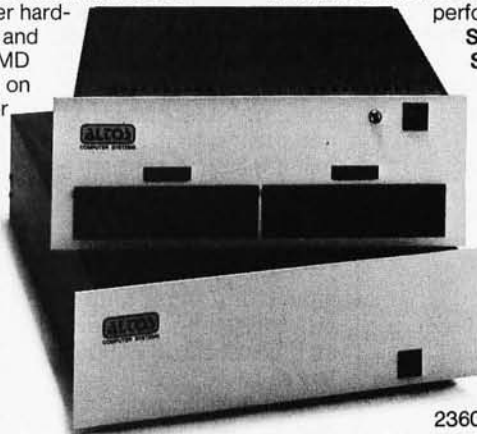
With MP/M at the helm, your Altos ACS8000-6 system can support up to four simultaneous users with 48K bytes of RAM each plus 58 megabytes of Winchester storage and 4 megabytes of floppy back up. And that adds up to the first microcomputer to give you the power and performance of a minicomputer.

SINGLE-USER, HARD-DISK SYSTEMS START AT \$9450.

The Altos ACS8000-6 series. It's a barrier breaker in every sense. Our entry-level, single-user, hard-disc system with floppy back up is priced under \$10,000 and even our 4-user CP/M model is available for under \$12,000. And all configurations are easily upgraded. For specific details about pricing or performance, call or write:

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Circle 83 on inquiry card.



ALTOS
COMPUTER SYSTEMS

BYTE LINES

NEWS AND SPECULATION ABOUT PERSONAL COMPUTING

Conducted by Sol Libes

What To Look For At NCC: The computer show of the year is the National Computer Conference (NCC), which will be held this month (May 19 thru 22) at the Anaheim Convention Center in Anaheim, California. In 1979, 60,000 people attended the NCC. Many new products are introduced each year at NCC. The 1980 show will see many more Japanese manufacturers displaying, among other things, 8-inch Winchester disk drives and microcomputer systems. Furthermore, look for several manufacturers from the United States to show complete microcomputer systems that use the Zilog Z8000 and Motorola 68000 16-bit microprocessors. Last year's show saw the introduction of 8086-based microcomputers. Also, look for disk-operating-system-based languages and applications packages for these new 16-bit microcomputer systems. Several multiprocessing and multiuser microcomputer systems will also be shown.

John Mauchly, Computer Pioneer, Dies: Dr John W Mauchly, co-inventor of the digital computer, died on January 8, 1980 at the age of 72. Together with his colleague Dr J Presper Eckert, Dr Mauchly conceived, designed, and built ENIAC, the first electronic digital computer.

It was built at the University of Pennsylvania and became operational in 1944. ENIAC contained thousands of vacuum tubes, filled 150,000 square feet of space, and weighed 30 tons. It was used for ten years.

Mauchly and Eckert later formed the Electronic Control Company (later called the Eckert-Mauchly Computer Corporation) to manufacture BINAC (Binary Automatic Computer), which became the prototype for the UNIVAC I (Universal Automatic Computer). The UNIVAC I was the first commercial computer; it was installed at the United States Census Bureau in 1951.

When the company was purchased by Remington-Rand in 1950, Dr Mauchly continued with the Univac Division as Director of Applications and worked on weather-forecasting projects. In 1959 he left to form Mauchly Associates, a consulting firm that developed the critical-path method for construction.

In 1967 he founded Dynatrend, a computer consulting firm, and since 1973 he had served as a consultant to Sperry Univac.

Mauchly and Eckert met in 1941 at the University of Pennsylvania's Moore School of Electrical Engineering, where both were instructors. They first proposed the building of the digital computer to the US Army in 1942 for calculating

trajectory tables. ENIAC contained ten accumulators, had internal memory, used subroutines, and was all-electronic, while prior machines were electromechanical and very limited in power. Some parts of ENIAC can be seen at the Smithsonian Institution in Washington, DC.

At the time of his death Dr Mauchly was believed to be working on a word-processor project using a Radio Shack computer. He was an active proponent of personal computing, and he will be missed by many.

News Bits: Friends Amis has developed an interface for the Craig M-100 hand-held language translator that allows the user to add read-only memories containing data bases such as wine lists, Olympic scores, history, or metric conversion.... Panasonic will introduce a hand-held computer to sell for about \$180 in late 1980. The RLT500 Electronic Data Center can be connected to a television set for display, to an acoustic modem for communication, to a printer for hard copy, or to a speech synthesizer for audible output. Quasar will bring out the HC2000RA Information Processor for \$150, which should work with the accessories for the Panasonic machine.... Amateur robot builders have a new source for parts: Vedos Ltd, Suite

1113, 19 W 34th St, New York NY 10001.

Random News Bits: In last month's column I mentioned a rumor about a new printer to compete with the Sanders Technology word-processing dot-matrix printer. The unit has now been formally announced by Florida Data Corporation of West Melbourne, Florida. It offers up to 900 characters per second (cps) speed with correspondence-quality type and high-resolution graphics (at a slower speed). It is said to use a magnetic stored-energy print head, and to offer an almost unlimited choice of type fonts, full graphics, and extended-character format. The machine will be available in the fourth quarter of 1980, and it should be priced under \$2000.... Micro Peripherals Incorporated of Salt Lake City, Utah, plans an under-\$1000 word-processing printer using a seventeen-wire matrix head and printing at 60 to 75 cps.... In the meantime Diablo, Qume, and Nippon Electric Company (NEC) are rumored to be developing under-\$1000 daisy-wheel printers.... Dataproducts will soon introduce a daisy-wheel printer; some observers speculate that it will sell for 20 to 30% less than current daisy-wheel units.... Next year, General Motors (GM) will make much use of on-board microcomputer systems in its vehicles to

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Mostek's MD Series™ of STD-Z80 BUS compatible microcomput-

er cards makes all this possible. There are more than twenty different boards in this off-the-shelf family available now, including data processing boards; memory boards (Static and Dynamic RAM, ROM/PROM); I/O cards; A/D; D/A; high speed floating point math; and floppy disk controller cards.

QC Micro Systems offers all of these products directly, including a full range of support products such as prototyping hardware,

support software and, of course, extensive documentation. And much more. Contact us for details so they can be put to work for you, by sending in the coupon below. Today. QC MicroSystems, P. O. Box 401326, Garland, TX 75040, (214) 343-1282.



Yes! I'm ready for more information on the STD-Z80 BUS products from QC MicroSystems. My application is

<input type="checkbox"/> Personal	<input type="checkbox"/> Resale
<input type="checkbox"/> Industrial Control	<input type="checkbox"/> Other _____
<input type="checkbox"/> Yes, I would like to use my TRS-80 as my STD BUS development station.	

Name _____

Company _____

Address _____

City _____ State _____ Zip _____

meet the stringent requirements for emissions control and fuel economy. GM's need for electronic parts will be so great that the company will use 56% of the world's supply of 8 K-byte read-only memories and 40% of the analog-to-digital converters, according to a GM estimate. In all, GM will buy 13 to 15 million electronic parts each day, more than 3 billion parts per year.... Chase Manhattan Bank is developing the Personal Computer Bank Communications System. Any bank customer who has a home terminal or computer system will be able to access (via telephone) his or her account, get an up-to-the-second status report, and cause funds to be transferred. The user with a computer will also be able to do batch-mode transfers and off-line processing of bank account data.... The precursor of flat solid-state data displays may have appeared. Crockroft International of Sunnyvale, California, has introduced a liquid-crystal display (LCD) panel with 32-by-32-dot display. It operates about four times faster than current LCD displays. The company also expects to have a variable-color display in the near future.... For the first time, a microcomputer-software package has been placed on the prestigious Datamation magazine Honor Roll of Software Packages. Naturally, the software package was the CP/M operating system, a product of Digital Research. Microsoft BASIC and UCSD Pascal received honorable mention.... A report from International Resource Development, a management consulting firm, predicts that four billion dollars will have been spent on electronic-mail services and equipment by 1990. The field will be dominated by IBM,

AT&T, and GT&E, with the US Postal Service getting about one quarter of the business.... A new supercomputer project has been started. Denelcor of Denver, Colorado, is planning to manufacture a computer that uses 50 processors, capable of performing 500 million instructions per second in parallel.... Texas Instruments and Hitachi are developing 64 K-bit programmable memories, which should become available next year....

Court Upholds FCC Ruling On TI Modulator:

The District of Columbia Court of Appeals has rejected an appeal by Atari Corporation (see last month's column). Atari challenged the ruling of the Federal Communication Commission (FCC) that allows Texas Instruments (TI) to sell its stand-alone radio-frequency (RF) modulator while the FCC reexamines its own guidelines for electronic television accessories. Atari argued that the FCC should have forced Texas Instruments to abide by the present rules until changes became final. The present regulations prohibit the marketing of stand-alone modulators. Texas Instruments uses these modulators with its Model 99/4 personal computer system.

Radio Shack And Apple Ask FCC For Deadline

Extensions: Tandy Corporation (parent company of Radio Shack) and Apple Computer Company have filed separate petitions with the FCC, asking that the FCC's July 1, 1980 deadline for compliance with new radiation standards be extended. They feel that there could be an adverse effect on products still in dealer stocks, which could take 6 to 9 months to sell. All units

manufactured after July 1 will have to comply with the standards. General Electric, General Telephone and Electronic (GT&E) Services Corporation, Honeywell, Control Data Corporation, Atari, American Telephone and Telegraph (AT&T), the Computer and Business Equipment Manufacturers Association (CBEMA), and Electronic Industries Association (EIA) have also filed petitions. Most of these petitioners asked for a 2-year extension, while some asked for as many as 7 years.

Word-Processing Standard In Development:

An American National Standards Institute (ANSI) Group (number 4 of X4A12) has completed a working draft of the page-image format of a word-processor standard. The purpose is to facilitate communications between word processors from different vendors in a common language. The present draft is considered only a first step; the first part of the standard is expected to be adopted by midyear.

Microprocessor Technology Seen Affecting Employment:

A report presented at a recent conference of the Organization for Economic Cooperation and Development (OECD) in Paris, France, cited an impact on employment in Japan by microcomputers. The report was prepared by a special committee organized by the Japan Information Processing Development Center and sponsored by the Ministry of International Trade and Industry.

The report forecasts substantial job layoffs due to labor-saving microcomputer-controlled equipment. The biggest effect will be felt in assembly manufac-

turing where automation will substantially reduce the number of unskilled workers on the assembly line. On the other hand, the report predicted an increased need for systems and software personnel.

Microcomputer Lip-Reader For Deaf:

The Research Triangle Institute in North Carolina, working with funds from the National Aeronautics and Space Administration (NASA) and the Veterans Administration, is developing a microprocessor-based system to help the deaf read lips. The device, called Autocuer, can increase a trained lip-reader's comprehension from the typical 25% to about 90%. A light-emitting diode (LED) display projects representations of sounds as nine simple patterns corresponding to the sound.

Commodore Introduces New 4-bit Microprocessor:

While other semiconductor makers are going to larger microprocessors (typically 16-bit or enhanced 8-bit devices) Commodore has decided to go in the other direction. Chuck Peddle, the wizard who created the 6502 microprocessor (used in the PET, Apple, Ohio Scientific, Atari, and other computers) and who also created the KIM-1 and PET computers, has now turned his efforts to designing a "super" 4-bit microprocessor called the MCS4500. Using complementary metal-oxide semiconductor (CMOS) technology, it has thirty-four instructions, on-board memory (including 2 K bytes of read-only memory and 176 nybbles of scratch-pad memory), and can directly drive up to four multiplexed liquid-crystal displays (LCDs). Memory can be expanded, and many of

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WK-7

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- MOS-40 36-40 CMOS SAFE INSERTER
- EX-1 14-16 EXTRACTOR
- EX-2 24-40 CMOS SAFE EXTRACTOR

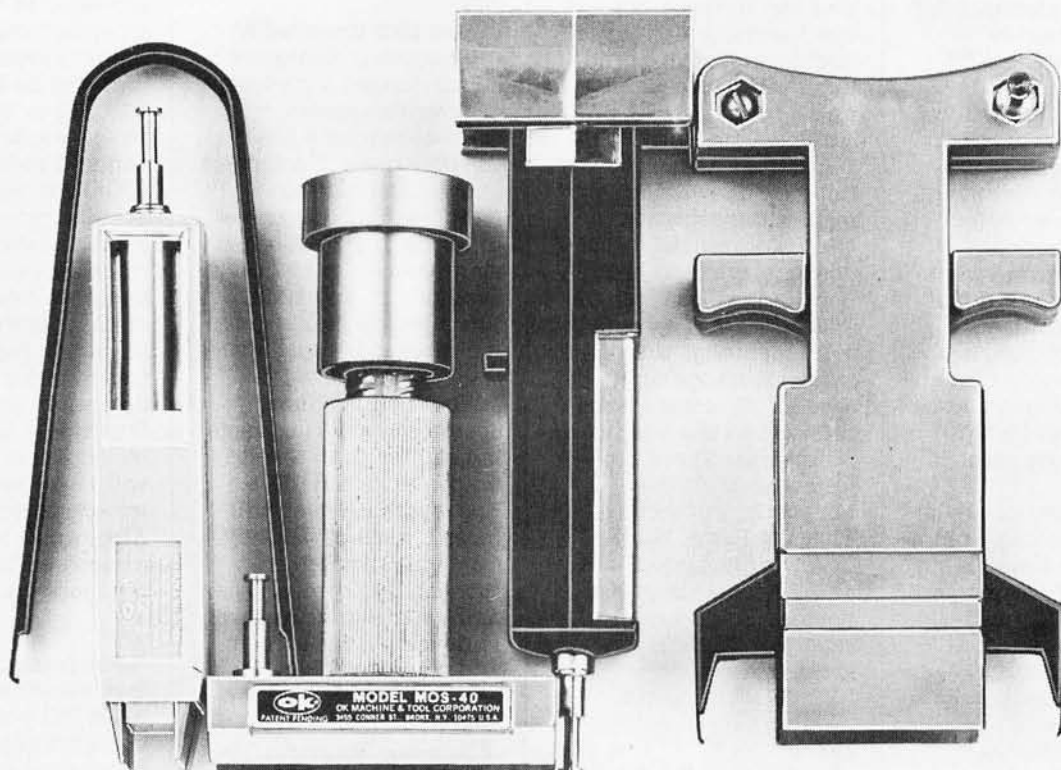


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the features found on 8-bit processors are included. Commodore will offer an assembler and emulator for the device that runs on a PET microcomputer.

IEEE Developing Assembly-Language Standard For Microcomputers:

The Institute of Electrical and Electronics Engineers (IEEE) is developing a standard for assembly language on microprocessors (IEEE Task P694/D11). It is long overdue and will be of enormous value to all assembly-language programmers who are struggling to write code for different microprocessors. The group working on the standard has done some genuinely worthwhile things, such as demonstrating that all the current major microprocessors can be handled by a single standard.

The problems of present inconsistency are incredible. For example, in assembly code for some processors, MOV A,B means "move the contents of register B to A," while for others it means just the opposite.

The new IEEE standard should cure problems such as those that occurred when Zilog did not use the Intel mnemonics for the Z80's instructions, which are a superset of the 8080's instructions (probably because Intel copyrighted the mnemonics).

The standard also covers instruction names, address modes, operand sequences, expression evaluation, constants, labels, comments, and assembler directives. The standard does not specify the syntax necessary to support macroinstructions or conditional assembly.

The IEEE Computer Society is to be congratulated for its activities in developing computer standards,

which are overcoming problems created by companies that all too often intentionally create incompatibilities to protect their competitive position.

I predict that this assembly-language standard will meet with the wide adoption that the other IEEE standards (such as the IEEE-488 interface and IEEE S-100 bus standards) have met. You can obtain a copy of the Assembly Language Standard draft by sending a self-addressed 10 by 13 inch (25.4 by 33 cm) envelope with \$0.54 US postage affixed to Dr Robert G Stewart, Chairman of Computer Standards Committee, IEEE Computer Society, 1658 Belvoir Dr, Los Altos CA 94022.

Incidentally, the IEEE is also working on several other standards relevant to the microcomputer area. These projects are: Multibus, Microbus, Futurebus, Floating Point, High-Level Languages, Pascal and Relocatable Object Format. I will try to report on IEEE's progress in a future BYTELINES column.

Telecomputing Companies Off To A Good Start:

The Source, a telecomputing service provided by Telecomputing Corporation of America (or TCA, headquartered in McLean, Virginia), is just six months old. The Source has 3000 subscribers and is adding 500 more per week. The company, which provides information retrieval and software services via a telephone network, has grown to thirty-five employees and a monthly revenue of \$100,000. TCA is aiming to have 100,000 customers by the end of 1980.

A competing service called MicroNet, provided by CompuServe Incorporated of Columbus,

Ohio, is aimed more at the hobbyist. They claim to have 1200 customers already. However, there is a dark cloud on the horizon, in the form of the Teletext and Viewdata systems now being tested by GT&E, Texas Instruments, and others. This may provide much lower cost but less flexible data access to the home television screen.

Flat CRT Unveiled At CES: Sinclair Radionics demonstrated a prototype of their flat-screen cathode-ray tube (CRT) at the Consumer Electronics Show (CES) held in January. Sinclair hopes to use it in a \$125 television receiver to be available in late 1981. The electron gun is mounted sideways, with the beam deflected to strike the phosphor-coated screen. The image is brighter than images on conventional CRTs. The entire receiver will measure 2.5 by 10.2 by 12.7 cm (1 by 4 by 5 inches). The company is doing additional research to develop large-screen and color flat CRTs.

Random Rumors: Centronics, the largest supplier of printers today, will soon cut prices 20 to 30% on existing low-cost printers and will unveil new products directed specifically at the personal computer market, including both impact and nonimpact serial matrix units....

Dataproducts, Okidata, and a number of Japanese manufacturers including NEC are rumored working on multipass, high-density, dot-matrix printers to compete with the RC Sanders Technology Systems Media 12/7 printer. However, at present Sanders Technology has about a 2-year lead time on this technology.... Radio Shack might introduce

more than one new personal computer system in the late fall (see the February 1980 column for previous rumors)... Reports have been circulating that Data General is developing a desk-top computer, code-named Wing. It will use a microprocessor, have two floppy-disk drives, and will be made in Taiwan.... It is rumored that Toshiba Electric Company is working on an experimental voice-input typewriter. The unit will be able to type 100,000 to 200,000 different words in Japanese and will recognize words with 90% accuracy. Toshiba recently demonstrated prototype voice-activated television and high-fidelity equipment.... More rumors are surfacing regarding the future plans of Apple Computer Company. Reportedly the new model Apple computer will be a Pascal machine for educational users. Also, Apple will place increased emphasis on the business market....

Congress Considering Two Personal Computer Bills:

Did you know that two bills about personal computers have been introduced in Congress? One is H.R.3822, which would set up a national endowment for personal computers. The other is H.R.4326, which would create a presidential commission to make recommendations about the personal computer field.

MAIL: I receive a large number of letters each month as a result of this column. If you wish a response, please include a stamped, self-addressed envelope.

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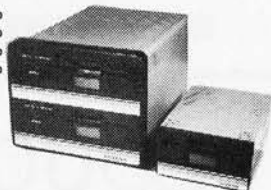
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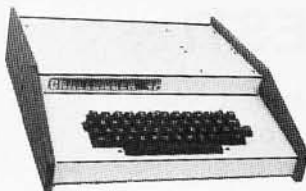
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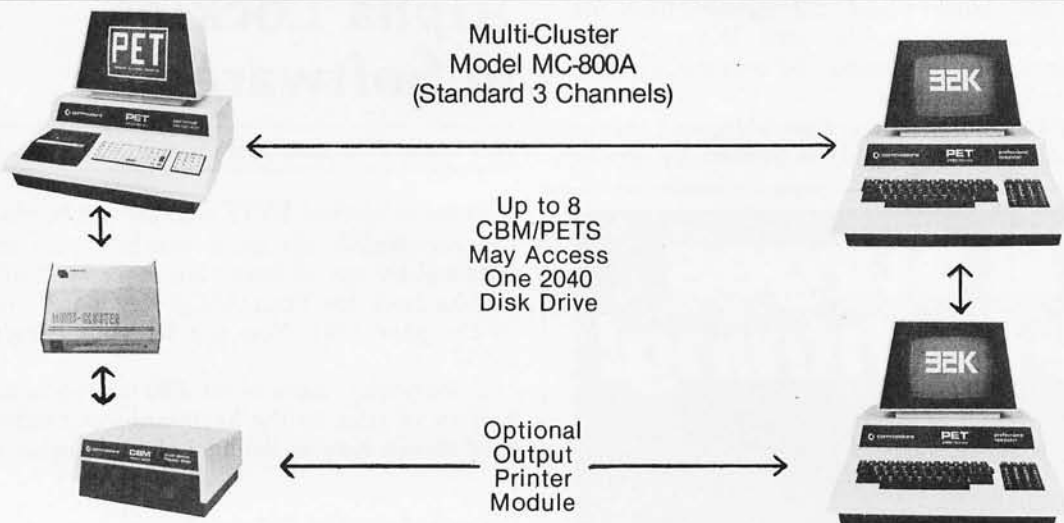


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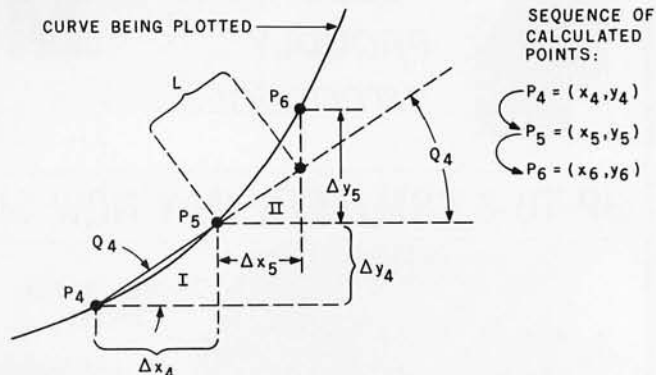
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Simplifying the Curve-Plotting Calculation by Geometric Means

A David Nawrocki, 1101 Wiltshire, San Antonio TX 78209

I enjoyed reading Timothy G Bowker's interesting article "Minimizing Curve-Plotting Calculation" (December 1979 BYTE, page 134). Perhaps it is worth pointing out that his equation (1) on page 138, which involves arctangent and cosine functions, can be reduced to a more efficient form for computational purposes. Although the improvement is slight, the use of a single square-root term will allow more rapid calculation than the trigonometric functions originally used. If a very large number of points must be plotted, the accumulated savings in time can be significant.

First, let us note from the illustration in figure 1 that his Δx_5 (the quantity to be found) is related by similar



triangles (I and II) to Δx_4 , Δy_4 , and L (quantities known from previous steps) as follows:

$$\frac{\Delta x_5}{\sqrt{\Delta x_4^2 + \Delta y_4^2}} = \frac{L \Delta x_4}{\Delta y_4}$$

The possible scale factors M and N cancel out, and it is not necessary to compute Q_4 to obtain Δx_5 . ■

Alpha Locking in Software

W S Lewis, POB 1555, East Canton OH 44730

Those readers of BYTE who are not hardware fanatics can accomplish the same results in software as was obtained by use of hardware in Terry Conboy's article "Alpha Lock for Your ASCII Keyboard" (January 1980 BYTE, page 156). You can let your computer do the work!

In particular, users of the Z80 microprocessor can add 8 bytes of code to the keyboard-input subroutine. The code shown here as listing 1 should appear in the input

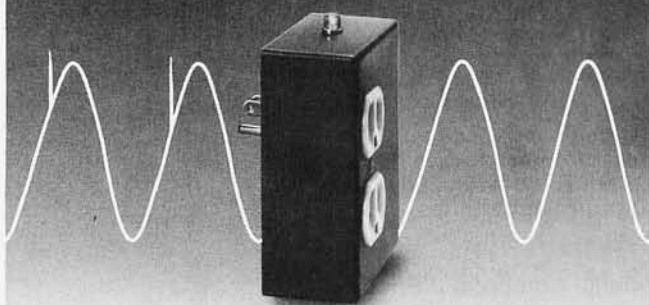
Listing 1: Portion of Z80 code for uppercase to lowercase conversion, input section.

Hexadecimal Object Code	Instruction Mnemonics	Comments
DB 30	XIN IN A,(30H)	;STATUS PORT
CB 4F	BIT 1,A	
28 FA	JR Z,XIN	
DB 31	IN A,(31H)	;KEYBOARD
CB BF	RES 7,A	;MASK PARITY

Listing 2: Final portion of Z80 code for uppercase to lowercase conversion.

Hexadecimal Object Code	Instruction Mnemonics
FE 61	CP 61H
F8	RET M
FE 7B	CP 7BH
F0	RET P
D6 20	SUB 20H
C9	RET

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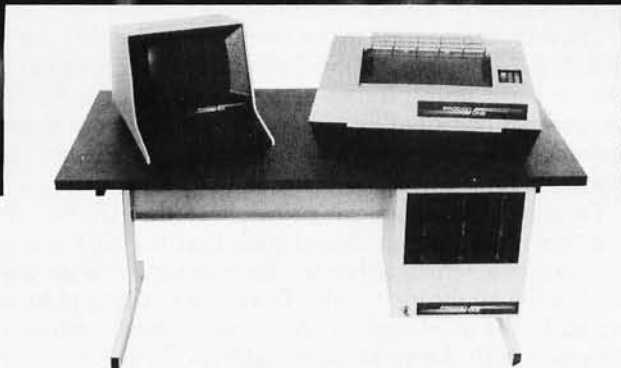
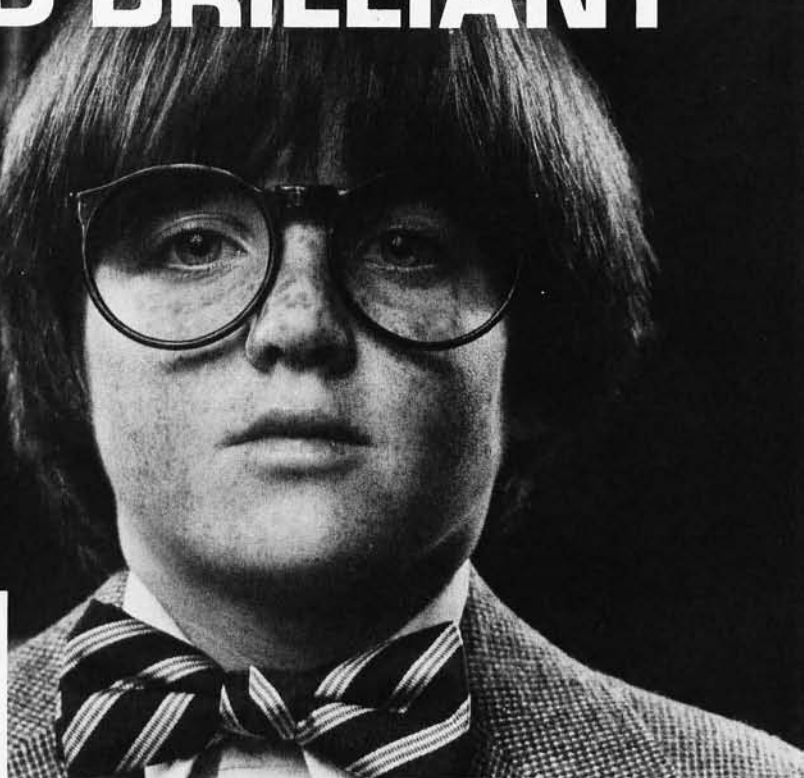
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subroutine. The code in listing 2 goes at the end of the input subroutine, just before it returns to its calling routine.

Note that the uppercase option is completely under software control. The first compare-immediate (the CP 61H) instruction in listing 2 can be changed to a return (RET) instruction when lowercase is desired, and restored to CP when uppercase is desired. ■

Maintaining a Single Exit Point

Armond Inselberg, 234 Central Ave, Mountain View CA 94040

I agree with James Lewis, author of "Some Notes on Modular Assembly Programming" (December 1979 BYTE, page 222), in his emphasis on modular programming. However, another important tenet of structured programming is the use of a single entry point and a single exit point for a given program module.

The ABORT routine in the modular 8080 code example of listing 2 (on page 224) violates this principle of having only one exit point. In this case we find that the ABORT routine can be exited by either the JNZ (ie: jump if accumulator is not equal to 0) instruction or by the RET (return from subroutine) instruction.

To apply the single-exit principle to the ABORT routine, we must arrange things such that the RET instruction causes a return either to the monitor or to the main level of the application code. To return to the monitor using RET, we must replace the current return address on the stack with the entry-point address for the monitor.

The top of the stack can be changed with the XTHL instruction, which exchanges the contents of the H and L registers with the top of the stack. The ABORT routine would then be coded:

```
ABORT   LDA SHKEY
        ORA A
        JZ RETURN           ;no shift key request
        LXI H,MONITOR      ;shift key hit
        XTHL                ;exchange stack and HL
RETURN  RET
```

However, my preference is that the return to the monitor never be made at all from the ABORT routine, since ABORT is nested below the main level of code. I would rather proceed as follows.

First, in ABORT, test for the conditions requiring a monitor return, and set up the stack (if necessary) for the return to the monitor. Then, ABORT should set a signal requesting a return to the monitor, and then just return to the main level of the application code. At the main level, either a return to the monitor or a jump to the starting point of the application would be made.

The main level would then be coded:

```
START  CALL RANDOM
        CALL NOTE
        CALL ABORT
        JZ  START           ; no monitor request
        RET                 ; monitor return requested. ■
```


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TFS lets you make multiple copies of any text. For example: Personalized form letters complete with name & address & other insertions from a disk file. Text is not limited to the size of RAM making TFS perfect for reports, manuals or any big job.

Text is entered using CP/M standard editor or most any CP/M compatible editor. TFS will link completely with Super-M-List making personalized form letters easy.

Requires: 24K CP/M.

Supplied with extensive user manual: \$85.00. Manual alone: \$20.00.

Source to TFS in 8080 assembler (can be assembled using standard CP/M assembler) plus user manual: \$250.00.

MAILING LIST

SUPER-M-LIST: A complete, easy to use mailing list program package. Allows for two names, two address, city, state, zip and a three digit code field for added flexibility. Super-M-List can sort on any field and produce mailing labels direct to printer or disk file for later printing or use by other programs. Super-M-List is the perfect companion to TFS. Handles 1981 Zip Codes!

Requires: 24K CP/M.

Supplied with complete user manual: \$75.00. Manual alone: \$10.00

UTILITIES

Utility pack #1: A collection of programs that you will find useful and maybe even necessary in your daily work (we did!). Includes:

- CMP:** Compare two files for equality.
- ARCHIVER:** Compacts many files into one, useful when you run out of directory entries.
- SORT:** In core sort of variable length records.
- XDIR:** Extended, alphabetical directory listing with groupings by common extension.
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- PG:** Lists files to CRT a page at a time.
- ... plus more ...

Requires: 24K CP/M.

Supplied with instructions on discette: \$50.00.

SYSTEM MAINTENANCE

DIAGNOSTICS I: Easily the most comprehensive set of CP/M compatible system check-out programs ever assembled. Finds hardware errors in your system, confirms suspicions, or just gives your system a clean bill of health. Tests:

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Minimal requirements: 24K CP/M. Supplied with complete user manual: \$50.00. Manual alone: \$15.00.

SOFTWARE SECURITY

ENCODE/DECODE: A complete software security system for CP/M. Encode/Decode is a sophisticated coding program package which transforms data stored on disk into coded text which is completely unrecognizable. Encode/Decode supports multiple security levels and passwords. A user defined combination (One billion possible) is used to code and decode a file. Uses are unlimited. Below are a few examples:

- data bases
- general ledger
- inventory
- payroll files
- correspondence
- accounts pay/rec
- programs
- tax records
- mailing lists

Encode/Decode is available in two versions:

Encode/Decode I provides a level of security suitable for normal use. Encode/Decode II provides enhanced security for the most demanding needs. Both versions come supplied on discette and with a complete user manual.

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- more

'Tiny' Pascal is fast. Programs execute up to ten times faster than similar BASIC programs.

SOURCE TOO! We still distribute source, in 'Tiny' Pascal, on each discette sold. You can even recompile the compiler, add features or just gain insight into compiler construction.

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- terminal mode for timesharing between systems
- conversational mode
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Text continued from page 50:

address in the computer's memory from which the data was written onto the disk. All DTS numbers written on the disk have the bits that indicate the disk-drive number masked to 0 so that the file can be read from any disk drive, regardless of the drive in which it was loaded when it was written.

The *sector trailer* is 4 bytes long. The first 2 bytes contain the check sum. The last 2 bytes, except in the last sector in a file, contain the DTS number of the first sector of the file. In the last sector of the file, the last 2 bytes of the sector trailer contain the address at which execution of the contents of the file begins.

Software: The Basic Disk Routines

The basic disk routines handle head positioning, drive selection, sector selection, motor control, and computation of the check sum. Head positioning is performed by the use of the step and direction bits of the drive-select/status word (hexadecimal location CC03). Since the only indication of the position of the head is the track-0 bit in the drive-select/status

KIMDOS is a KIM-1 compatible version of the Percom MINIDOS disk operating system.

word, the position of the head must be kept by software as a value in memory.

In a multiple-drive disk system, it is desirable to keep track of the head positions of all drives in the system. The drive-selection routine (subroutine DRIV in listing 1) takes care of this. It saves the current track number of the current drive, restores the current track of the desired drive, and latches the desired drive into the controller. KIMDOS reinitializes the track registers (hexadecimal locations 000F thru 0013) with each operation so that preservation of these bytes is not necessary. However, if the system should be expanded with additional software, the track registers become very important. Inadvertant altera-

tion of these locations would cause reading or writing of the wrong track.

In a multiple-drive system, drive motors are either all running or all stopped. The motors cannot be controlled individually since the drive-selection circuitry does not affect the motor-on signal. This necessitates some special handling of drive selection.

The drive-selection routine must insure that the write head is disabled before switching drives, or the area currently under the head of the newly selected drive will be overwritten. The drive-selection routine must also insure that the sector counter on the controller board is synchronized with the newly selected drive. This can be done only after at least one index pulse has been received from the new drive to reset the sector counter.

The sector-selection routine reads the sector number from the controller. It must catch the leading edge of the desired sector so that the read or write operation does not begin in the middle of the sector; it does this by looking for the change from the previous sector to the desired sector. The sector-selection routine detects the disk-missing condition by setting a KIM hardware timer located on one of the 6530 devices for a quarter of a second. If the timer times out before the desired sector is found, the routine assumes that the disk is not properly inserted in the drive.

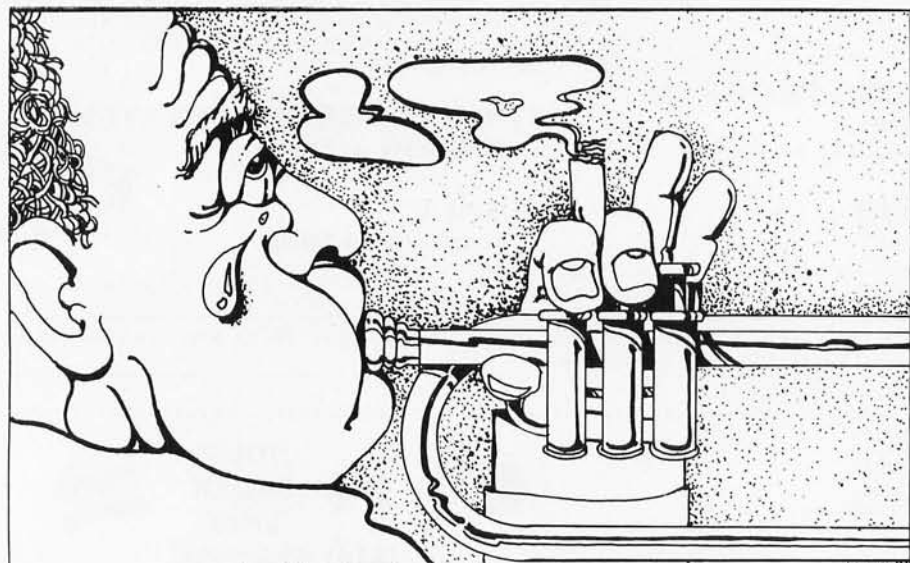
Read and Write Routines

The read and write routines are a fundamental part of KIMDOS, which is given in listing 1. Listing 2 is a cross-reference table for the symbols used in listing 1.

The read routines are designed to automatically try again to read incorrectly read sectors. They will try to read a sector up to six times before reporting a read error. Intermittent errors (such as those caused by random electrical noise, airborne contaminants, slight fluctuations in motor speed, small defects in the written data or track surface, or any combination of the above) can be recovered by rereading the sector.

After a read error, the read routine acts as follows: first, the routine rereads twice. If that fails, the routine moves the head to track 0 and back in an attempt to clear any interfering

Text continued on page 178



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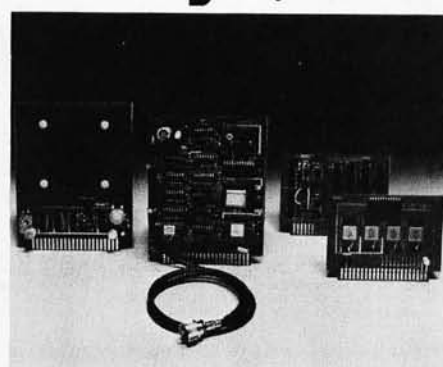
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Listing 1: KIMDOS, a small disk-operating system for the KIM-1 microcomputer. KIM-DOS is a set of disk read and write routines used with a KIM-1 connected to a Percom LFD-400 floppy-disk system. KIMDOS occupies under 1 K bytes of memory (from hexadecimal addresses C000 thru C3FE) and can be stored in one 2708 erasable programmable read-only memory (EPROM). Observe that this listing does not use standard 6502 mnemonics.

Line Number	Hexadecimal Address	Object Code	Label	Instruction Mnemonic	Operand	Commentary
0001:						
0002:						
0003:						
0004:						
0005:						
0006:						
0007:						
0008:						
0009:						
0010:	C000		KIMDOS ORG	\$C000		
0011:						
0012:	C000	D5DR *		\$0000	DESIRED DRIVE	
0013:	C000	D5TK *		\$0001	AND DESIRED TRACK	
0014:	C000	D5EC *		\$0002	DESIRED SECTOR	
0015:	C000	BLTK *		\$0003	BACK LINK TRACK #	
0016:	C000	RLSC *		\$0004	BACK LINK SECTOR #	
0017:	C000	FLTK *		\$0005	FORWARD LINK TRACK #	
0018:	C000	FLSC *		\$0006	FORWARD LINK SECTOR #	
0019:	C000	LEN *		\$0007	BYTE COUNT (RECORD LENGTH)	
0020:	C000	TGTP *		\$0008	TARGET ADDRESS	
0021:	C000	TCTL *		\$0008		
0022:	C000	TCTH *		\$0009		
0023:	C000	FTYP *		\$000A	FILE TYPE	
0024:						
0025:						
0026:						
0027:	C000	CKSL *		\$000B	THE CHECKSUM	
0028:	C000	CKSH *		\$000C		
0029:	C000	PSTL *		\$000D	POSTAMBLE/EXECUTION ADDRESS	
0030:	C000	PSTH *		\$000E		
0031:	C000	CHTK *		\$000F	CURRENT TRACK	
0032:						
0033:	C000	CTKP *		\$0010	DRIVE 0	
0034:	C000	CTKQ *		\$0011	DRIVE 1	
0035:	C000	CTKH *		\$0012	DRIVE 2	
0036:	C000	CTKS *		\$0013	DRIVE 3	
0037:						
0038:	C000	OPTR *		\$0014	DATA POINTER	
0039:	C000	OPTL *		\$0014		
0040:	C000	OPTH *		\$0015		
0041:	C000	ALTP *		\$0016	ALTERNATE LOAD POINTER	
0042:	C000	ALTL *		\$0016		
0043:	C000	ALTH *		\$0017		
0044:	C000	TPXH *		\$0018		
0045:	C000	EXCL *		\$0019	CKSUM TEMP STORAGE	
0046:	C000	EXCH *		\$001A	PROGRAM EXECUTION ADDRESS	
0047:	C000	SAVEP *		\$001A		
0048:	C000	CRDR *		\$001D	CURRENT DRIVE TEMPORARY	
0049:	C000	HIOR *		\$001E	TEMPORARY STORAGE FOR COITS	

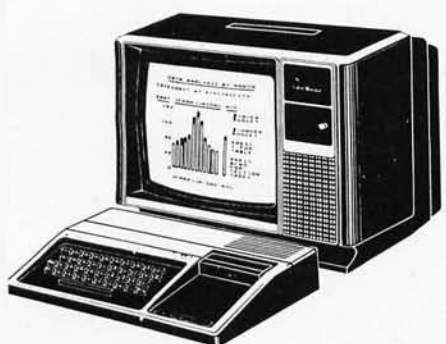
0050:	C000	RCNT *		\$001B	HEAD COUNT TEMPORARY	
0051:	C000	CKPT *		\$001C	CKSUM POINTER	
0052:	C000	CKPL *		\$001C		
0053:	C000	CKPH *		\$001D		
0054:	C000	DTSA *		\$001C	DRIVE TRACK SAVE	
0055:	C000	TSSA *		\$001D	TRACK SECTOR SAVE	
0056:	C000	ENDL *		\$001E	END OF DATA	
0057:	C000	FNDR *		\$001F		
0058:						
0059:	C000	PCL *		\$00EF	PROGRAM COUNTER SAVE	
0060:	C000	PCH *		\$00F0		
0061:	C000	PHTL *		\$00FA	DISPLAY WINDOW	
0062:	C000	PPTH *		\$00FB		
0063:						
0064:						
0065:						
0066:						
0067:	C000	R0ST *		\$CC00	USRT STATUS	
0068:	C000	R0TA *		\$CC01	RECEIVE DATA	
0069:	C000	SECT *		\$CC02	SECTOR COUNTER	
0070:	C000	DVST *		\$CC03	DRIVE STATUS	
0071:	C000	HRST *		\$CC04	RECEIVER RESTART PULSE	
0072:	C000	MON *		\$CC05	MOTOR ON PULSE (SEND)	
0073:	C000	MOFF *		\$CC06	MOTOR OFF PULSE (SEND)	
0074:						
0075:	C000	OUTPUT				
0076:	C000	SYNC *		\$CC00	SYNC WORD	
0077:	C000	W0TA *		\$CC01	SEND DATA	
0078:	C000	FILL *		\$CC02	FILL WORD	
0079:	C000	RTSL *		\$CC03	DRIVE SELECT	
0080:	C000	WPLS *		\$CC04	WRITE PULSE	
0081:						
0082:						
0083:						
0084:	C000	TJX *		\$1705	TIMER START	
0085:	C000	TOUT *		\$1707	TIME OUT CHECK	
0086:	C000	STRT *		\$1C4F		
0087:						
0088:						
0089:						
0090:						
0091:	C000	WRTRIT *		\$000B		
0092:	C000	WRTRIT *		\$0004		
0093:	C000	MILSEC *		\$007D		
0094:	C000	ZERO *		\$0000		
0095:	C000	DRVMSK *		\$00CF		
0096:	C000	STEPIN *		\$0010		
0097:	C000	SC1MSK *		\$000F		
0098:	C000	HEDLEN *		\$000A		
0099:	C000	TRKMSK *		\$003F		
0100:	C000	TRKMT *		\$0023		
0101:	C000	STRTIT *		\$0010		
0102:	C000	STP0IT *		\$0020		
0103:						
0104:						
0105:						
0106:						
0107:	C000	DISKMS *		\$0000	DISK MISSING	
0108:	C000	WPROT *		\$0001	WRITE PROTECT	
0109:	C000	INVSEC *		\$0002	INVALID SECTOR #	

Listing 1 continued on page 162

Fantastic Introductory Savings!

TEXAS INSTRUMENTS
INCORPORATED

TI-99/4 home computer



You can begin using the TI Home Computer in minutes — Without any previous computer experience. You simply snap in one of TI's Solid State Software™ Command Modules. Step-by-step instructions are displayed right on the screen.

Solid State Software Command Modules come in a wide range of application areas — from education to entertainment to personal finance and home management.

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apple computer



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ONLY \$989

32K, List \$1395 **\$1169**
48K, List **\$1259**

Exidy SORCERER COMPUTER

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List \$1295.

OUR PRICE ONLY \$999

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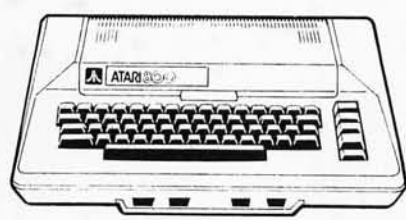
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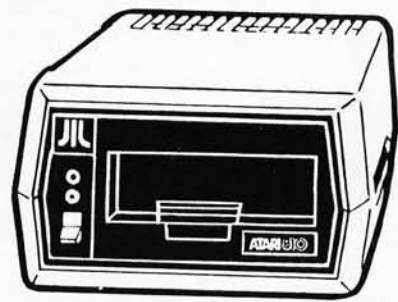
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Listing I continued:

```

0110: C000          BLANK SECTOR
0111: C000          DISK OVERHUN
0112: C000          PERMINENT READ ERROR
0113:
0114:
0115:
0116:
0117:
0118:
0119: C000 4C AA C1          JMP RSEX READ SECTOR
0120: C003 4C CF C2          JMP WSEX WHITE SECTOR
0121: C006 4C 7E C2          JMP SAVX
0122: C009 4C 89 C1          JMP LODX
0123: C00C 4C DA C0          JMP PHEP
0124: C00F 4C RB C3          JMP CVTBIN
0125: C012 4C 90 C3          JMP CVTDEC
0126: C015 4C 4C C3          JMP FWDC
0127:
0128:
0129:
0130: C010 A9 FF          INITDV LDXIM $FF OFFLINE CODE
0131: C01A A2 04          LDXIM $04 5 TRACK REGISTERS
0132: C01C 95 0F          INTLUP STAZX CRTK INIT A REGISTER
0133: C01E CA          DEX COUNT
0134: C01F 10 FB          DPL INTLUP NEXT
0135: C021 60          RTS
0136:
0137:
0138:
0139: C022 20 40 C0          CTXK JSR TKIN MOVE IN
0140: C025 20 40 C0          JSR TKIN
0141: C028 20 38 C0          CEXP JSR TKOT MOVE OUT
0142: C02B AD 03 CC          LDA DVST TRACK 0?
0143: C02E 4A          LSHR
0144: C02F 4A          LSHR
0145: C030 00 F6          DCS GETP NO
0146: C032 A9 00          LDXIM $00 ZERO CURENT THACK
0147: C034 85 0F          STAZ CRTK
0148: C036 F0 47          BEQ SETL UNCONDITIONAL BRANCH
0149:
0150:
0151:
0152: C038 AD 03 CC          TKOT LDA DVST GET DRIVE# IN 2 MSB
0153: C03D 29 CF          ANDIM DRVMSK
0154: C03D 4C 47 C0          JMP MTRV
0155: C040 AD 03 CC          LDA DVST
0156: C043 29 CF          ANDIM DRVMSK
0157: C045 09 10 C0          DRAIM STEPIN STEP IN PIT
0158: C047 8D 03 CC          STA DTSL SET DIRECTION
0159: C04A 20 83 C0          JSR DEL
0160: C04D 09 20 C0          DRAIM STPBIT SET STEP BIT
0161: C04F 8D 03 CC          STA DTSL
0162: C052 EA          NOP
0163: C053 FA          NOP
0164: C054 FA          NOP
0165: C055 29 DE          ANDIM $DF RESET STEP BIT
0166: C057 8D 03 CC          STA DTSL
0167: C05A AD 05 CC          LDA MON RETRIGGER MOTOR
0168: C05D 4C 83 C0          JMP DEL
0169:

```

```

0170:
0171:
0172:
0173:
0174:
0175:
0176:
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0201:
0202:
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0210:
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0220:
0221:
0222:
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0224:
0225:
0226:
0227:
0228:
0229:
0230:

SEEX : MOVE HEAD TO DESIRED THACK
LDAZ DSTK GET DESIRED THACK#
ANDIM THKMSK IGNORE DRIVE#
TAY CRTK THERE ALREADY?
BEQ SOUT YES
BCC STPO LESS THAN CURRENT
JSR TKIN STEP IN
INCZ CRTK
CRTK THERE YET?
STPI NO
BNE STPI
BEQ SETL
JSR TKOT STEP OUT
DECZ CRTK
CPYZ CRTK THERE YET?
DNE STPO NO
LDXIM $1E 30 MS HEAD SETTLING
DNE DELA
DELAY 20 MS
DEL LDXIM $14
DELA : DELAY 1 MILLISEC FOR EACH INC OF X
DELA PHA
LDAIM WILSEC
STA TJX START TIMER
LDA TOUT TIME UP?
BEQ LOOP NO
DEX
DNE LLOOP 1 MS PER LOOP
PLA
RTS
DRVTST : SYNC SECTOR COUNTER TO CURRENT DRIVE
DRVTST JSR START MOTOR
LDYIM $19 25 CHANGES
JSR FFTIME SET TIMER
DVLUP LDAIM SCITBIT
AND DVST GET SECTOR BIT
LDX TOUT TIME UP?
DNE ERHJ YEP
TAX
EORZ SAVEP CHANGE IN SECTOR BIT?
BEQ DVLUP NO, WAIT
STX SAVEP YES SAVE AND COUNT
DEY
DNE DVLUP
RETRIG LDA MON RETRIGGER MOTOR
CLC
RTS
ERRJ LDAIM DISKMS DISK MISSING
SEC
RTS
PHEP : SELECT AND PREPARE DRIVE FOR OPERATION
PREP LDA DSEC GET SECTOR

```



```

0231: C0BC C0 0A 0A      CMP $0A LESS THAN 10?
0232: C0FC 00 0C          PCS PADPHM NO, ERROR
0233: C0C1 A5 01          LDA PSTK RET TRACK
0234: C0C3 29 3F          ANDIM TRKMSK CLEAR DRIVE
0235: C0C5 C9 23          CMPIM TRKLMT OVERFLOW?
0236: C0C7 90 07          BCC DRV NO, GO CHECK DRIVE
0237: C0C9 A9 04          LDVFL
0238: C0CB 30          LDA
0239: C0CD 60          RTS
0240: C0CD A9 02          PADPHM LDAIM INVSEC INVALID SECTOR
0241: C0CF 60          RTS
0242:
0243: C0D0 AD 03 CC          IDA DVST GET CURRENT DRIVE
0244: C0D3 29 C0          ANDIM $C0
0245: C0D5 85 10          STAZ CRDR SAVE
0246: C0D7 A5 00          LDVZ DSDR GET DESIRED DRIVE
0247: C0D9 29 C0          ANDIM $C0
0248: C0DB C5 10          CMPZ CHDR SAME?
0249: C0DD C0 08          PNE SWIT NO, SWITCH DRIVES
0250: C0DF A5 0F          LDA CRTK GET CURRENT TRK
0251: C0E1 C9 FF          CMPIM $FF DRIVE INITIALIZED?
0252: C0E3 F0 24          BEQ DI NO
0253: C0E5 D0 30          BNE DS YES
0254:
0255: C0E7 48          SWIT
0256: C0E8 A5 10          LDVZ CHDR
0257: C0FA 10          CLC
0258: C0EB 2A          ROLA
0259: C0FC 2A          ROLA
0260: C0FE 2A          ROLA
0261: C0FE AA          TAX
0262: C0EF A5 0F          LDVZ CRTK SAVE CURRENT TRACK
0263: C0F1 95 10          STVZX CTKP IN SAVEAREA
0264: C0F3 60          PLA
0265: C0F4 48          PHA
0266: C0F5 18          CLC
0267: C0F6 2A          ROLA
0268: C0F7 2A          ROLA
0269: C0F8 2A          ROLA
0270: C0F9 AA          TAX
0271: C0FA B5 10          LDVZX CTKP GET CURRENT TRACK
0272: C0FC B5 0F          STAZ CRTK FROM SAVEAREA
0273: C0FE A9 08          DA LDAIM WRITBIT
0274: C100 2C 03 CC          BIT DVST IS WRITE GATE OFF?
0275: C103 F0 FB          BEQ DB NO, THEN WAIT
0276: C105 68          PLA
0277:
0278: C106 8D 03 CC          STA DTSL NOW SELECT DRIVE
0279: C109 20 95 C0          JSH DRVTSI SYNC TO DRIVE
0280: C10C B0 10          BCS DP ERROR EXIT
0281: C10E A5 0F          LDA CRTK
0282: C110 C9 FF          CMPIM $FF DRIVE ONLINE?
0283: C112 D0 03          BNE DS YES
0284: C114 20 22 C0          JSH CTXK NO, ZERO TRACK
0285: C117 20 31 C1          DS JSH START CHECK MOTOR
0286: C11A 20 60 C0          JSH SEEX FIND DESIRED TRACK
0287: C11D 18          CLC
0288: C11E 60          RTS
0289:
0290:
0291:

```

CKSEC : PART OF CTSC

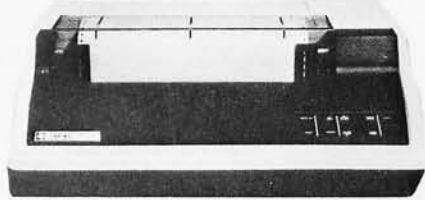
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0292: C11F AD 07 17      CKSEC LDA TOUT TIME UP?
0293: C122 D0 08          DNE MISS YEP
0294: C124 AD 02 CC          LDA SECT GET CURRENT SECTOR
0295: C127 29 0F          ANDIM SCTMSK
0296: C129 C5 02          CMP CSEC = DESIRED?
0297: C12D 60          RTS
0298: C12C 68          MISS RESTORE STACK
0299: C12D 68          PLA
0300: C12E 4C R6 C0          JMP ERHJ
0301:
0302: START : START MOTOR
0303:
0304: C131 A9 04          START LDVIM MTRBIT
0305: C133 2C 03 CC          PIT DVST IS MOTOR ON?
0306: C136 F0 0C          BEQ STAHR YES
0307: C138 A8          TAY
0308: C139 AD 05 CC          LDA MON START IT
0309: C13C A2 00          LDVIM ZERO THEN WAIT ASEC
0310: C13E 20 85 C0          DELSS JSH DELA
0311: C141 88          DEY
0312: C142 D0 FA          PNE DELSS
0313: C144 4C B1 C0          STARTR JMP RETRIG
0314:
0315: CTSC : WAIT FOR DESIRED SECTOR TO COME AROUND
0316:
0317: C147 78          CTSC SEI DISABLE INTERRUPTS
0318: C148 20 80 C1          JSH FFTIME START TIMER
0319: C14B 20 1F C1          CTLUPA JSH CKSEC IF DESIRED IS CURRENT
0320: C14E F0 FB          BEQ CTLUPA THEN WAIT TILL NXT REV
0321: C150 20 1F C1          CTLUPB JSH CKSEC THEN WAIT FOR
0322: C153 D0 FB          BNE CTLUPB DESIRED
0323: C155 18          CLC
0324: C156 60          RTS
0325:
0326:
0327:
0328:
0329: C157 A5 14          CHC LDA DPTL MOVE DATA PTR
0330: C159 B5 1C          STA CKPL TO CKSUM PTR
0331: C15B A5 15          LDA DPTH
0332: C15D B5 1D          STA CKPH
0333: C15F A6 07          LDVZ LEN GET LENGTH
0334: C161 A9 00          LDVIM ZERO CLEAR SUM
0335: C163 A8          TAY
0336: C164 B5 18          STAZ TPXH CLEAR TEMP STORAGE
0337: C166 20 72 C1          JSH CX COMPUTE DATA SUM
0338: C169 B6 1D          STVZ CKPH POINT TO HEADER
0339: C16B E8          INX
0340: C16C B6 1C          STVZ CKPL
0341: C16E A2 0A          LDVIM HDLEN HEADER LENGTH
0342: C170 A0 00          LDVIM ZERO
0343: C172 51 1C          FORTY CKPT COMPUTE CKSUM
0344: C174 0A          ASLA
0345: C175 26 18          ROLZ TPXH
0346: C177 90 02          BCC CQ
0347: C179 69 00          ADDIM ZERO
0348: C17B C8          INY
0349: C17C CA          DEX
0350: C17D D0 F3          BNE CX
0351: C17F 60          RTS

```

Listing 1 continued on page 166

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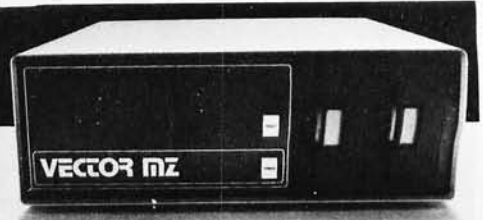


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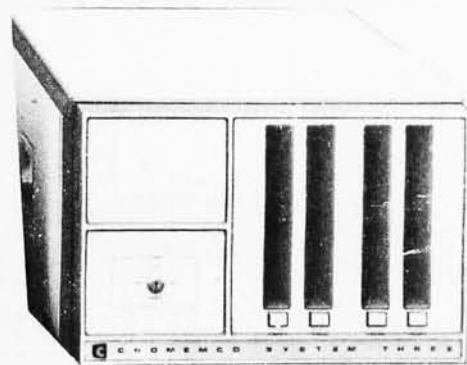
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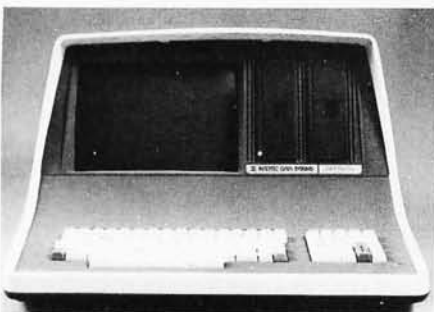
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- 10 Floppy Disks
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With Anadex DP-8000 Printer **\$1049**

With T.I. 810 Printer **\$1695**

— THIS OFFER EXPIRES JULY 10, 1980 —

Listing 1 continued:

```

0352:          FFFIME : START TIMER FOR 1/4 SECOND.
0353:          STORE TWICE FOR 6530 BUG.
0354:
0355:          FFFIME LD AIM $FF
0356:          STIMER STA TOUT
0357:          STA TOUT
0358:          STA TOUT
0359:          HTS
0360:
SECTION 2 READ ROUTINES
0361:
0362:          LDDX : READ A MEMORY FILE FROM DISK
0363:
0364:          LDDX JSR RSEX READ A SECTOR
0365:          BCS HDRT PERMINENT ERROR
0366:          LDZ FLSC
0367:          BNE NEND CHECK FOR LAST SECTOR
0368:          LDZ FLTK (FORWARD LINK ZERO)
0369:          NEQ COPPL END
0370:          NEND COPY FORWARD LINK TO
0371:          STAZ DSEC DESIRED TRACK/SECTOR
0372:          LDZ FLTK
0373:          STAZ DSTK
0374:          JMP LDDX READ NEXT SECTOR
0375:          LDA PSTL COPY EXEC ADDRESS
0376:          STA PCL TO KIM'S PC
0377:          LDA PSTH
0378:          STA PCH
0379:          HTS
0380:          RSEX : READ A SECTOR WITH ERROR RETRY
0381:
0382:          RSEX JSR PREP PREPARE DRIV
0383:          BCS HDRT ERROR EXIT
0384:          JSR RDS TRY UP TO 3 TIMES
0385:          BCS HDRT ERROR CODE IN A
0386:          BNE HDRT SUCCESS
0387:          JSR CTKX
0388:          JSR SEEX RE-SEEK TRACK
0389:          JSR RDS TRY AGAIN
0390:          BCS HDRT
0391:          BNE HDRT
0392:          LD AIM HEADER READ ERROR
0393:          STA RDS
0394:          HTS
0395:          RDS : READ A SECTOR WITH 2 RETRYs
0396:
0397:          RDS LD AIM $03 3 THYS
0398:          STAZ HCNT
0399:          LD AIM $FB SYNC CHAR
0400:          STA SYNC
0401:          PHP SAVE INTERRUPT
0402:          JSR CISC FIND SECTOR
0403:          BCS NOSEC
0404:          LD XIM $1E SHORT DELAY TO

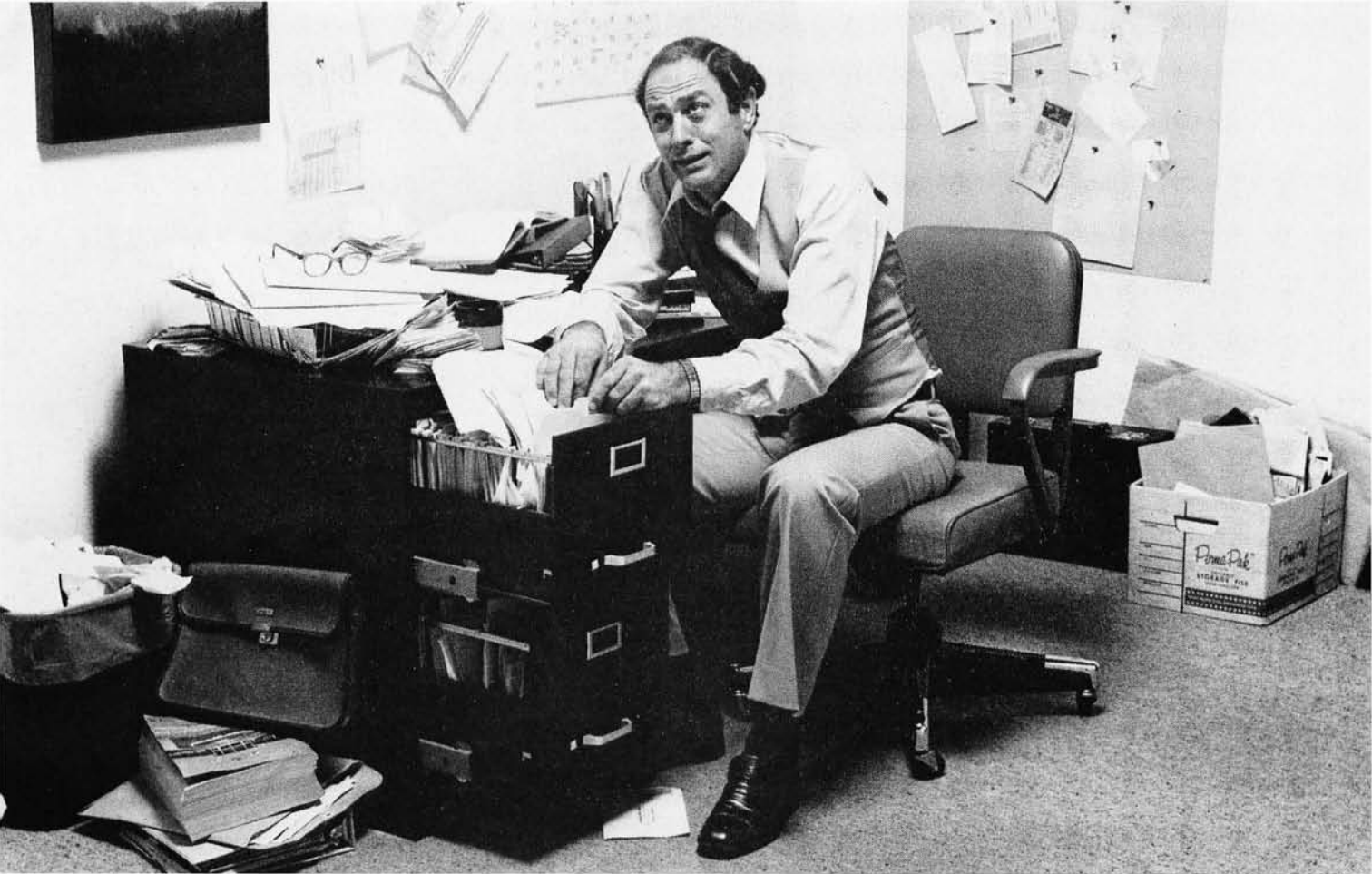
```

```

0412: C108 CA
0413: C109 D0 FD
0414: C10B AD 04 CC
0415: C10E 20 66 C2
0416: C1E1 90 03
0417: C1E3 28
0418: C1E4 3B
0419: C1E5 60
0420: C1E6 20 66 C2
0421: C1E9 A8
0422: C1EA 45 01
0423: C1EC 29 3F
0424: C1EE D0 56
0425: C1F0 90
0426: C1F1 85 01
0427: C1F3 20 66 C2
0428: C1F6 C5 02
0429: C1F8 D0 4C
0430: C1FA A2 00
0431: C1FC 20 66 C2
0432: C1FF 95 03
0433: C201 E8
0434: C202 E0 08
0435: C204 D0 F6
0436:
0437:          PREPARE FOR READING DATA
0438:          DETERMINE WHICH ADDRESS TO USE
0439:          LDZ ALTH
0440:          BEQ NOAL
0441:          STAZ DPTH
0442:          LDZ ALI
0443:          STAZ DPTL
0444:          JMP GDAT
0445:          LDZ TGLT
0446:          STAZ DPTL
0447:          LDZ TGLT
0448:          STAZ DPTH
0449:          LDYIM ZERO
0450:          LDZ HDST
0451:          BCC DALP
0452:          LDA HDTA
0453:          STAIY DPTH
0454:          INY
0455:          CPYZ LEN
0456:          BNE DALP
0457:          LD XIM $00
0458:          JSR IN
0459:          STAZ CKSL
0460:          INX
0461:          CPXIM $04
0462:          BNE CLUP
0463:          JSR CRC
0464:          CMPZ CKSL
0465:          BNE SKER
0466:          LDZ TPXH
0467:          CMPZ CKSH
0468:          BEQ SUCC
0469:          PLP
0470:          DECZ RCNT
0471:          SERH
0472:          JMP HEAD
PASS OVER SECTOR BOUNDARY
START RECIEVER
SKIP SYNC
SYNC FOUND
RESTORE INTERRUPTS
GET TRACK
CHECK FOR PROPER TRACK
IGNORE DRIVE
SEEK ERH
GET SECTOR
PROPER SECTOR?
NO
GET REST OF HEADER
STAZ BLTK
INX
CPXIM $08
BNE HLUP
PREPARE FOR READING DATA
DETERMINE WHICH ADDRESS TO USE
LDZ ALTH
BEQ NOAL
STAZ DPTH
LDZ ALI
STAZ DPTL
JMP GDAT
LDZ TGLT
STAZ DPTL
LDZ TGLT
LDZ DPTH
STAZ DPTH
LDYIM ZERO
LDZ HDST
LDA HDST
BCC DALP
LDA HDTA
STAIY DPTH
INY
CPYZ LEN
BNE DALP
LD XIM $00
JSR IN
STAZ CKSL
INX
CPXIM $04
BNE CLUP
JSR CRC
CMPZ CKSL
BNE SKER
LDZ TPXH
CMPZ CKSH
BEQ SUCC
PLP
DECZ RCNT
SERH
JMP HEAD
COUNT THYS
COUNT THYS
HEAD

```

Listing 1 continued on page 168



Record keeping problems? Our CCA Data Management System solves them easily.

Having information at your fingertips can make your job a whole lot easier. And that's what the CCA Data Management System is all about.

With this Personal Software™ package and an Apple II™ or TRS-80™ disk system, it will be far easier to keep inventories, customer lists, accounts receivable and payable records, patient histories and many more items.

In fact, you can use the CCA DMS for all of your data management needs, rather than buying (expensive) or writing (time consuming) separate programs for each application. That's because DMS lets you create your own filing systems, adapting itself to the types of records you keep. You specify the number and names of each data field—without any programming.

With DMS keeping all of your records, you only have to learn how to use one system. That's easier, too. It's menu driven, with plenty of prompts to help you create files and add, update, scan, inspect, delete, sort, condense and print data. Our comprehensive 130-page step-by-step instruction manual even provides complete "how to" inventory and mailing list applications so you can start processing immediately.

DMS is a very powerful system, with more file and record storage capacity than other data base programs on the market.

And it also gives you greater data handling flexibility. To customize DMS, write add-on BASIC programs that read or write DMS files and perform any kind of processing you want.

You can sort and print your data in nearly any form of report and mailing label you want. Sort data by up to 10 fields for zip code, balance due, geographic location or whatever. And print reports with subtotals and totals automatically calculated.

The CCA Data Management System, written by Creative Computer Applications, has two years of field testing on other microcomputers. Now Personal Software makes DMS available on the TRS-80 Level II and Apple II and II Plus 48k disk systems. And at under \$100, DMS is also easy to afford.

One demonstration will convince you how easy computerized record keeping is. Ask your Personal Software dealer to show you. To locate your nearest dealer, contact Personal Software, Inc., (408) 745-7841, 592 Weddell Dr., Sunnyvale, CA 94086.

See us at NCC booth 48 and 49.

*Apple is a trademark of Apple Computer, Inc.; TRS-80 is a trademark of the Radio Shack Div. of Tandy Corp.



**PERSONAL
SOFTWARE**

Listing 1 continued:

```

0473: C24E 10
0474: C24F 60
0475: C250 28
0476: C251 A5 17
0477: C253 F0 00
0478: C255 A5 07
0479: C257 10
0480: C258 F0 06
0481: C25A 65 16
0482: C25C 85 16
0483: C25E 90 02
0484: C260 E6 17
0485: C262 10
0486: C263 A9 FF
0487: C265 60
0488:
0489:
0490:
0491: C266 AD 00 CC
0492: C269 4A
0493: C26A 00 00
0494: C26C AD 02 CC
0495: C26F 29 0F
0496: C271 C5 02
0497: C273 F0 F1
0498: C275 A9 03
0499: C277 38
0500: C278 60
0501: C279 AD 01 CC
0502: C27C 18
0503: C27D 60
0504:
0505:
0506:
0507:
0508:
0509:
0510:
0511:
0512:
0513: C27E A9 00
0514: C280 85 03
0515: C282 85 04
0516: C284 A2 01
0517: C286 85 01
0518: C288 95 0D
0519: C28A 95 05
0520: C28C CA
0521: C28D 10 F7
0522: C28F 20 4C C3
0523: C292 20 20 C3
0524: C295 A5 14
0525: C297 85 08
0526: C299 A5 15
0527: C29B 85 09
0528: C29D 20 CF C2
0529: C2A0 80 39
0530: C2A2 A5 07
0531: C2A4 F0 07
0532: C2A6 10

```

SERR CLC
RTS
SUCC PLP
LDAZ ALTH
DEQ NOCQ
LDAZ LEN
CLC
DEQ INCA
ADCZ ALTL
STAZ ALTL
DCC NOCQ
INCA INCZ ALTH
MOCQ CLC
LDAIM \$FF
RTS

Z FLAG=1 MEANS ERROR
RESTORE INTERRUPT
ALTERNATE IN USE?
NO
YES, UPDATE ALTERNATE
00 MEANS 100
Z FLAG=0 MEANS GOOD READ

IN : READ A BYTE AND CHECK FOR OUT OF SECTOR
LDA RDST DATA READY?
LSHA
DCC INQ
INQ YES READ IT
LDA SECT GET SECTOR FROM CONTROLLER
ANDIM \$0F
CMPZ DSEC
DEQ IN
LDAIM FLNK5C EMPTY SECTOR
SEC
RTS
LDA RDTA GET A BYTE
CLC
RTS

SECTION 3 WHITE ROUTINES
SAVX : SAVE A FILE ON DISK
SAVX LDAIM ZERO
STAZ FLTK
STAZ RLSC
LDAIM \$01
KLUP LDAZ DSTK
LDAZ P2TL
STAZ FLTK
DEX
SXS KLUP
JSH FWDC
JSH LNTH
LDA DPTL
STA TCTL
LDA DPTH
STA TGT
JSH WSEX
BCS ERRO
LDAZ LEN
DEQ INCT
CLC

CLEAR BACK LINK
COPY TRACK/SECTOR
TO POSTAMBLE &
FORWARD LINK
CALC FORWARD LINK
CALC LENGTH
MOVE DATA PTH
TO TARGET
WRITE A SECTOR
GET LENGTH
00-100

```

0533: C2A7 65 14
0534: C2A9 85 14
0535: C2AB 90 02
0536: C2AD E6 15
0537: C2AF A5 1F
0538: C2B1 C5 15
0539: C2B3 F0 03
0540: C2B5 80 09
0541: C2B7 60
0542: C2B8 A5 1E
0543: C2BA C5 14
0544: C2BC F0 02
0545: C2BE 90 F7
0546: C2C0 A2 01
0547: C2C2 95 01
0548: C2C4 95 03
0549: C2C6 95 05
0550: C2C8 95 01
0551: C2CA CA
0552: C2CB 10 F5
0553: C2CD 30 C0
0554:
0555:
0556:
0557: C2CF 20 DA C0
0558: C2D2 80 08
0559: C2D4 A9 01
0560: C2D6 2C 03 CC
0561: C2D9 D0 02
0562: C2DB 38
0563: C2DC 60
0564: C2DD 20 57 C1
0565: C2E0 85 08
0566: C2E2 A5 18
0567: C2E4 85 0C
0568: C2E6 A9 FF
0569: C2E8 8D 02 CC
0570:
0571: C2EB 08
0572: C2EC 20 47 C1
0573: C2EF 80 37
0574: C2F1 80 04 CC
0575: C2F4 A2 10
0576: C2F6 A9 00
0577: C2F8 20 63 C3
0578: C2FB CA
0579: C2FC D0 FA
0580: C2FE A9 FB
0581: C300 20 63 C3
0582: C303 B5 01
0583: C305 20 63 C3
0584: C308 E8
0585: C309 E0 0A
0586: C30B D0 F6
0587: C30D A6 07
0588: C30F A0 00
0589: C311 B1 14
0590: C313 20 63 C3
0591: C316 C8
0592: C317 CA

```

ADCZ DPTL
STAZ DPTL
DCC NOCQ
INCT DPTH
LDAZ ENDH
CMPZ DPTH
DEQ CONT
BCS SETU
RTS
LDAZ ENDL
CMPZ DPTL
DEQ SETU
DCC SRET
LDAIM \$01
LDAZ DSTK
STAZ BLTK
LDAZ FLTK
STAZ DSTK
DEX
DPL SLUP
DMI SXS
UNCONDITIONAL
WSEX : WHITE A SECTOR
WSEX JSR PREP PREPARE DRIVE
BCS WSQ ERROR EXIT
LDAIM \$01
BIT DVST WRITE PROTECT ON?
DNE WSR NO
SEC
RTS
JSR CRC COMPUTE CHECKSUM
STAZ CKSL SAVE IT
LDAZ TPXH
STAZ CKSH
LDAIM \$FF
STA FILL
PHP JSR CTSC SAVE INTERRUPT STATUS
DCC WERR FIND SECTOR
STA WPLS START TRANSMITTER
LDAIM \$10
LDAIM \$00
JSH OUT WRITE LEADER 16 X 00
DEX
PNE WSS
LDAIM \$FB SEND SYNC
JSH OUT WRITE 10 BYTE HEADER
LDAZ DSTK
JSH OUT
INX
CPXIM \$0A
BNE WST
LDXZ LEN
LDYIM \$00
LDATY DPTH
JSH OUT
INX
DEX
GET LENGTH
WRITE DATA

Settle for More from Your TRS-80

BASIC Compiler. With TRS-80 BASIC Compiler, your Level II BASIC programs will run at record speeds! Compiled programs execute an average of 3-10 times faster than programs run under Level II. Make extensive use of integer operations, and get speeds 20-30 times faster than the interpreter.

Best of all, BASIC Compiler does it with BASIC, the language you already know. By compiling the same source code that your current BASIC interprets, BASIC Compiler adds speed with a minimum of effort.

And you get more BASIC features to program with, since features of Microsoft's Version 5.0 BASIC Interpreter are included in the package. Features like the WHILE . . . WEND statement, long variable names, variable length records, and the CALL statement make programming easier. An exclusive BASIC Compiler feature lets you call FORTRAN and machine language subroutines much more easily than in Level II.

Simply type in and debug your program as usual, using the BASIC interpreter. Then enter a command line telling the computer what to compile and what options to use.

Voila! Highly optimized, Z-80 machine code that your computer executes in a flash! Run it now or save it for later. Your compiled program can be saved on disk for direct execution every time.

Want to market your programs? Compiled versions are ideal for distribution.* You distribute only the object code, not the source, so your genius stays fully protected.

BASIC Compiler runs on your TRS-80 Model I with 48K and disk drive. The package includes BASIC Compiler, linking loader and BASIC library with complete documentation. \$195.00.

*Microsoft royalty information for the sale of programs compiled with BASIC Compiler is available from Microsoft.

muMATH Symbolic Math System

expands your TRS-80 beyond the limits of numerical evaluation to a much higher level of math sophistication.

Symbolic mathematics is muMATH's power. For the first time, algebra, trigonometry, calculus, integration, differentiation and more can be performed on a system smaller than an IBM 370. And in a fraction of the time you could do them manually.

Yet for all its power, muMATH is simple to use.

To perform a differentiation you could enter:
?DIF (A*X ↑ 3 + SIN(X ↑ 2),X);

In almost no time, the computer would reply with: @2*X * COS(X ↑ 2) + 3*A*X ↑ 2.

Or to add fractions: ?1/3 + 5/6 + 2/5 + 3/7;

The instantaneous answer: 419/210.

Or to perform a more difficult trigonometric expansion you enter: SIN(2*Y)*(4 * COS(X) ↑ 3 - COS(3*X) + SIN(Y)*(COS(X+Y+#PI) - COS(X-Y));

Just a few seconds later, the computer replies:
@4 * SIN(Y) * COS(X) * COS(Y).

muMATH has virtually infinite precision with full accuracy up to 611 digits.

If you use math, you'll find countless ways to save time and effort with muMATH. It's a professional tool for engineers and scientists. A learning tool for students at any level from algebra to calculus.

And if you want to expand your capabilities even beyond the standard muMATH, the option is open. muSIMP, the programming language in which muMATH is written, is included in the muMATH package. A superset of the language LISP, muSIMP is designed especially for interactive symbolic mathematics and other artificial intelligence applications.

muMATH and muSIMP were written by The Soft Warehouse, Honolulu, Hawaii. Priced at \$74.95, the package includes muMATH, muSIMP and a complete manual. It requires a Model I TRS-80 with 32K and single disk. muMATH for the Apple II Computer will be available later this year.



You can buy muMATH and BASIC Compiler at computer stores across the country that carry Microsoft products. If your local store doesn't have them, call us. 206-454-1315. Or write Microsoft Consumer Products, 10800 Northeast Eighth, Suite 507, Bellevue, WA 98004.

MICROSOFT
CONSUMER PRODUCTS

Listing I continued:

0593: C318 D0 F7
 0594: C31A A0 04
 0595: C31C 05 00
 0596: C31C 20 63 C3
 0597: C321 E8
 0598: C322 88
 0599: C323 D0 F7
 0600: C325 28
 0601: C326 18
 0603: C327 60
 0604: C328 28
 0605: C329 38
 0606: C32A 60
 0607:

WSV WSW
 LDYIM \$04
 LDZAX KSL
 JSR OUT
 INX
 DEY
 ONE WSV
 PLP
 CLC
 RTS
 PLP WERR
 SEC
 RTS

0654:
 0655:
 0656:
 0657:
 0658:
 0659:
 0660:
 0661:
 0662:
 0663:
 0664:
 0665:
 0666:
 0667:
 0668:
 0669:
 0670:
 0671:
 0672:
 0673:
 0674:
 0675:
 0676:
 0677:
 0678:
 0679:
 0680:
 0681:
 0682:
 0683:
 0684:
 0685:
 0686:
 0687:
 0688:
 0689:
 0690:
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 0692:
 0693:
 0694:
 0695:
 0696:
 0697:
 0698:
 0699:
 0700:
 0701:
 0702:
 0703:
 0704:
 0705:
 0706:
 0707:
 0708:
 0709:
 0710:
 0711:
 0712:
 0713:
 0714:

SECTION 4 KEYBOARD CONTROL ROUTINES
 SAVK : ENTRY TO WRITE FILE
 ENTER THE FOLLOWING VIA KIM:
 BEGINNING ADDRESS 14,15
 ENDING ADDRESS 1E,1F
 EXECUTION ADDRESS 19,1A
 DRIVE/TRACK/SECTOR 1C,1D
 FILE TYPE 0A

0609:
 0610:
 0611:
 0612:
 0613:
 0614:
 0615:
 0616:
 0617:
 0618:
 0619:
 0620:
 0621:
 0622:
 0623:
 0624:
 0625:
 0626:
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 0628:
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 0631:
 0632:
 0633:
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 0637:
 0638:
 0639:
 0640:
 0641:
 0642:
 0643:
 0644:
 0645:
 0646:
 0647:
 0648:
 0649:
 0650:
 0651:
 0652:
 0653:

LNTH : COMPUTE LENGTH AND FIND LAST BLOCK
 LNTH LDZ ENDL
 SEC SBCZ DPTL
 STAZ LEN
 LDZ ENDH
 SBCZ DPTH
 BEQ LQ
 LDZ ENH
 STAZ LEN
 RTS
 INCZ LEN
 LDZ ENH
 STAZ FLTK
 STAZ FLSC
 LDZ EXCL
 STAZ P5TL
 LDZ EXCH
 STAZ P5TH
 RTS

0654: C36E 20 05 C3
 0655: C371 00 15
 0656: C373 20 7E C2
 0657: C376 00 10
 0658: C378 20 90 C3
 0659: C37B 4C 4F 1C
 0660: C37E 20 05 C3
 0661: C381 00 05
 0662: C383 20 09 C1
 0663: C386 90 F0
 0664: C388 05 FA
 0665: C38A 09 FF
 0666: C38C 05 FB
 0667: C38E 00 EB
 0668: C390 A9 FF
 0669: C392 05 FB
 0670: C394 A5 01
 0671: C396 29 3F
 0672: C398 30
 0673: C399 E6 FB
 0674: C39B C9 0A
 0675: C39D 00 FA
 0676: C39F 69 0A
 0677: C3A1 48
 0678: C3A2 A5 02
 0679: C3A4 4A
 0680: C3A5 90 02
 0681: C3A7 69 04
 0682: C3A9 85 FA
 0683: C3AB 68
 0684: C3AC 0A
 0685: C3AD 0A
 0686: C3AE 0A
 0687: C3AF 0A
 0688: C3B0 05 FA
 0689: C3B2 85 FA
 0690: C3B4 60

0691:
 0692:
 0693:
 0694:
 0695:
 0696:
 0697:
 0698:
 0699:
 0700:
 0701:
 0702:
 0703:
 0704:
 0705:
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 0707:
 0708:
 0709:
 0710:
 0711:
 0712:
 0713:
 0714:

FWDC : CALCULATE FORWARD LINK. ASSUMES
 FLTK =CURRENT TRACK
 FWDC LDZ FLSC
 CMPIM \$08
 BEQ FR
 DCS FQ
 INCZ \$02
 DNE FS
 INCZ FLTK
 LDZIM \$00
 BEQ FS
 LDZIM \$01
 STAZ FLSC
 RTS
 OUT : SEND A BYTE WHEN USRT IS READY
 OUT PHA
 LDZ RDST
 RPL OUTQ
 PLA
 STA WDTA
 RTS

NEECO
PROUDLY
INTRODUCES

COMMODORE'S NEW 8000 SERIES (80 column) COMPUTERS



\$1695 (available May/June '80)

CBM™ 8050 DUAL DRIVE FLOPPY DISK

The CBM 8050 Dual Drive Floppy Disk in an enhanced version of the intelligent CBM 2040 Disk Drive. The CBM 8050 has all of the features of the CBM 2040, and provides more powerful software capabilities, as well as nearly one megabyte of online storage capacity. The CBM 8050 supplies relative record files and automatic diskette initialization. It can copy all the files from one diskette to another without copying unused space. The CBM 8050 also offers improved error recovery and the ability to append to sequential files.

HARDWARE SPECIFICATIONS

Dual Drives
Two microprocessors
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 is a registered trademark of Commodore. All prices and specifications are subject to change without notice.

CBM™ 8000 SERIES BUSINESS COMPUTERS

The new Commodore 8000 series computers offer a wide screen display to show you up to 80-character lines of information. Text editing and report formatting are faster and easier with the new wide-screen display. The 8000 series also provides a resident Operating System with expanded functional capabilities. You can use BASIC on the 8000 computers in both interactive and program modes, with expanded commands and functions for arithmetic, editing, and disk file management. The CBM 8000 series computers are ideally suited for the computing needs of the business marketplace.

SCREEN

2000 character display, organized into twenty-five 80-column lines
64 ASCII, 64 graphic characters
3 x 8 dot matrix characters
Green phosphor screen
Brightness control
Line spacing: 1½ in Text Mode
1 in Graphics Mode

KEYBOARD

73-key typewriter style keyboard with graphic capabilities
Repeat key functional with all keys

MEMORY

CBM 8016: 16K (15359 net)
random access memory (RAM)
CBM 8032: 32K (31743 net)
random access memory (RAM)

POWER REQUIREMENTS

Volts: 110V
Cycles: 60 Hz
Watts: 100

SCREEN EDITING CAPABILITIES

Full cursor control (up, down, right, left)
Character insert and delete
Reverse character fields
Overstriking
Return key sends entire line to CPU regardless of cursor position

INPUT/OUTPUT

Parallel port
IEEE-488 bus
2 cassette ports
Memory and I/O expansion connectors

FIRMWARE

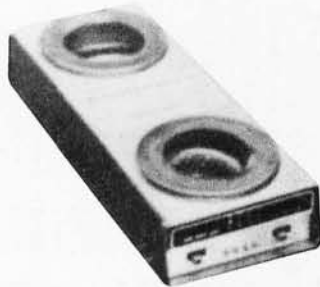
24K or ROM contains:
BASIC (version 4.0) with direct (interactive) and indirect (program) modes
9-digit floating binary arithmetic
Tape and disk file handling software

The 8000 Series will be available May/June '80
Model 8016 Model 8032 2040 Dual Floppy

\$1495

\$1795

\$1295



Available June/July

\$395

CBM™ IEEE MODEM

SPECIFICATIONS

*Full or half duplex operation
*300 bits per second
*Standard IEEE 488 interface
*Switch selectable originate, off, answer-full duplex, test, half duplex
*Visible indicators are transmit data, receive data, carrier ready, test
*Frequency shifted modulation
*Bell 103/113 compatible

"Exceptional performance - even on noisy phone lines"

NEECO

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MICROAMERICA DISTRIBUTING

"Nationwide distributors of Computer Equipment"

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Needham, MA
02194

(617) 449-4310

Listing 1 continued:

```

0715:
0716:
0717:
0718:
0719:
0720:
0721:
0722:
0723:
0724:
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0750:
0751:
0752:
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0754:
0755:
0756:
0757:
0758:
0759:
0760:
0761:
0762:
0763:
0764:
0765:
0766:
0767:
ALTH
BLNKSC
COR
CKSEC
CONT
ALTL
BLSC
COR
CKSH
COPPL
ALTP
BLTK
C3C0
CKPL
CQ
ALTJ
C003
C010
C00C
C1A1
C016
C003
C01C
C00B
CQ
BADPHM
C000
C003
C00C
C01C
C00B
C17B
C000
C3CC
C01C
C22F
C157
C3B5 20 18 C0 INTCVT JSR INITDV INIT AND CONVERT
CVTBIN LDA TSSA
ANDIM SCTMSK EXTRACT SECTOR
CMPIM $0A VALID?
BCS INVS NO
CONVERT IT TO ALTERNATING SECTOR
CMPIM $05 LESS THAN 5?
BCC C00
SEC
SBCIM $05 MINUS 5
ASLA 'MULTIPLY BY 2
ADCM $01 ADD 1
BNE CDR UNCONDITIONAL
ASLA 'MULTIPLY BY 2
STAZ DSEC SAVE SECTOR
LDZ TSSA GET HIGH NYBBLE
LSRA
LSRA
LSRA
CMPIM $0A VALID?
DCS INVS NO
STAZ DSTK SAVE LOW ORDER TRACK #
MULTIPLY HI ORDER TRACK BY 10
LDZ DTSa
ANDIM $0F CLEAR DRIVE #
STAZ HIOR SAVE
ASLA 'MULTIPLY BY 4
CLC
ADDC HIOR ADD ONCE (5X)
ASLA 'MULTIPLY BY 2 (10X)
ADDC DSTK ADD LOW ORDER
CMPIM TRKLMT
STAZ DSTK
DCS INVS
LDZ DTSa
ANDIM $F0
CMPIM $40
DCS INVS
ASLA
ASLA
STAZ DSDR
RTS
INVS LDZIM $02 INVALID SECTOR
THEEND RTS
0715:
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0765:
0766:
0767:
CHDR 001E
CTKR 0013
CX C172
DELA C085
DISKMS 0000
DPTR 0014
DS 0000
DTSa 001C
ENDL 001F
EXCH 001A
FLSC 0006
FS C360
GCTP C028
GTSC C147
IN C266
INQ C379
INVSCT C388
KERR C399
KSS C37E
LOOK C32R
LSG C33D
M'OFF C12C
MTVR C047
NOCW C2AF
OVFL C0C9
PNTH 00FB
PSTL 000D
RDS C1C7
RETRIG C001
RSEX C1AA
SCTBIT 0010
SEHR C24E
SLUP C2C2
STARTR C144
SWIT C0E7
TGTI 0009
TJX 1705
TPXH 0018
WDTA C001
WRTBIT 0008
WSS C2F8
ZERC 0000
CRTK 000F
CTKS 0013
DA C0FE
DELS C13E
DP C11E
DRIV C0C0
DSDR 0000
DTSL C003
ENDL 001F
EXCL 0019
FLTK 0005
FTYP 000A
GTXK C022
HEDLEN 000A
INCA C260
INTCVT C3P5
KEHR C388
KSS C3A9
LOOK C37E
LSG C399
M'OFF C006
NEND C198
NSEC C1E3
NVRUN 0004
PNTH 00FA
RCNT 0010
RDTA C001
ROK C1E6
SAVECP 0010
SCTMSK 000F
SETL C07F
SOUT C094
STEPI 0010
STPO C076
SX5 C20F
TGTI 0008
TKIN C040
TRKLMT 0023
WERH C32B
WSEX C2CF
WST C303
CTKP 0010
CVTBIN C38B
DALP C210
DEL C083
DPTH 0015
DRVMSK 00CF
DSEC 0002
DVLUP C09D
ERRJ C0C6
FFTIME C180
FQ C358
FWDC C34C
GTLUPA C14C
HIOR 001C
INCT C2AD
INTLUP C01C
KIMQ C008
LAST C378
LOOP C086
M'LRBIT 007D
NOCQ C262
OUT C364
PCH 0009
PREP C0BA
RDRT C1C6
READ C10B
RHSR C004
SAVK C36E
SECT C002
SETU C2C0
SRET C207
STIMER C182
START 1C4F
SXT C29D
TGTI 0008
TKOT C038
TRKMSK 003F
WPLS C004
WSQ C2DC
WSV C311
CTKQ 0011
CVTDEC C390
DB C109
DI C109
DPFL 0014
DRVST 0095
DSTK 0001
DVST CC03
ERHO C2DB
FILL C002
FR C35E
GDAT C21E
GTLUPB C150
HLUP C1FC
INITDV C01B
INVS C3FC
KIMQ C37B
LEN 0007
LOOP C08B
M'LRBIT 007D
NOCQ C262
OUT C364
PCH 0009
PREP C0BA
RDRT C1C6
READ C10B
RHSR C004
SAVK C36E
SECT C002
SETU C2C0
SRET C207
STIMER C182
START 1C4F
SXT C29D
TGTI 0008
TKOT C038
TRKMSK 003F
WPLS C004
WSQ C2DC
WSV C311

```

Listing 2: Cross-reference table for the symbols in listing 1.

SYMBOL	DEFINED	REFERENCES	210	DVLUP	216	219	155	211	243	274	305
ALTH	43	438 476 484	70	DVST	142	152					
ALTL	42	441 481 482	57	ENDH	560	614					
ALTP	41		56	ENDL	537	610					
PADPRM	240		223	FRRJ	213	300					
PLNKSC	110		562	EXCH	625						
RLSC	16		45	EXCL	623						
RLTK	15		356	FFTIME	209	318					
CDQ	733	514 548	78	FILL	569						
CDR	734		18	FLSC	371	375	622	632	642		
CRPH	53	332 338	17	FLTK	373	377	519	549	621	638	
CKPL	52	330 340	638	FQ	635						
CKPT	51	343	641	FR	634						
CKSEC	292		642	FS	637	640					
CKSH	28	467 567	23	FTYP							
CKSI	27	459 464	632	FWDC	126	522					
CLUP	458	462	448	GDAT	443						
CONT	542	539	141	GETP	145						
COPPL	380	374	139	GTKX	284	393					
CO	348	346	319	CTLUPA	320						
CHC	329	463 564	321	CTLUPB	322						
CRDR	48	245 248	317	GTSC	409	572					
CRTK	31	147 175 179 180 184 185 250	98	HEDLEN	341						
		262 272 281	49	HIOR	746	750					
		263 271	431	HLUP	435						
CTKP	33		491	IN	415	420	427	431	458	497	
CTKQ	34		484	INCA	480						
CTKR	35		536	INCT	531						
CTKS	36		130	INITDV							
CVTBIN	721	124	501	INQ	493						
CVTDEC	692	125 672	719	INTCVT	668	680					
CX	343	337 350	132	INTLUP	134						
DA	273		765	INVS	724	741	754	759			
DALP	449	451 456	109	INVSEC	669	671	681				
DB	274		685	KERR							
DEL	191	159 168	10	KIMDOS							
DELA	195	188 310	673	KIMG	688						
DELSU	310	312	517	KLUP	521	521					
DI	279	252	706	KSS	704						
DISKMS	107	223	672	LAST	683						
DP	288		19	LEN	333	455	478	530	587	613	618
DPTH	40	331 440 447 526 536 538 615	610	LNTH	620						
DPTL	39	329 442 445 524 533 534 543	680	LOOK	523						
DPTR	38	453 589	369	LOOP	122	379	682				
DRIV	243	236	198	LOOK	199						
DRVMSK	95	153 156	620	LQ	616						
DRVST	207	279	697	LSQ	699						
DS	285	253 283	196	LUUP	201						
DSDR	12	246 762	93	MILSEC	196						
DSEC	14	230 296	290	MIS	196						
DSTK	13	172 233 376 428 496 702 734	73	MOFF	293						
DISA	54	550 582 694 742 752 755	72	MON	167	308					
DISL	79	744 756 161 166 278	92	MTRBIT	304						

Listing 2 continued on page 176

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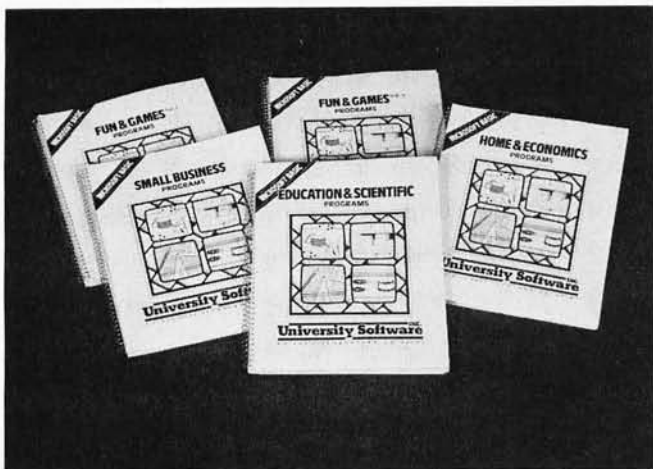
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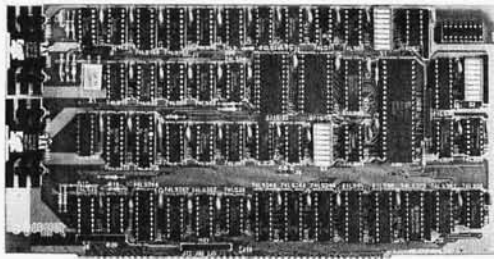
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16K Econoram XV-16	H8 (3)	\$339	\$399	n/a
16K Econoram IX-16	Dig Grp	\$319	\$379	n/a
24K Econoram VIIA-24	S-100	\$449	\$499	\$599
24K Econoram XIII-A-24	S-100 (2)	\$479	\$539	\$649
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32K Econoram XIII-A-32	S-100 (2)	\$649	\$729	\$849
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Text continued from page 158:

particles from the head surface. In addition, this operation insures that the head is on the proper track. Another three reads are attempted; if this fails, the data is assumed to be unrecoverable.

The memory locations that must be initialized before a read operation are given in table 4.

The write routines write a contiguous block of memory to the disk on the required number of sequential sectors. They are also responsible for calculating the forward and backward links and the check sum for each sector. Each sector except the last contains 256 bytes of data; if the number of bytes to be saved is not an integer multiple of 256, the last sector may be shorter. Each sector is preceded by 16 bytes of 0s before the sync character. This is followed by the sector header, the data, and the trailer. No read operation is done after writing to verify the data, because the infrequency of write errors does not warrant the extra overhead.

The memory locations that must be initialized before an area of memory can be saved on disk are given in table 5.

Control Routines

The routines SAVK and LODK provide the interface between the user and the disk routines. These routines expect the appropriate information to

be preset in memory by use of the KIM keyboard. The only incompatibility with the Percom MINIDOS routines here is in the indication of an omitted value. The Percom routines use the value hexadecimal FFFF to indicate a field not in use, and KIMDOS uses a high-order byte of 0. This is not important since the 6800 and 6502 microprocessors store their high- and low-order address bytes in the opposite order and are not compatible anyway.

The control routines SAVK and LODK convert their parameters into the proper format where necessary and call the disk subroutines. Upon return, these two routines display the results of the requested operation on the KIM display and return control to the KIM monitor. The information displayed is either the DTS number of the last sector read or written in decimal, or FFnn, where nn is an error code. The error codes are given in table 6.

Interrupts

In any system, it is often desirable to use interrupts for various processes. Because KIMDOS is involved in time-critical functions when doing disk input/output (I/O), an interrupt at the wrong time could cause catastrophic errors. Therefore, the non-maskable interrupt (NMI) line cannot be used during disk I/O.

However, KIMDOS does allow for

the use of the maskable interrupt request (IRQ) line. This is done by saving the status register and disabling the IRQ line before starting any time-critical functions. The status register is then restored after the critical function is completed. This causes the servicing of the IRQ interrupt to be delayed for as much as 20 ms at a time. Any interrupt-driven system that can tolerate this limitation can function properly with KIMDOS.

Testing

Since the drive and controller both come assembled and tested, the checkout procedure is relatively simple. The only equipment I used was a logic probe and a multimeter.

The first step is to connect the drive and controller to the KIM bus and verify all power-supply voltages. When they are correct, basic communication with the controller can be verified by entering the hexadecimal address CC05 via the KIM-1 keypad. This should start the motor and keep it on until the address is changed. If the motor does not start, then there is probably a bad connection to KIM.

Next, the motor-off pulse can be checked by pressing the + key on the KIM keypad to increment the address on the display to hexadecimal CC06. This should turn off the motor immediately. The motor time-out circuit can be checked by entering hexadecimal CC05 on the KIM display,

Hexadecimal Address	Contents
0016, 0017	Beginning memory address (optional; substitute 0 to use address stored in the disk file)
001C, 001D	Drive/Track/Sector (DTS) number of first sector in the file being read

Table 4: Information required to read a file into memory from disk. The file being read into memory will begin at the address pointed to by hexadecimal memory locations 0016 and 0017. However, if the contents of these two bytes are 0, the file will be loaded into memory beginning at the address stored with the file. The DTS number is stored here in binary-coded decimal format, with the high-order byte stored first.

Hexadecimal Address	Contents
0008, 0009	Beginning address of memory to be saved
000A	File type
0019, 001A	Execution address (optional; use 0 to omit)
001C, 001D	Drive/Track/Sector number of first sector to be written
001E, 001F	Ending address of memory to be saved

Table 5: Information required to save a file. These are the hexadecimal memory locations that must be set before the SAVK (save a file) routine from listing 1 is called. The DTS number is stored here in binary-coded decimal format, with the high-order byte stored first.

Error Code	Message
0	Disk missing (given after read or write operation)
1	Disk protected (given after write operation only)
2	Invalid sector number (given after read or write operation)
3	Blank sector (given after read operation only)
4	Disk overrun; attempted to write more than 349 sectors
5	Permanent read error

Table 6: List of disk-related error codes. If a read or write operation ends in failure, the left four digits of the KIM display will read FFnn, where nn is one of the error codes listed in this table.

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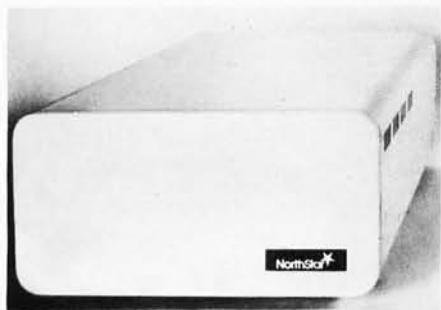
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Hard sectoring means that sector boundaries are detected by means of holes punched in the floppy disk.

followed by another address. The motor should run about 3 seconds and stop.

Now the sector-counting circuitry can be checked. With a disk inserted in the drive, enter hexadecimal CC05 and then hexadecimal CC02. The rightmost digit of the KIM display (which shows the low nybble of the contents of hexadecimal location CC02) should be rapidly changing as long as the motor is running. When the motor stops, this digit should contain a decimal digit (0 thru 9) indicating the last sector passed.

After all of the previously mentioned tests have been completed, the software can be used to do further testing. The TEST routine, given in listing 3, is included for this purpose. TEST does a static test of most of the controller functions and their interaction with various subroutines within KIMDOS. It uses the number of the key pressed on the keypad as an index into a table of subroutine addresses. From there, it does a subroutine jump to the routine thus addressed.

Upon return, the TEST routine displays the value of the accumulator in the rightmost two digits of the KIM display. It also displays the value of the carry flag in the left four digits — FFFF for carry set and 0000 for carry clear. (This is done for those routines that return the carry flag set as an error indicator and use the value in the accumulator as an error code.)

Execution of the TEST routine begins at hexadecimal 0200. The appropriate data must be set in the 0 page for the subroutines to be tested. Some subroutines must be used together. For example, the motor must be started and the drive must be selected before the head-movement routines will work. To add more subroutines, increase the value in the compare instruction at hexadecimal location 020C and add the appropriate addresses to the end of the table.

The final test that I had to do was

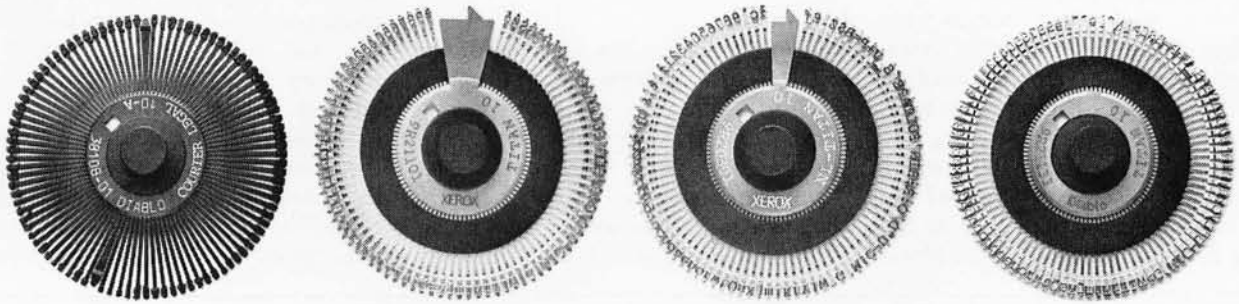
Listing 3: Listing for program TEST. This program executes a given KIMDOS routine (see documentation at the beginning of the listing) depending on which key on the KIM keypad is pressed.

Hexadecimal Address	Object Code	Label	Instruction Mnemonic	Operand	Commentary		
0001:							
0002:					TEST : ROUTINE TO TEST THE BASIC DISK		
0003:					DRIVER SUBROUTINES		
0004:							
0005:					SUBROUTINES UNDER TEST		
0006:							
0007:		SUB	ADDRESS	KEY#			
0008: 2000		GTKX	* \$C022	0	GO TO TRACK 0		
0009: 2000		PREP	* \$C00C	1	PREPARE DRIVE FOR I/O		
0010: 2000		START	* \$C131	2	START MOTOR		
0011: 2000		TKOT	* \$C038	3	MOVE HEAD OUT 1		
0012: 2000		TKIN	* \$C040	4	MOVE HEAD IN 1		
0013: 2000		SEEX	* \$C060	5	FIND TRACK IN 01		
0014: 2000		GTSC	* \$C147	6	FIND SECTOR IN 02		
0015:				7	RETURN TO KIM		
0016:							
0017:					KIM ADDRESSES		
0018:							
0019: 2000		SCND	* \$1F1F				
0020: 2000		GETK	* \$1F6A				
0021: 2000		KIM	* \$1C4F				
0022:					ZERO PAGE STORAGE		
0023:							
0024:							
0025: 2000		TOAD	* \$0020				
0026: 2000		TODQ	* \$0021				
0027: 2000		SAKE	* \$0022				
0028: 2000		PNTH	* \$00FB				
0029: 2000		PNTL	* \$00FA				
0030: 2000		INH	* \$00F9				
0031:							
0032: 2000		ORC	\$2000				
0033:							
0034: 2000 20 1F 1F		STAR	JSR	SCND	LITE DISPLAY		
0035: 2003 20 6A 1F			JSR	GETK	GET KEY		
0036: 2006 C5 22			CMPZ	SAKE	DEBOUNCE		
0037: 2008 F0 F6			REQ	STAR			
0038: 200A 85 22			STAZ	SAKE			
0039: 200C C9 08			CMPIM	\$00	VALID?		
0040: 200E C0 F0			BCS	STAR	NO		
0041: 2010 0A			ASLA		YES, MULTIPLY BY 2		
0042: 2011 AA			TAX		TO GET INDEX		
0043: 2012 0D 32 20			LDAAX	TABL	MOVE OBJECT ADDRESS		
0044: 2015 85 20			STAZ	TOAD	TO JUMP VECTOR		
0045: 2017 E8			INX				
0046: 2018 0D 32 20			LDAAX	TABL			
0047: 2010 85 21			STAZ	TODQ			
0048: 2010 20 2F 20			JSR	JMPP	CALL SUBROUTINE		
0049: 2020 85 F9			STAZ	INH			
0050: 2022 A9 FF			LDAIM	\$FF	ERR0R FLAG		
0051: 2024 00 02			BCS	STOR	BRANCH ON EHH0H		
0052: 2026 A9 00			LDAIM	\$00	COOD FLAG		
0053: 2028 85 FA		STOR	STAZ	PNTL			
0054: 202A 85 FB			STAZ	PNTH			
0055: 202C 4C 00 20			JMP	STAR			
0056: 202F 6C 20 00		JMPP	JMI	TOAD			
0057:							
0058: 2032 22		TABL	=	GTKX			
0059: 2033 C0			=	GTKX	/		
0060: 2034 0C			=	PREP	/		
0061: 2035 C0			=	PREP	/		
0062: 2036 31			=	START	/		
0063: 2037 C1			=	START	/		
0064: 2038 38			=	TKOT	/		
0065: 2039 C0			=	TKOT	/		
0066: 203A 40			=	TKIN	/		
0067: 203B C0			=	TKIN	/		
0068: 203C 60			=	SEEX	/		
0069: 203D C0			=	SEEX	/		
0070: 203E 47			=	GTSC	/		
0071: 203F C1			=	GTSC	/		
0072: 2040 4F			=	KIM	/		
0073: 2041 1C			=	KIM	/		
0074:							
0075:							
0076:							
GETK	1F6A	GTKX	C022	GTSC	C147	INH	00F9
JMPP	202F	KIM	1C4F	PNTH	00FB	PNTL	00FA
PREP	C00C	SAKE	0022	SCND	1F1F	SEEX	C060
STAR	2000	START	C131	STOR	2028	TABL	2032
TKIN	C040	TKOT	C038	TOAD	0020	TODQ	0021

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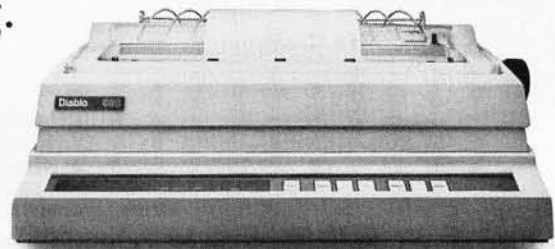
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to read and write data using a floppy disk previously recorded in the Percom format. I did this to confirm that the KIMDOS software produces results using the controller board and disk that are identical to the results produced by the Percom 6800 code. Since I found this to be the case, no one using KIMDOS needs to repeat that test.

Error Recovery

As in all systems, there will occasionally be unrecoverable errors. The Percom format allows for recovery of broken files. Since each sector contains the DTS number of the first sector of the file, each sector can be associated with its file. Reading does not have to start with the first sector; it can start on any sector and will continue to the end of the file.

When a read error occurs, try rereading the sector several times. Also try to read a sector on another track of the disk (to move the head around some) before rereading the original sector in error. Reinserting the disk may also help. If all of the above measures fail, then execute the routine LAST at hexadecimal address

Alternating-sector addressing allows time for the housekeeping routines that must be executed between reading and writing sectors.

C378. This will display the number of the sector containing the error. To try a partial recovery, start the read operation at one sector past the displayed address. If that fails, try the next sector, and so on. Any valid sector can be read in this way. A file may have only one bad sector, with the rest readable.

Expansion

To fully utilize the features of the LFD-400 disk system, a more extensive disk-operating system is necessary. This software is designed to be the basis of such a system. These subroutines can be used to perform the basic functions needed by a larger disk-operating system that provides

for named files, automatic space management, and buffered I/O.

To facilitate expansion, KIMDOS has a jump table located at the beginning of the executable code that contains JMP instructions to all subroutines in KIMDOS needed by external software. This allows KIMDOS to be updated (in case of bugs or enhancements) without reassembling the calling routines. With the nine routines in the jump table, any disk I/O can be performed under external program control.

RSEX and WSEX are used to read and write individual sectors. To use them, the data at hexadecimal locations 0000 thru 000A must be supplied. (See the beginning of listing 1.) To read an individual sector, the alternate address pointer, hexadecimal locations 0016 and 0017, must point to the starting location of the file when it is loaded into memory. If the value of the alternate address pointer is 0, the sector will load beginning at an address stored in the sector header. Similarly, to write an individual sector, the data pointer, hexadecimal locations 0014 and 0015, must point to the beginning byte of

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- 08 = ENTER/UPDATE BANKS
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- 10 = EXAMINE/MONITOR PURCHASE LEDGER
- 11 = EXAMINE/MONITOR (INCOMPLETE RECORDS)
- 12 = EXAMINE PRODUCT SALES

SELECT FUNCTION BY NUMBER-

- 13 = PRINT CUSTOMER STATEMENTS
- 14 = PRINT SUPPLIER STATEMENTS
- 15 = PRINT AGENT STATEMENTS
- 16 = PRINT TAX STATEMENTS
- 17 = PRINT WEEK/MONTH SALES
- 18 = PRINT WEEK/MONTH PURCHASES
- 19 = PRINT YEAR AUDIT
- 20 = PRINT PROFIT/LOSS ACCOUNT
- 21 = UPDATE END MONTH FILES MAINTENANCE
- 22 = PRINT CASH FLOW FORECAST
- 23 = ENTER/UPDATE PAYROLL (NOT YET AVAILABLE)
- 24 = RETURN TO BASIC

WHICH ONE? (ENTER 1-24)

01 SUB. MENU EXAMPLE: 01 = EXAMINE: 02 = INSERT: 03 = AMEND: 04 = DELETE
05 = PRINT (1,2,3): 06 = NUMERIC COMBINATIONS: 07 = SORT
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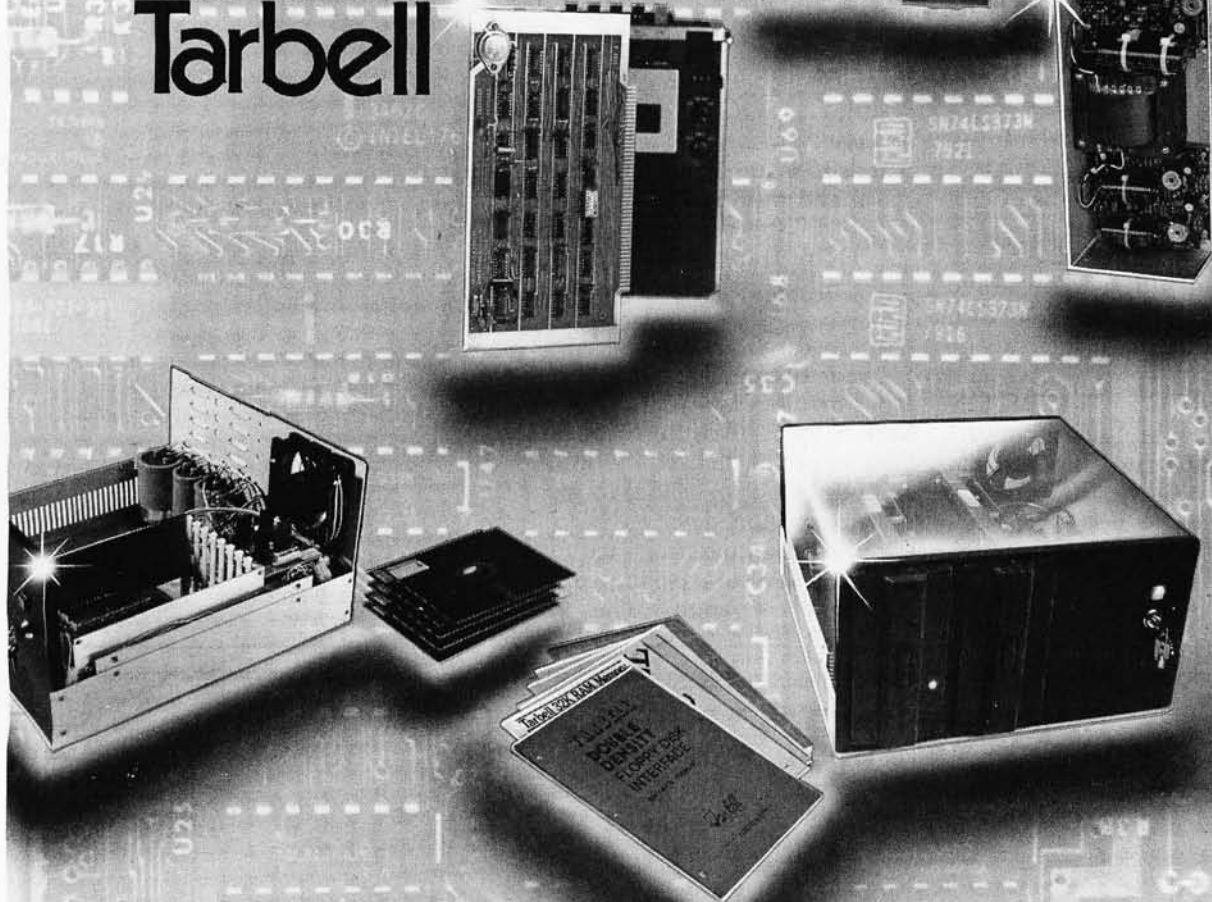
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*CP/M & MP/M are products of Digital Research Corp.

Since the drive and controller both come assembled and tested, the checkout procedure is relatively simple.

the area to be stored on the disk file. All head positioning and drive preparation is taken care of.

LODX and SAVX are the subroutine versions of LODK and SAVK. They require the same data as LODK and SAVK, except that the DTS number must be converted to three single-byte quantities and stored in hexadecimal locations 0000 thru 0002. The subroutine PREP can be used to select the desired drive and seek the desired track. The CVTBIN and CVTDEC subroutines convert the DTS number to binary and decimal, respectively. Subroutine FWDC calculates the next sector in a file. The INITDV subroutine sets the track registers to hexadecimal FF. If any errors are encountered, control is

returned to the calling routine with the carry bit set and the error code in the accumulator. This allows complete external control of the disk system.

Since developing KIMDOS, I have developed ZAPDOS. ZAPDOS is modeled after Percom's MINIDOS-PLUSX disk-operating system. It allows loading and saving of up to thirty-one named files per disk. It occupies the upper two read-only-memory sockets in the LFD-400 board. ZAPDOS contains thirteen read-only-memory resident commands to manipulate and display disk space and memory. When used with its ten disk-resident utility programs, ZAPDOS transforms KIM into a powerful microcomputer system.

Conclusion

I have been independent of cassette tape for over two years now. It has been a great pleasure to be able to load even the largest file in 1 or 2 seconds. I no longer leave my KIM system on for days to keep from spending the time necessary to write all of memory to tape and verify that the tape is good. The Percom

LFD-400 is a viable and cost-effective answer to the mass-storage problem.

KIMDOS should be easily converted for use on other 6502 systems. An interface for the Apple II should be straightforward. KIMDOS is available in a 2708 read-only memory from Percom. (See below.) I would like to express thanks to Bob Haas for his valuable consultation on this project. ■

Percom Data Company (211 North Kirby, Garland TX 75042) is making available the current version of KIMDOS on a 2708 erasable programmable read-only memory (EPROM) part to be used on the disk-controller board of the Percom LFD-400 5-inch floppy-disk drive. This can be obtained along with a Percom LFD-400 disk drive for \$15 above the current price of the disk-drive unit. A floppy disk containing KIMDOS-related software (including the ZAPDOS disk-operating system mentioned at the end of this article) is also available from Percom.

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THE PROGRAM

Introduction

Carl T. Helmers, Jr.
Editor-in-Chief
BYTE Magazine

Writing in high level languages has numerous well-publicized advantages: programs are more portable; they have superior structures; they are easier to write and debug. At this first session of the conference, Carl Helmers will survey and define language systems, analyze language systems as complete tools, discuss the evolution of all high level languages, and establish reasons why specific high level languages are appropriate for microcomputers.

The Importance of Tools

Dr. Fred H. Martin
Executive Officer
Intermetrics, Inc.

The use of software tools in the development of systems involving computers is crucially important. Fred Martin, one of the designers of the HAL/S language, will review the advantages of high level language techniques and automated aids to programming from the point of view of his NASA experience with HAL/S, developed specifically to replace the machine-dependent, low-level programming that plagued the Apollo project. The crucial importance of high level languages in reliable software design will be reviewed in the context of this system—in which a software crash can literally lead to a pile of broken parts on the ground.

The microcomputer revolution in system design, engineering, and technology is here!

Sophisticated 32 bit computer architectures are appearing in single packages that may be used in a personal computer, a word processor, or even automobile or microwave oven controls. A typical microcomputer-oriented, finished-product design can incorporate total memory, with an address-space utilization of 16K to 64K bytes. With high-volume manufacturing, the total package may cost as little as \$100 to \$500.

Over the past 25 years there has been a tremendous evolution in the functional capabilities of language systems. These systems need no longer be confined to "big" machines. Much of the improvement in function is becoming available in language systems for microcomputers.

Yet, major manufacturers are still promoting their "super" micro assemblers/debuggers as the best software tool for applications software of computer systems. Consequently, many programmers and designers continue to work with primitive language tools.

This first BYTE-sponsored conference on languages and tools for microcomputing will introduce designers, systems analysts, implementers, and managers to various high level languages and associated systems tools that are becoming commercially available. Knowledge of these recent developments is absolutely essential to productive use of microcomputer technology when that scarce resource, programmer/designer time, is being spread more and more thinly among a myriad of potential applications.

The conference will zero in on five specific high level languages because they are—or shortly will become—readily available for implementations with small computers. Speakers will explore these languages and tools for programming in terms of their usefulness for practical microcomputer applications.

Three of the featured languages are members of a family of languages evolved from FORTRAN by way of Algol: Pascal, C, and Ada. These are most appropriate for uses in which documentation is as much a part of the design philosophy as the achievement of a functional design itself. HAL/S, also in this family, will be discussed at the conference in terms of the history of software tools used in the NASA space-shuttle project's flight-control system design. These languages share purposes with some of the more common commercial languages available on large computers, such as PL/I and COBOL.

Differing in philosophy and point of view—but also commercially available—are two other languages and corresponding language concepts: LISP and FORTH. Each is characterized by a concept of language extensibility, which is implemented in a highly interactive approach. The central and dominant theme of LISP is one of list structures, which may be either data or program material. The concept of tree structures and relationships underlies LISP's usefulness in the artificial-intelligence milieu. FORTH has a central theme of a stack-oriented processor, emulated as a threaded code interpreter, and an extensible library of operations that may be defined beyond a basis set of standard primitives.

The Pascal Perspective

Peter Grogono

*Analyst/Programmer
Concordia University*

The Pascal language is one of the most attractive alternatives in the small computer field. It has steadily gained popularity in use on machines as small as the Apple-II. Peter Grogono, the author of *Programming in Pascal*, will provide an introduction to the language and discuss its use as a more powerful, more modular, more elegant solution to business data problems.

After Pascal, What?

Dr. Kenneth L. Bowles

*Director, Institute for
Information Systems
University of California,
San Diego*

While Pascal is an immensely useful language, it is not necessarily a panacea. Limitations of the language in areas of real time control and handling of multiple concurrent processes, in particular, argue for a new look at the design of the language. Ken Bowles will introduce one evolutionary variant that will become very important over the next decade—the Ada language, originally designed for the Department of Defense. Microcomputer implementations of this language, using machine-independent techniques, will make it a strong alternative for programming microcomputer applications systems.

Trees And Lists as Tools

Dr. Henry G. Baker, Jr.

*Assistant Professor
University of Rochester*

Not all programming problems are amenable to convenient solutions using conventional block-structured, sequential languages. Many require representing complex heterogeneous objects and relationships among those objects. This approach is attractive for selected applications: symbolic mathematical computation, computer-aided design, commercial integrated databases, English front-end processors, computer-aided manufacturing, robotics control, interactive graphic systems, and interactive integrated circuit-design systems.

The LISP language offers the block-structured control of Pascal, together with the friendly interactive nature of BASIC. In addition, it offers lists and trees as data structuring primitives and a tireless "garbage collector" to keep memory neat and clean.

Henry Baker will discuss the LISP language and the kinds of automated tools required to use it.

What is C?

John A. Morse

*Principal Engineer,
Corporate Research
Digital Equipment Corporation*

The language C was originally developed at Western Electric for use as a tool for development of the UNIX operating system at Bell Laboratories. Now that C compilers are starting to become available for microcomputer sys-

tems, this language becomes a viable alternative for both operating system and application developers. John Morse will give an overview of the language C and will detail the types of applications for which it is most appropriate.

The Forth Alternatives

Charles H. Moore

*Chairman of the Board
Forth, Inc.*

One viable and unconventional approach to programming is the highly interactive language FORTH, a language in which the feature of extensibility is emphasized. The typical implementation of FORTH is a highly integrated combination of software development tools and programming aids oriented toward a conceptual stack machine with integers as the primitive data type. In any given application, unique extensions that fit into the matrix basic core of the language are created by the designer. Charles Moore, the inventor of FORTH, will demonstrate some of the more dynamic uses of the language in real-time applications.

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Tentative Schedule

June 16, 1980

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9:00-10:00 A.M.
10:00-10:30 A.M.
10:30-12:00 P.M.
12:00- 1:30 P.M.
1:30- 3:00 P.M.
3:00- 3:15 P.M.
3:15- 4:45 P.M.
4:45- 5:15 P.M.

June 17, 1980

8:30-10:00 A.M.
10:00-10:30 A.M.
10:30-12:00 P.M.
12:00- 1:30 P.M.
1:30- 3:00 P.M.
3:00- 4:00 P.M.

REGISTRATION

INTRODUCTION: Carl Helmers

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THE IMPORTANCE OF TOOLS: Fred Martin
LUNCHEON

THE PASCAL PERSPECTIVE: Peter Grogono

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AFTER PASCAL, WHAT?: Ken Bowles

OPEN DISCUSSION

TREES AND LISTS AS TOOLS: Henry Baker

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B-5

Programming Quickies

Decisions, Decisions

Geoffrey Gass, 5240 SW Dosch Rd, Portland OR 97201

Frequently, a program has to select one of two positive actions as the result of a test (eg: print a "+" or a "-" after checking the sign of a number).

Conventionally, it might be done in a skip chain like this 6800 code:

SGN	TST NUMB	Make the test.
	BMI NEG	One course if negative.
	LDA A #' +	The other course if positive.
	BRA PRINT	Watch out — don't run into NEG.
NEG	LDA A#' -	Minus sign for negative number.
PRINT	JSR OUTPUT	Back together again; print the sign.

It's awkward, running into yourself like that. Here is how to avoid the awkwardness and save a couple of bytes:

SGN	LDA A #' +	Set up for one course in advance.
	TST NUMB	Then make the test.
	BPL PRINT	Confirming advance choice.
	LDA A #' -	Change course if advance choice wrong.
PRINT	JSR OUTPUT	Print the proper sign.

The bytes saved (if not otherwise needed) can be used after the TST NUMB to BEQ (branch on accumulator equal to 0) past the PRINT routine if the number is zero, so 0 will be output without a sign, assuming we are dealing with a 1-byte number. ■

Formatted Program Output for the KIM-1

Lawrence A Ezard, PhD, Associate Professor of Engineering, Pennsylvania State University, Capitol Campus, Middletown PA 17057

Here is a short program that might be useful for owners of the MOS Technology KIM-1 system. It can be used to find bugs, and to print out and document programs.

The flowchart in figure 1 illustrates the algorithm utilized. This program will examine the contents of programmable memory and print the program instructions found there. The output is in a format of address, operation code, and operand. The user specifies the starting and stopping addresses to be examined by storing values in the appropriate locations. At the end of its execution, the program returns control to the KIM monitor.

In writing the program, I made use of the fact that, with three exceptions, the least significant digit (in hexa-

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decimal) of 1-byte op codes is always 8 or A. Also, with nine exceptions, the least significant digit of 3-byte op codes is always C, D, or E.

Listing 1 was produced by the program. The labels,

source code mnemonics, and comments were added later. The program uses several subroutines from the KIM-1 monitor: CRLF, PRTPNT, OUTSP, PRTBYT, and INCPT.■

Listing 1: Program in 6502 code to print out hexadecimal instruction codes from KIM-1 memory. Before running the program, do the following. Load the starting address for examination in locations 17F5 (SAL, low-order) and 17F6 (SAH, high-order). Load the ending address plus 1 in locations 17F7 (EAL, low-order) and 17F8 (EAH, high-order). Clear the decimal mode by entering 00 in location 00F1. The starting address for execution is hexadecimal 0301. The memory used is 0300 to 03D0.

Hexadecimal Address	Hexadecimal Code		Label	Op Code	Operand	Comments
0300			TEMP1			
0301	AD	F5	17	LDA	SAL	Load starting address in POINTL
0304	85	FA		STA	FA	and POINTH
0306	AD	F6	17	LDA	SAH	
0309	85	FB		STA	FB	
030B	20	2F	1E	START1	JSR	CRLF
030E	20	1E	1E	JSR	PRTPNT	Do carriage return and line feed
0311	20	9E	1E	JSR	OUTSP	Print starting address
0314	20	9E	1E	JSR	OUTSP	Print 2 spaces
0317	A2	00		LDX	#\$00	
0319	A1	FA		LDA	(FA,X)	Load Contents of address at FB, FA
031B	8D	00	03	STA	TEMP1	
031E	C9	00		CMP	#\$00	Decide if Op Code is 1 byte
0320	F0	15		BEQ	PRNT1	
0322	C9	40		CMP	#\$40	
0324	F0	11		BEQ	PRNT1	
0326	C9	60		CMP	#\$60	
0328	F0	0D		BEQ	PRNT1	
032A	29	0F		AND	#\$0F	
032C	C9	08		CMP	#\$08	
032E	F0	07		BEQ	PRNT1	
0330	C9	0A		CMP	0A	
0332	F0	03		BEQ	PRNT1	If not 1 byte
0334	4C	40	03	JMP	B3	Jump to test for 3-byte Op Code
0337	AD	00	03	PRNT1	LDA	TEMP1
033A	20	3B	1E	JSR	PRTBYT	Print 1-byte Op Code
033D	4C	B7	03	JMP	INCAD	Jump to increment address
0340	AD	00	03	B3	LDA	TEMP1
0343	C9	19		CMP	#\$19	Test for a 3-byte Op Code
0345	F0	31		BEQ	PRNT3	
0347	C9	39		CMP	#\$39	
0349	F0	2D		BEQ	PRNT3	
034B	C9	59		CMP	#\$59	
034D	F0	29		BEQ	PRNT3	
034F	C9	79		CMP	#\$79	
0351	F0	25		BEQ	PRNT3	
0353	C9	99		CMP	#\$99	
0355	F0	21		BEQ	PRNT3	
0357	C9	B9		CMP	#\$B9	
0359	F0	1D		BEQ	PRNT3	
035B	C9	D9		CMP	#\$D9	
035D	F0	19		BEQ	PRNT3	
035F	C9	F9		CMP	#\$F9	
0361	F0	15		BEQ	PRNT3	
0363	C9	20		CMP	#\$20	
0365	F0	11		BEQ	PRNT3	
0367	29	0F		AND	#\$0F	
0369	C9	0C		CMP	0C	
036B	F0	0B		BEQ	PRNT3	
036D	C9	0D		CMP	#\$0D	
036F	F0	07		BEQ	PRNT3	
0371	C9	0E		CMP	#\$0E	
0373	F0	03		BEQ	PRNT3	
0375	4C	A1	03	PRNT3	JMP	PRNT2
0378	AD	00	03	LDA	TEMP1	GOTO print 2 bytes
037B	20	3B	1E	JSR	PRTBYT	Print 3 bytes
037E	20	9E	1E	JSR	OUTSP	Print Op Code
0381	20	9E	1E	JSR	OUTSP	Space
0384	20	63	1F	JSR	INCPT	Increment address
0387	A2	00		LDX	#\$00	Load contents of address
0389	A1	FA		LDA	(FA,X)	at FBFA
038B	20	3B	1E	JSR	PRTBYT	Print Operand
038E	20	9E	1E	JSR	OUTSP	
0391	20	9E	1E	JSR	OUTSP	
0394	20	63	1F	JSR	INCPT	Increment address
0397	A2	00		LDX	#\$00	Load contents of address
0399	A1	FA		LDA	(FA,X)	at FBFA
039B	20	3B	1E	JSR	PRTBYT	Print Operand
039E	4C	B7	03	JMP	INCAD	
03A1	AD	00	03	PRNT2	LDA	TEMP1
						Print 2 bytes

Listing 1 continued on page 194

Listing 1 continued:

03A4	20	3B	1E		JSR	PRTBYT	Print Op Code
03A7	20	9E	1E		JSR	OUTSP	Space
03AA	20	9E	1E		JSR	OUTSP	
03AD	20	63	1F		JSR	INCPT	Increment address
03B0	A2	00			LDX	#\$00	Load contents of
03B2	A1	FA			LDA	(FA,X)	address at FBFA
03B4	20	3B	1E		JSR	PRTBYT	Print Operand
03B7	20	63	1F	INCAD	JSR	INCPT	Increment to next Op Code
03BA	A5	FB			LDA	FB	Address
03BC	CD	F8	17		CMP	EAH	
03BF	F0	03			BEQ	NEXT	
03C1	4C	0B	03		JMP	START1	If this address is
03C4	A5	FA		NEXT	LDA	FA	equal to the ending
03C6	CD	F7	17		CMP	EAL	address then stop
03C9	F0	03			BEQ	STOP	Otherwise go to START1
03CB	4C	0B	03		JMP	START1	and print the Op Code
03CE	4C	4F	1C	STOP	JMP	START	

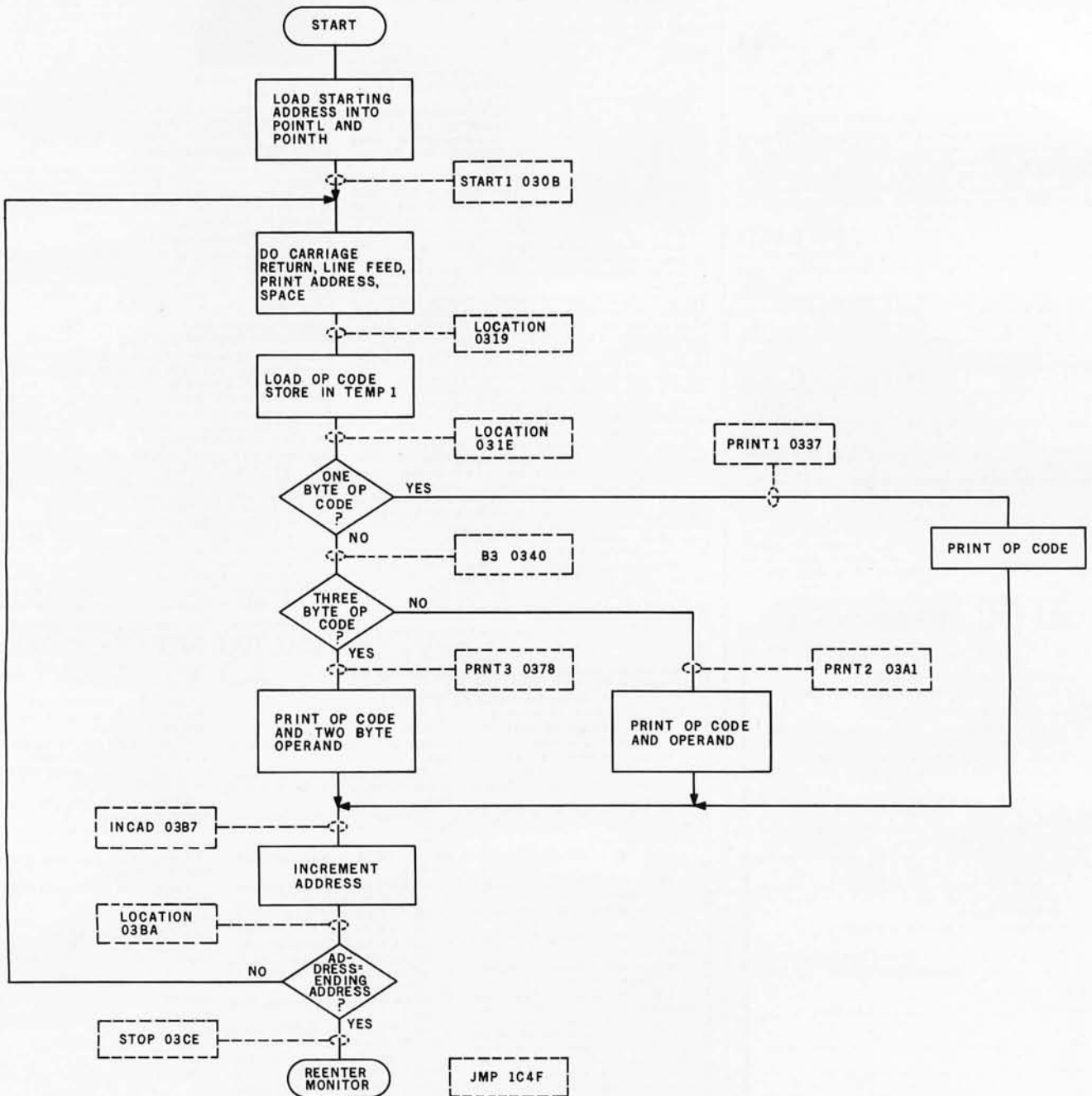


Figure 1: Flowchart of procedure used to print hexadecimal instruction codes from KIM-1 memory.

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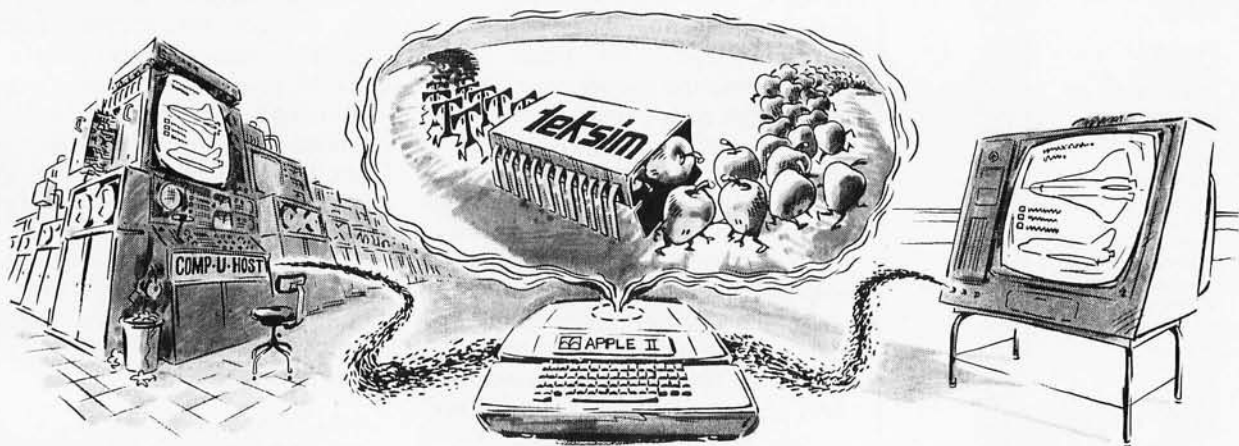
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Give Your Computer an Ear for Names

Tom Munnecke
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One of the major criticisms of the computer is that it is too literal (ie: unable to accept minor errors from fallible human operators). When the computer asks a question, if an answer is not *exactly* right the computer rejects it, even if the answer was *nearly* correct. The computer does not apply a human's reasoning ability

to determine the intent of the operator. Instead, it works only with the exact response.

There is a technique which has been used since the turn of the twentieth century to retrieve names based on pronunciation, rather than their spelling. It is called the Soundex code, and was originally developed to search for names in the 1890 census files. The technique is to give each name a four-character code, consisting of the first letter of the last name followed by three digits representing the sounds found in the rest of the name. This code is then used to group together all names which "sound like" each other.

The Soundex code allows the user to enter a name in a form believed to be the proper spelling. The computer responds with a menu listing all sound-alike names, allowing the user to make a selection. If only one name is found, the computer could confirm the name identity and proceed.

For example the user could

misspell "Gonzales" as "Gonzalez"; "Smythe" as "Smith"; or "Andersen" as "Anderson." I am particularly sensitive to this problem because my name (loosely pronounced "money-key") is regularly misspelled. Table 1 shows a sample of the misspellings, as collected from actual mail I have received during the last two years.

The exact use of the Soundex code varies greatly with the computer's file-management system. Some database management systems support Soundex codes directly; others require the programmer to structure the search logic. The program is easily modified to arrange sounds in groups other than as shown. Therefore, there are many modified versions of this technique in use around the country to account for local variations in names and programmer's whims.

The user might see the Soundex routine working as follows (user input is italicized):

WHAT NAME: *SMITH*

SELECT ONE:

1. Smith, Jack 123 Main St
2. Smith, John 456 Central St
3. Smythe, Zachary 789 First Ave

Enter Choice: _____

If there is only one name with the sound, the computer might respond:

WHAT NAME: *SMITH*

John Smith, 123 Main St

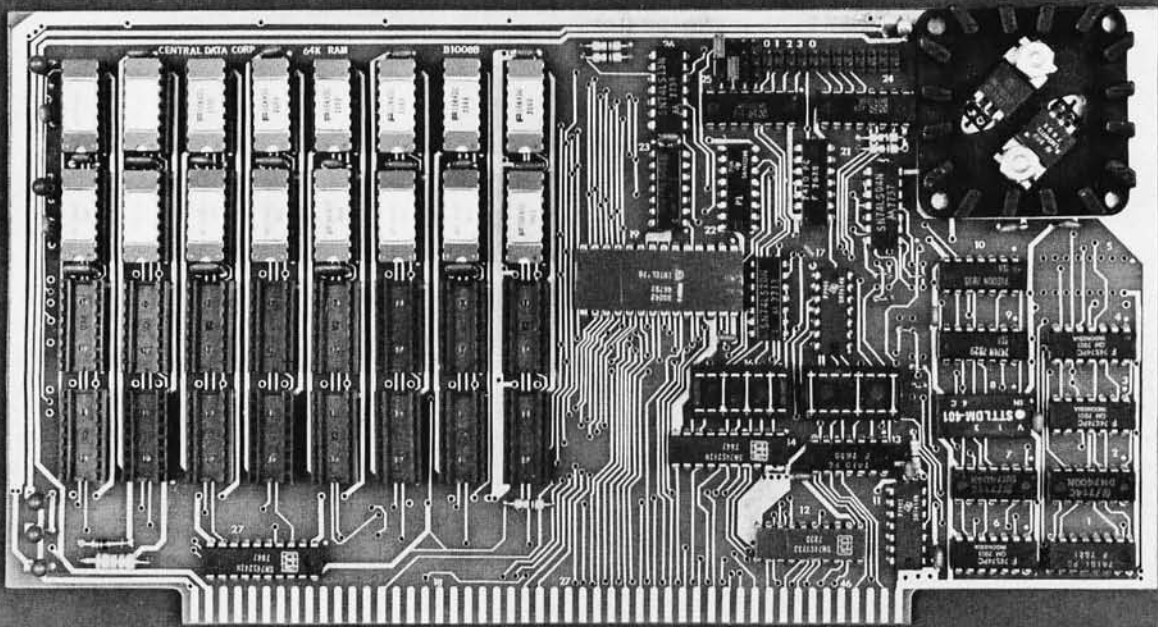
This approach is only the most simple technique. It can be enhanced by adding the first initial of the first name, sex, birthdate, or other characteristic

Name	Code
Munnecke	M520
Minnecke	M520
Munnuke	M520
Munneake	M520
Munneeke	M520
Municky	M520
Muneeck	M520
Monkey	M520
Muneick	M520
Munnick	M520
Monnecks	M521
Muuncake	M522
Munnedie	M530
Lunnecke	L520
Munnecl	M524
Euler	E460
Gauss	G200
Hilbert	H416
Knuth	K530
Lloyd	L300
Lukasiewicz	L222
Smith	S530
Smyth	S530
Smythe	S530
Smitty	S530
Gonzales	G524
Gonzalez	G524

Table 1: Sample Soundex code for several names. The first fourteen names following the author's are misspellings of his name, actually found on mail, along with their respective Soundex codes. Notice that most of the misspellings reduce to the same Soundex code and could identify the correct name.

Letters	Code Digit
b,f,p,v	1
c,g,j,k,s,x,z	2
d,t	3
l	4
m,n	5
r	6

Table 2: Numeric single-digit codes that are assigned to letters from the corresponding groups as they occur in a name being encoded in the Soundex system.



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Listing 1: Soundex program written in Microsoft BASIC for the Commodore PET. Table 3 describes variables used in the program.

```

100 REM TEST DRIVER FOR SOUNDEX
110 INPUT "LAST NAME":N$
120 GOSUB 2000:REM EXECUTE SUBROUTINE
130 PRINT "SOUNDEX CODE =";S$
140 GOTO 100
2000 REM SOUNDEX ROUTINE TOM MUNNECKE 2/22/79
2010 REM RETURNS SOUNDEX CODE S$ FROM LAST NAME N$
2020 REM SEE KNUTH, "ART OF COMPUTER PROGRAMMING", VOL #3, P 391
2030 REM L$=" ": REM LAST SOUND
2040 S$=MID$(N$,1,1):REM START WITH FIRST LETTER OF NAME
2050 IF LEN(N$) < 2 THEN 2200:REM SKIP SHORT NAMES
2060 FOR I = 2 TO LEN (N$):REM FOR EACH REMAINING LETTER
2070 E$=MID$(N$,I,1):REM SELECT I-TH LETTER
2080 E=ASC(E$)-64:REM CONVERT A THRU Z TO NUMBER 1 THRU 26
2090 IF E > 26 OR E < 1 THEN 2160:REM USE ONLY LETTERS
2095 REM SELECT SOUNDEX CODE
2100 K$=MID$("0 1 2 3 0 1 2 0 0 2 2 4 5 5 0 1 2 6 2 3 0 1 0 2 0 2",E,1)
2110 REM ABCDEFGHIJKLMNOPQRSTUVWXYZ
2120 IF K$=L$ OR K$="0" THEN 2160:REM SKIP TWO CONTIGUOUS SOUND-ALIKES
2140 S$=S$+K$:REM BUILD UP SOUNDEX RESULT
2150 IF LEN(S$)> 3 THEN 2200:REM ONLY FIRST 4 SOUNDS
2160 L$=K$:REM SAVE LAST SOUND
2170 NEXT:REM DO NEXT CHARACTER IN NAME
2200 S$=LEFT$(S$+"000",4):REM PAD TO RIGHT WITH ZEROS AND SHORTEN TO 4 CHARS
2210 RETURN
2999 END
    
```

to identify the person with greater accuracy.

Constructing the Soundex Code

The technique for constructing the Soundex code is found on page 391 of *The Art of Computer Programming, Volume 3: Sorting and Searching* by

Donald Knuth (published by Addison-Wesley, Reading MA). The four steps in generating a Soundex code are:

1. Retain the first letter of the name, and drop all occurrences of a,e,i,o,u,w,y,h and q in

other positions.

2. Assign group numbers to the remaining letters after the first according to the scheme given in table 2.
3. If two or more letters with the same code are adjacent in the original form of the name

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Basic In A Nutshell

Name: Step-By-Step

Vendor: Program Design, Inc., 11 Idar Court, Greenwich CT 06830

Price: \$49.95

Purpose: Teaches how to program a TRS-80 using BASIC

Documentation: Outstanding

Loading: OK—Level 6, not critical

Implementation: This is a case of a BASIC program that teaches BASIC programming. It starts out with the assumption that the student only knows how to turn the TRS-80 on. Three cassette tapes are mounted in the cover of a loose-leaf notebook that also contains supplementary information frames. The course is divided into ten two-part lessons. From a simple PRINT "Hi" through arrays and graphics to complex programs, all of the Level II commands and statements are exercised.

The instruction method consists of explanation, example, trial and testing. Commands and statements are presented and explained, examples are shown both on the screen and in the notebook, and then the student is presented with some problems to solve using the BASIC elements under discussion. If an incorrect answer is given,

two more tries are allowed, and then the correct answer is displayed. Each lesson ends with a test that is administered and scored by the computer. The results are then entered into the student's progress chart. More comprehensive examinations are given at the end of Lesson 5 and at the end of the course.

Suitability: This is the kind of educational programming that personal computing needs more of. The student (my teenage son) learned much more quickly than I could have taught him, and at his own pace. However, this course isn't just for youngsters but for anyone who wants to be able to program effectively using the BASIC language. In a household where there isn't anyone to do the teaching, this course would be especially useful. I'd like to see a similar course for assembly-language programming.

Other software available from the same vendor: IQ Builders (four different kinds), Memory Builder and Story Builder.

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80 Microcomputing, February 1980

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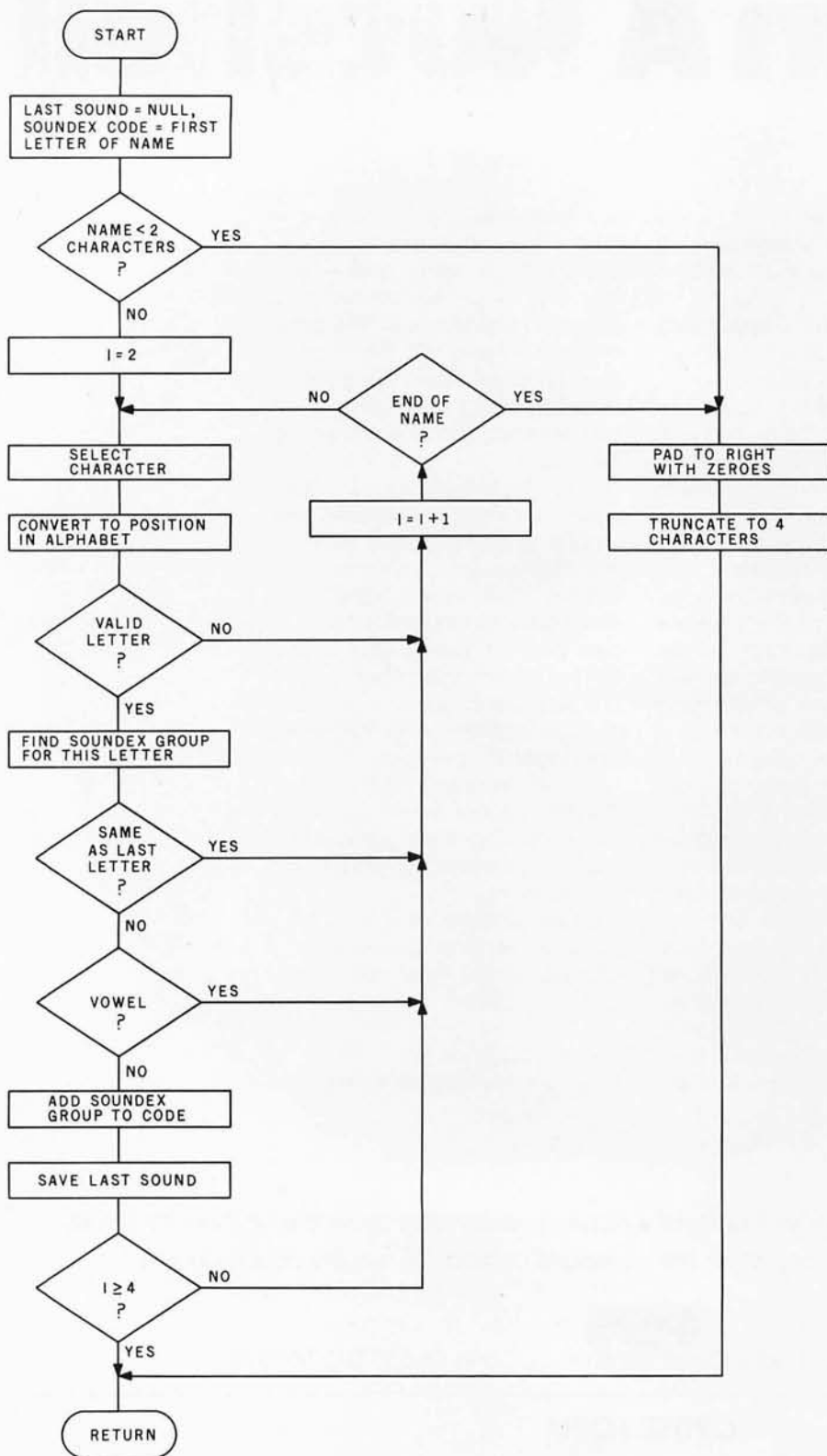
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Input	
N\$	— Name to be coded
Output	
S\$	— Soundex code of N\$ (form: letter,digit,digit,digit)
Temporary	
I	— Character position in N\$ under consideration
E\$	— Ith Character in N\$
E	— Alphabetic sequence of E\$
L\$	— Last sound during evaluation
Table 3: Variables used in the Soundex program.	

structs the encoded form from a last name. It was written and tested on a Commodore PET 2001 computer, but it should work on any computer using Microsoft BASIC. It should work on other BASICs which have LEFT\$, RIGHT\$, and MID\$ functions, and use "+" for string concatenation.

Figure 1 shows the flowchart describing the program's operation. Line numbers on the flowchart correspond to the BASIC line numbers in listing 1. The program is separated into two parts: the Soundex routine, starting at line 2000, and a test driver starting at line 100. The driver is used to ask for a name, invoke the Soundex generator, then print the results. It will be replaced by your program logic for filing and retrieving. The Soundex generator in line 2000 accepts as input the variable N\$, representing the last name to be converted. It returns S\$, the Soundex code for N\$.

The only tricky part of the program is contained between lines 2080 and 2110. Instead of testing each letter individually, as shown in the original technique above, the program converts the letter to a number from 1 to 26, representing its position in the alphabet. It then uses this number to index a character string, containing the group codes for each letter. The comment below the index line at line 2110 documents this technique, and provides a reference in case the codes need to be changed.

The Soundex subroutine may be incorporated into programs that require the computer to understand user input. The addition of a Soundex routine can increase the usefulness of a computer. ■

Figure 1: Flowchart of the Soundex algorithm subroutine.

(before step 1), omit all but the first.

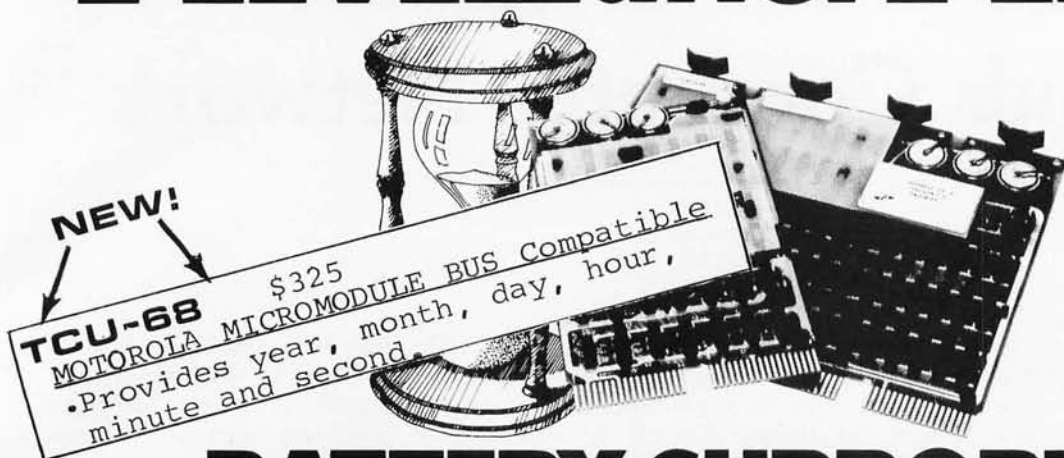
- Convert the name to the form letter, digit, digit, digit by adding trailing zeroes (if there are less than three digits), or by

dropping rightmost digits, if there are more than three.

BASIC Program

Listing 1 shows the Soundex code generating subprogram that con-

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DIGITAL PATHWAYS

The Club Computer Network

Joe Kasser
11532 Stewart Ln
Silver Spring MD 20904

Does a club need a computer network? What are its uses? What are the advantages of having such a network?

This article attempts to answer these questions and provide ideas on the techniques used in implementing the network.

Basic Communications Needs

An important aspect of any hobby is communication. The sharing of information and experiences can add a great deal of enjoyment and save much time. If the techniques used to solve some problem are made available by the solvers to others, the recipients of the solution can advance the state of the art. This is done by building upon the foundations developed by the original solvers, rather than by rebuilding the same foundations.

In the computer field, communications fall into two similar but distinct categories: the exchange of personal messages and the exchange of computer data (programs or data bases).

Personal messages may contain any plain language text. Computer data may contain programs, data bases, and instructions for processing files.

About the Author

Joe Kasser is vice-president of the Chesapeake Microcomputer Club, director of information and publicity of the Radio Amateur Satellite Corp (AMSAT), and editor of ORBIT. He has worked with microcomputers professionally since 1975, and has built an 8080-based, S-100 computer system which served as the prototype for the club's construction project. He has contributed other articles to BYTE, including "AMSAT 8080 Standard Debug Monitor" (September 1976, page 108, with Richard C Allen), "The Sky's the Limit" (November 1978, page 48) and "The AMSAT-GOLEM-80" (September 1979, page 182).

Computer data comes in many forms. In the personal computer area, data may be on paper tape, cassette tape, or floppy disk. If it is on cassette, it may be in a digital saturation format or some modulated audio format. It may also be recorded at one of several data rates.

If data is on a floppy disk, the disk may be soft-sectored or hard-sectored. Data may be on 5- or 8-inch disks, which may be single or double density, single or double sided. The disk format may be compatible to a disk operating system such as CP/M or North Star, or it may not.

Most computer users do not have the means for reading or writing all of the different types of off-line storage media. Thus, two users who wish to share software may have what is known as a "media incompatibility problem."

A typical example occurs in the Chesapeake Microcomputer Club (CMC). Two members own 8080 or Z80-based systems, each running the Digital Research CP/M disk operating system. One member, however, uses 8-inch soft-sectored disks, while the other uses a North Star system (5-inch hard-sectored disks). They have no compatible medium such as tape. How then are they to share computer files?

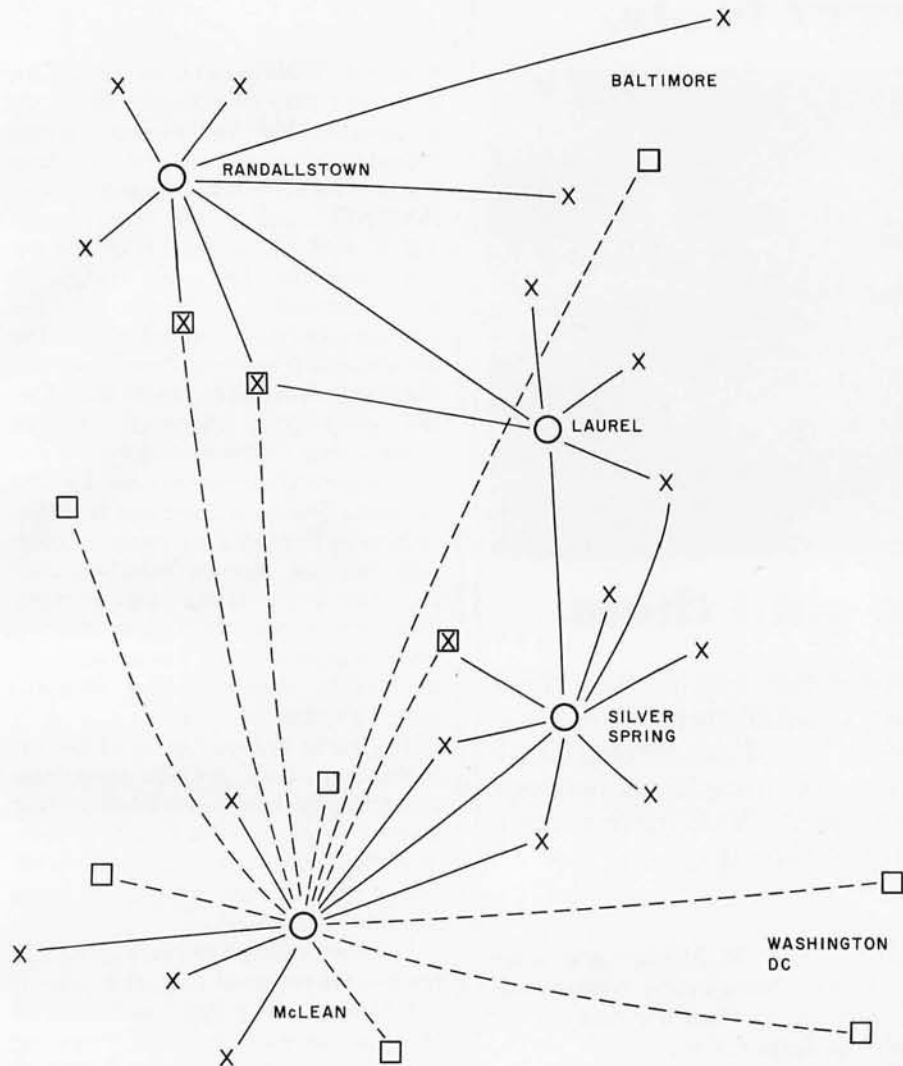
The club is spread out over a wide geographic area. Several of the officers require access to the club roster or membership list. Currently the list is kept by one officer who has to update it, see that labels are printed for mailings, and send physical copies of the list to the other officers. Since officers may live 30 to 50 miles apart, the telephone and postal services are the only practical method for information exchange. There must be a better way.

The club has a need for disseminating information. Reports concerning main meetings, chapter meetings, group purchases, surplus information, and special interest groups have to be made available to the membership. Currently the information is passed out at meetings and through the mails by a monthly newsletter. Is there a better way?

Many of the members possess their own computer systems. The degree of sophistication ranges from a simple KIM-1 to a system with dual disk drive, large amounts of memory, and line printers. A number of members have become involved with the club computer project and the group-purchase plan for equipment. Each one of these systems is in a different stage of development. Many people are finding that their system cannot perform the tasks that they wish it to perform, because several system components (such as extra memory or disk storage capability) are lacking for one reason or another. Perhaps the capital outlay involved is not available, or they are waiting for deliveries to take place.

When contemplating the purchase of additional hardware and software, decisions involving hundreds of dollars must be made, sometimes with little factual information. At club meetings members can discuss their requirements and experiences, but that just results in acquisition of information about how a particular item of computerware works in someone else's environment and how it meets his requirements.

It would be nice to be able to get together with a friend and gain hands-on experience of the way that a computer system component performs in one's own environment before purchasing it. Visiting friends



- = COMPUTER
- X = PHONE USER
- = RADIO USER (HAM)
- ⊠ = PHONE/RADIO USER (HAM)
- = TELEPHONE LINK
- - - = RADIO LINK

Figure 1: Diagram of sample telephone and radio-data transmission links in a typical club computer network. Several computers form nodes in the network. Solid lines indicate telephone links; dotted lines indicate links through a 2-meter band amateur radio repeater system (at the same location as one of the computers). Communities identified are located in northern Virginia and in Maryland (except for Washington DC).

and using their systems can provide this facility, but it is inconvenient, especially when a long session is planned or the traveling distance is great. There must be a better way.

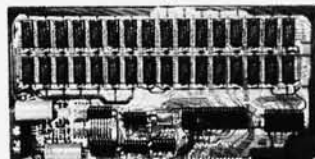
Basic Network

There is a better way. It is called a club computer network. All club members can have access to it. It may be centralized or distributed, but it

will provide a service to the club members. Access may be via the telephone line or via amateur radio-teletypewriter (RTTY) circuits. Each access method has its own advantages and disadvantages.

An example of such a network is shown in figure 1. It incorporates both radio and telephone links. It also allows for a number of computers in the system. It is spread out over a

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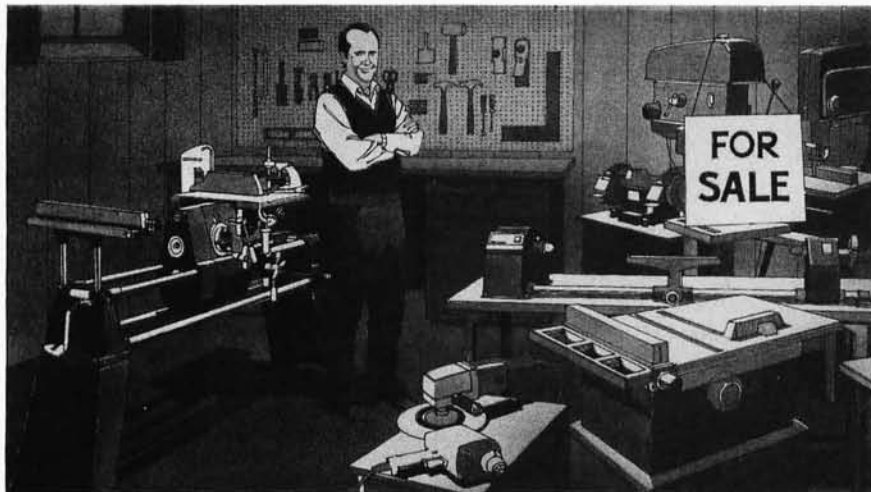
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relatively wide geographic area. One computer may be accessed either via a 2-meter FM radio-teletypewriter repeater (operated by the Amateur Radio Development Association, AMRAD, using the frequencies 147.81 and 147.21 MHz), or via the telephone line. The other computers are operated on behalf of the Chesapeake Microcomputer Club Inc by various members. Note that this area-wide operation is necessitated by the geographic dispersal of the membership of the two clubs.

The central computers are located so that at least one computer is within local telephone-dialing range of each club member. Several members may be within local dialing range of more than one. If one machine in the network is down, or in use at any particular time, these members can try to access another computer.

The radio link can be used by virtually any amateur radio teleprinter station in the area that is equipped for 2-meter FM operation. Of course, any member of the club can access any computer by making a long-distance telephone call.

Data is collected in each computer for remote retrieval at a later time. If the data in one machine is addressed to a user outside the local telephone area, the data is automatically sent to the computer in the distant area in the late evening, when long-distance telephone rates are lowest. This inter-computer transfer takes place once per night per machine in a predetermined sequence to transfer the maximum number of messages with the minimum number of calls.

Link Types

Consider first the characteristics of the radio links. Many amateur radio operators already use noncomputerized automatic-starting radio-teletypewriter equipment for receiving message traffic. A computer network for message handling is a logical successor to these existing autostart networks.

The existing noncomputerized network works as follows. All stations monitor the same frequency. Messages are sent blind; when a message is originated into the network, the sender does not know for certain if the destination station is

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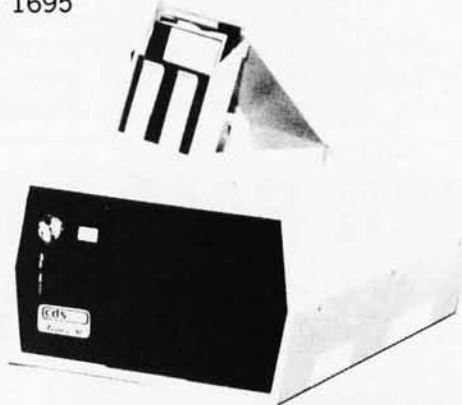
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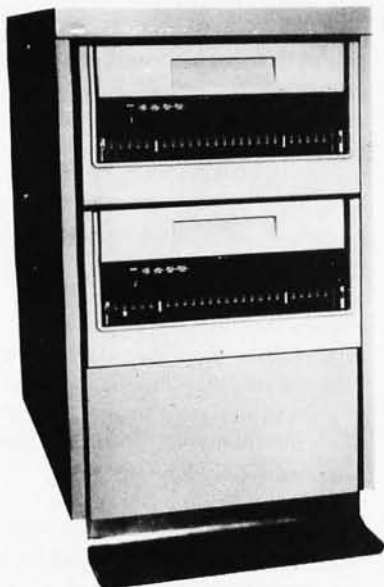


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monitoring the frequency, unless 2-way contact is first established. In the evening, or during weekends, this may not pose much of a problem, because the probability of someone being at home is great. However, during the working day, that probability decreases. Thus, if contact cannot be established directly, the message can still be sent, but there is a probability that the destination receiver will not be on line, and the message will be lost.

If, however, the message can be stored in a central computer by the sender, and retrieved later by the

receiver, the probability of successful transmission of the message from sender to receiver is almost certain. The addition of a computer therefore becomes an asset to the network.

If several stations in the network have computers capable of answering back to the sender, the utilization of the computer may be reduced. A sender can put out a direct call. If an answer is not received (indicating that the destination is not on line or monitoring at the time), the message can either be transmitted to the computer for storage, or held and the transmission attempted again at a

later time. It is also possible for the assignment of which network computer will perform the store and forward operation to be rotated among the various member-station computers on basis of availability, as long as the network computer has a distinctive identification.

With a radio network set up in this way, anyone equipped either with simple radio-teleprinter equipment or with sophisticated computer equipment may make use of the full network message storage and forwarding capabilities. This concept of allowing minimally equipped stations to access the network requires that simple techniques be used for data transfer. These include 5-level ("Baudot") or ASCII plain language text, a control language that is readable by both man and machine, with minimal error checking. The advantages of more sophisticated techniques mean that many people will want to use them. That leads to a hierarchical concept of the network utilization. This will be discussed later.

The disadvantage of the radio network is that since everyone is on line, the privacy level is zero. Therefore, data that is not intended for public knowledge cannot be passed over the network. For this reason, mailing lists and other confidential club data should not be passed over the radio link. [Also, FCC regulations require that no message traffic pertaining to any business or commercial activity may be transmitted by an amateur radio station...RSS]

Use of the telephone line for gaining access to the computer limits the number of users that can be on line at the same time. One great advantage of the telephone line is security. The connection between the user and the computer is private. Mailing lists can be accessed and changed remotely without compromising the security of the data, provided that only authorized users are allowed access to these data files.

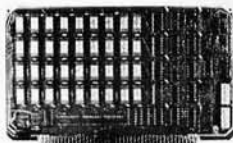
System Implementation

Bringing up the network for the first time can be simple or complex. One method is to install a computer equipped with dual floppy-disk drives, 32 K bytes of memory, and the phone line, and make it available 24 hours per day. It is an expensive method, especially when the demand

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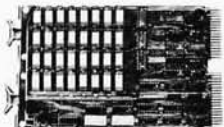
S-100 - \$750.00 ● 6800 - \$750.00 ● 6800-2 - \$995.00



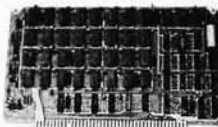
CI-6800-2 64K x 9



CI-S100 64K x 8



CI-1103 32K x 16



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CI-6800-2 — 16KB to 64KB. Plugs directly into Motorola's EXORciser I or II. Hidden refresh up to 1.5 Mhz. Cycle stealing at 2 Mhz. Addressable in 4K increments with respect to VXA or VUA. Optional on Board Parity. 64K x 9 \$995.00.

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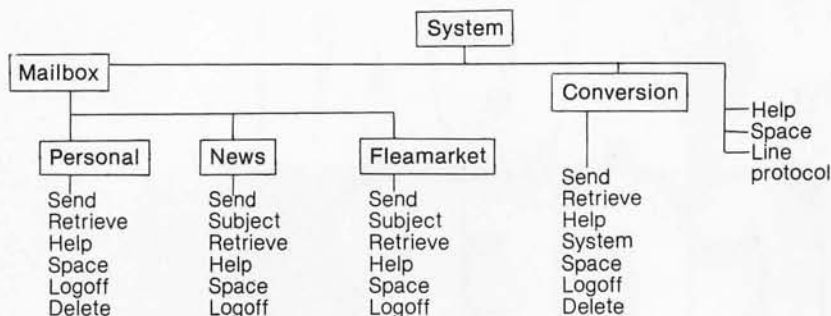


Figure 2: Hierarchy of software modes in the club computer network software. Names of program routines are enclosed in boxes. Commands available with each program are listed below.

A Message to our Subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers promotional material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

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A Message from North Star Computers Inc.

Due to a miscommunication between our advertising agency and BYTE Magazine, an advertisement for North Star Computer new Applications Software ran in April instead of May. This ad was not intended to appear until all North Star dealers had been informed of our new software products and were prepared to handle customer inquiries.

We regret any inconveniences and embarrassment this has caused North Star dealers and customers, and we are grateful to BYTE for allowing us to clarify this situation. The new Application Software packages will be available through North Star dealers in early May.

Sincerely
 Charles A. Grant
 President
 North Star Computers Inc.

for such a service has not yet been demonstrated in the club.

A second method is to bring the service on line gradually, using equipment belonging to club members, and then put together a club system as club finances allow. This method has the advantage that the cost can be spread out over a period of time, but does have a disadvantage because there will be many intervals during the early stages of the network implementation when the system is not available.

The network can be started by one or more club members making their personal systems available. On the radio link, there will be no noticeable difference with the different computers, since they should all answer to the same call sign, and the user need not know which machine is storing his traffic. In practice each computer will also transmit its own station call sign as required by law.

Telephone access is a little more difficult, because a list of numbers must be made available to the network members, and a rule must be established for dialing the computer. An example of such a rule is that if the computer does not answer by the second ring, dial another number.

When the system is first put into use, it will be lightly loaded. It can thus be used for secondary purposes apart from the message storage or media transfer applications. Club members will have a chance to use the sophisticated system and to play with it. The availability of any single computer during the early stages may be intermittent: since it is the personal system of a club member, it will be available for club use only when the owner is not using it. This unreliable accessibility will encourage members to upgrade their systems as fast as possible for their noncommunication uses. However, the system as a whole will have a greater reliability, since there is a good probability that at least one computer will be available when one is required.

Using the Telephone Link

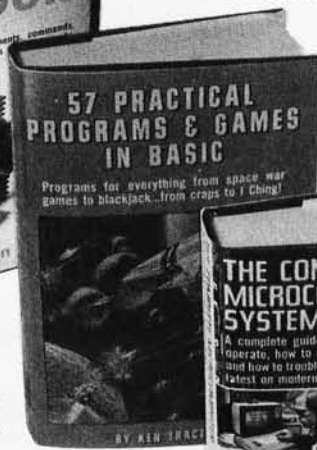
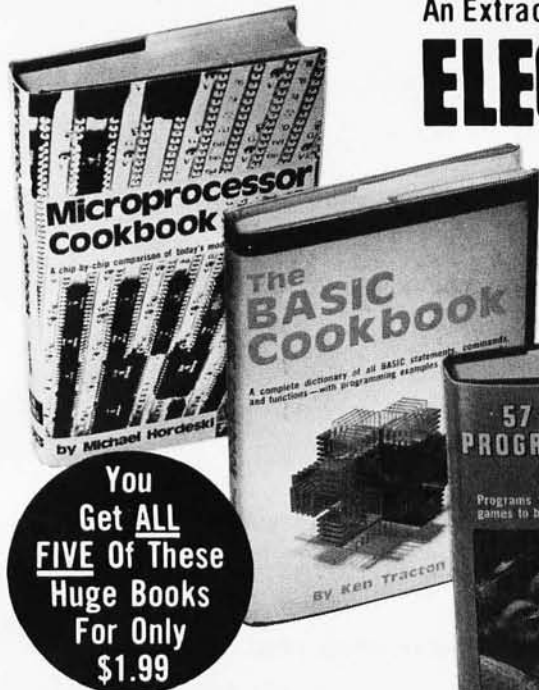
The typical telephone communication system operates at a data rate of either 110 or 300 bits per second (bps), allowing the use of simple Bell 103-compatible modems. In order to set the data rate for a transmission, each user must transmit a carriage

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```

CMC NETWORK. ENTER LOGON: - G3ZCZ
G3ZCZ LOGON IN PROGRESS AT 1115 ON 6 NOV 1978
4 MESSAGES
READY MAILBOX
MAILBOX READY HELP
CHOOSE BETWEEN 'SEND, RETRIEVE, HELP, SPACE, LOGOFF'
MAILBOX READY SPACE
DISC SPACE = 25K
MAILBOX READY SEND
DESTINATION? WB4APR
INPUT: - BOB, WE HAVE TO DISCUSS THE RADIO PROTOCOL. CALL ME WHEN YOU HAVE A MOMENT, BETWEEN 9 AND 11
PM ANY NIGHT EXCEPT FRIDAY. [control-Z]
MESSAGE ACCEPTED
MAILBOX READY RETRIEVE
RETRIEVE IS NOT VALID
MAILBOX READY RETRIEVE

```

MESSAGE	SOURCE	DATED
1	WB4APR	1 NOV 1978
2	CMC 105	3 NOV 1978
3	TERRY FOX	5 NOV 1978
4	G8BTB	5 NOV 1978

```

MAILBOX READY RETRIEVE 2
MESSAGE READS: BRING THE DOCUMENTATION ON THE GLOOP BOX TO THE MEETING. FRED.
MAILBOX READY

```

Figure 3: Sample interaction between the author (G3ZCZ) and the Chesapeake Microcomputer Club-Amateur Radio Development Association (CMC-AMRAD) computer system. Characters sent by the system are shown in regular type; those typed by the user are shown in boldface type. Note that when the "RETRIEVE" command (a misspelling) is entered, an error message is generated by the system.

return character so that the computer can set up the correct data rate. Once the data rate is established, the computer sends out a sign-on message and asks the user to log in with an identification code. This identification can be a membership number, an amateur radio call sign, or some arbitrary name. It is limited to a length of eight characters. The computer will then indicate the presence or absence of any personal messages addressed to the user that has just logged in.

The software in each computer is identical in behavior and is organized in a structured top-down approach as shown in figure 2. The user has a choice of programs as shown that

perform the various functions. Various commands are associated with each program as listed. Consider each program and mode in turn.

The mailbox program is designed to enable club members to send short messages (up to 256 characters) to each other. The messages are in plain language. The response to a SEND command is to prompt the user with DESTINATION? Upon entering the identification code of the destination, the user is prompted to send the message and terminate it with a control-Z character. Should more than 256 characters be entered, the entire message will be rejected. This discourages long messages.

The response to the RETRIEVE

command is to list the sender identification of each message in the system awaiting the user.

A sample user session is shown in figure 3. The computer output is shown in regular type, the user input in boldface type.

The other messages may be retrieved in turn. The RETRIEVE command has the following characteristics: If followed by a carriage return, it lists all messages. If followed by a 0, it lists all messages. If followed by a number, it lists the corresponding message.

Identification numbers are assigned to the messages only to allow the user to retrieve them. The numbers are reassigned as messages are deleted.

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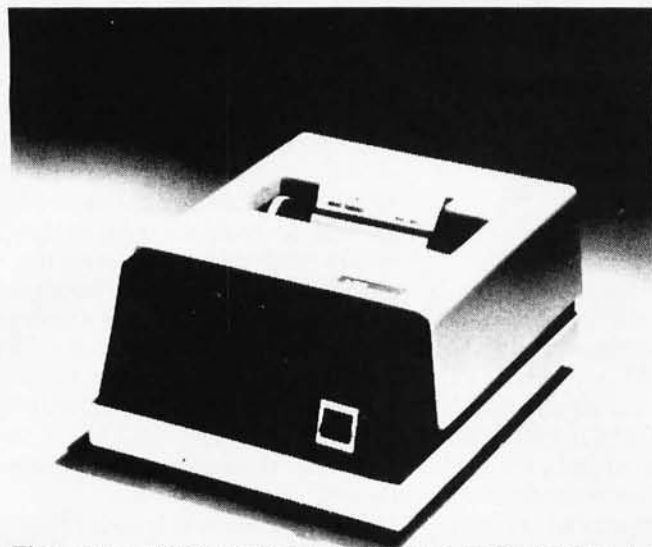
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Deletion of messages is allowed by the system under restricted conditions. Only the system manager, the sender, or the retriever can delete messages. Each user is assigned a password that must be entered prior to a DELETE command. This allows some degree of security. Messages will be deleted by the system manager periodically, depending on the storage requirements of the system.

In the *news* and *fleamarket* modes, updates are handled by a single club member designated for that duty. All messages for input to the system are routed to this person for scanning before being placed on the system. This is to keep the system from being cluttered up with undesirable messages. Updates of these messages take place as time permits, with a maximum delay time of one week.

The *conversion* program is designed for exchange of data between different media. One club member desiring to receive a data file from another will arrange for the second member to put the file into the system for retrieval within hours. The expected life of a file in the conversion mode is about 24 hours. Conversion uses a different protocol than the mailbox mode. Since long files are being exchanged, the data flow has to be stopped from time to time to allow disk read and write operations. A full-duplex mode is used.

The maximum message length of 256 characters applies in all modes except conversion. Messages with more than 256 characters are rejected in their entirety. This encourages brevity. A rejection message is printed by the computer to the sender in the case of a message rejection. A user who has to retype messages will soon get the idea.

Several existing network systems carry a large number of undesirable messages. We hope to minimize them in the CMC-AMRAD network. Any user trying to enter unwanted messages may have them rejected by the system manager.

Data Complexity Levels

Data may be transmitted over a link at one of several levels of complexity of internal organization. The basic level (level 0) is plain ASCII-encoded text in half-duplex mode. Level 1 is a simple ASCII-based, full-duplex mode developed by Tim Pugh. Level 2 is an emulation of the PCNET (personal computer network) protocol. Level 0 is used by anyone in talking to the computer during execution of any user program. Level 1 may be used in the conversion mode, while Level 2 is used for intercomputer data exchange. Any properly equipped user can request any level when he logs onto the system.

Any club member having an *answer-mode* modem can run the basic network system software on his or her machine. An extension can be made to the system to allow access to the disk operating system so that other club members can play with the other software available on the machine.

Radio Restrictions

Mailbox and news are the only categories of data exchange available via radio links. Conversion-mode data may contain binary or other unusually coded files, and fleamarket may contain advertisements; radio transmission of both of these classes of messages is forbidden by law.

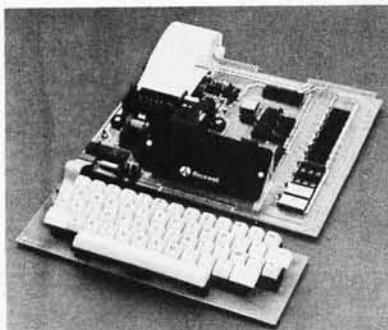
The procedure for logging onto the system is different from the one used

over the telephone. Half-duplex mode is employed when using a single-band repeater, such as the 147.81/147.21 MHz AMRAD machine. If the inputs and outputs were on different amateur frequency bands, full-duplex operation would be easily achievable. In order to avoid the requirements for duplex exchanges and to reduce the amount of information exchanged, the modified *Q code* is employed. See my article "The Sky's the Limit: Use Ham Radio Bands for Intercomputer Communication" (November 1978 BYTE, page 48), for a more complete discussion of the use of these Q codes.

[The Q code is a system of 3-letter abbreviations that all begin with the letter Q. Various Q codes are used during Morse-code radio transmissions to speed up message exchange. An adapted set of Q codes is used for computer network communication... RSS]

Any amateur can log into the network and receive a reply from any on-line computer that has a message for him or her. Thus, users without computers can store their messages in the network computer; those with computers can leave messages on their own machine for later remote retrieval. Possible contention interference (from more than one machine simultaneously trying to communicate over the network) can be overcome initially by employing a different time-delay response characteristic for each computer in the network (both user and system computers).

The radio link can also be used for long-distance links between the club network and other club networks. Again, see "The Sky's the Limit" for a more complete discussion. ■



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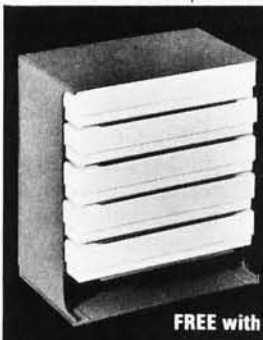


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The COSMAC Doodler

Jeff Duntemann
 301 Susquehanna Rd
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When the COSMAC ELF micro-computer first appeared several years ago, its designer called it a microcomputer trainer. That meant that you had a few hexadecimal displays and a light-emitting diode (LED) to play with in your programs, and nothing else. Clever people managed to make the ELF play music or even generate Morse code without much additional hardware.

As far as I know, the ELF is the only microcomputer that has often been built from scratch by hobbyists without using a predesigned printed-circuit board. There is *no* better way to learn microprocessor hardware than to buy a handful of parts and wire-wrap all of the connections. In ironing out your mistakes, you will become familiar with every processor timing signal, every kink in every system timing diagram, and every little architectural quirk that can grow up to be a big bug in later programs. It is a rigorous education, I promise you, but an excellent one.

Then RCA released the CDP1861 video-display-controller integrated circuit for sale, and suddenly the ELF could do something no comparable computer could do for triple the price. With the CDP1861, the ELF displays a bit-map of 1024 bytes of memory on a video screen (in black and white), with no hardware needed except the CDP1861 and several resistors, and with software consisting of a 30-byte interrupt routine.

This development was not purely a gift to hobbyists, of course. The

CDP1861 formed the heart of RCA's Studio One home video game. In such games cost is probably the most important factor. Video-game-type graphic displays are now easily done on the ELF. The fourth article in the ELF series ("Build the PIXIE Graphics Display," Joseph A Weisbecker, *Popular Electronics*, July 1977, page 41) outlined the hardware required and included a simple test program, but it was up to hobbyists to come up with video software to make the ELF earn its keep.

The Video Doodler program presents a winking cursor in the upper left-hand corner of the screen. By actuating toggle switches, the cursor can be made to move horizontally, vertically, or diagonally. As it moves, it either leaves behind a trail of white dots against the black background, or it "eats" previously written white dots and lines back to blackness. Once you fill the screen, one push of the INPUT switch wipes it clean again.

Memory Requirements

The only problem is the program's size. Within the limits of a typical ELF one-page memory system, there is no room left in memory after you toggle in the program to do any drawing on the screen. The only way out of this problem is to expand memory to at least two 256-byte pages. If you shop wisely, you can do this for less than \$9.00. Adding another page of memory requires only two additional 2101 static memory chips and a CD4042 complementary metal-oxide semiconductor (CMOS) latch. Figure 1 details an ELF two-page memory system.

If you do not intend to add much more memory beyond two or three pages, you might consider replacing

Text continued on page 218

About the Author

Jeff Duntemann works for Xerox Corp. He has built a small robot (named Cosmo) that he controls with his computer, and enjoys amateur radio operation (as KB2JN). His writing is not confined to technical articles; he has had a science fiction story published in Isaac Asimov's Science Fiction Magazine.

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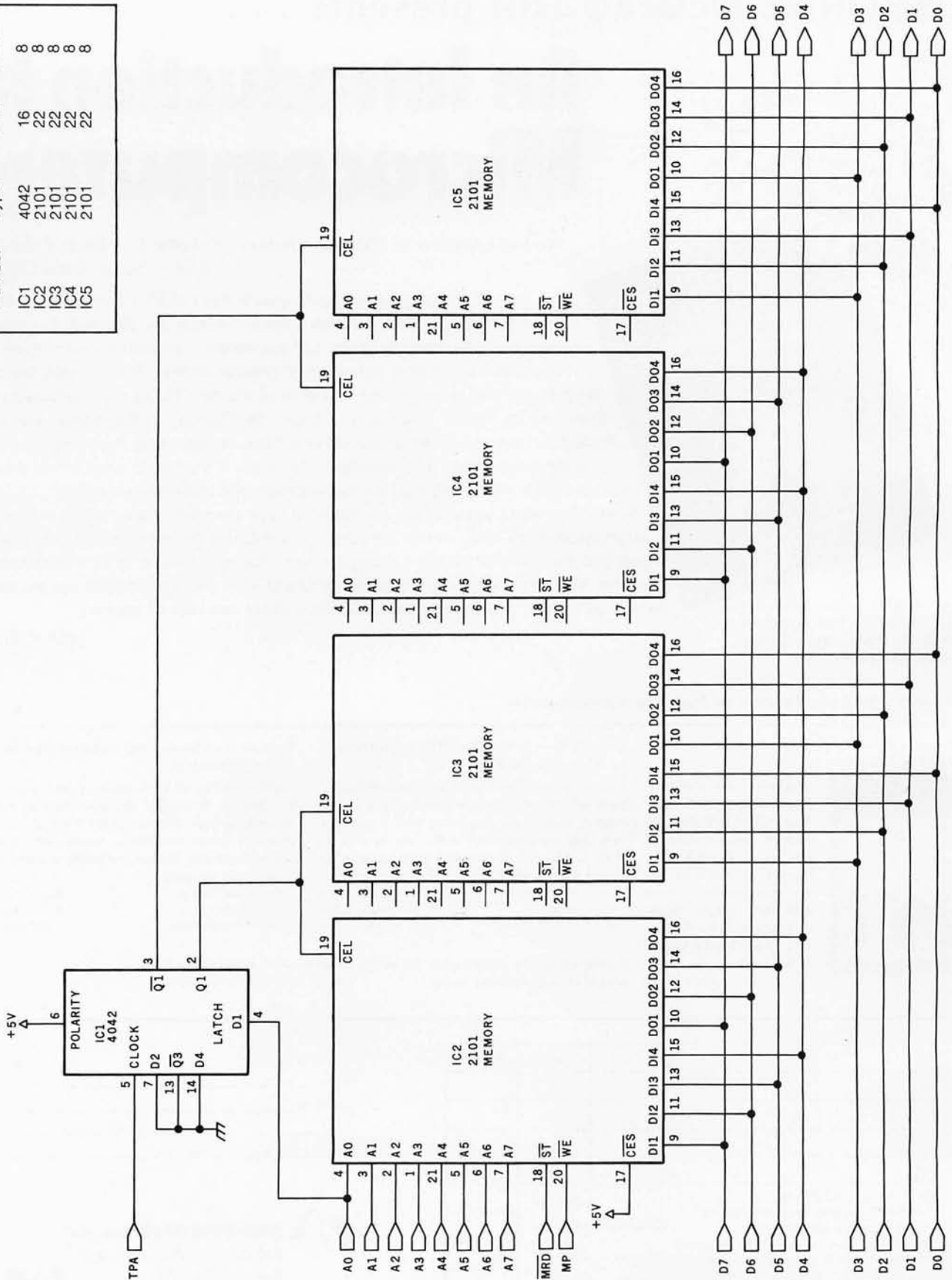


Figure 1: Schematic diagram of a two-page programmable-memory system that can easily be added to a COSMAC ELF microcomputer. Pins 17 and 22 of the memory parts should not be connected together. Instead of 2101 memory devices, it is possible to substitute CMOS 5101, 74C920, or CDP1822CD parts. Use of complementary metal-oxide semiconductor memories enables the use of batteries to retain data in memory even when the main power supply is shut off.

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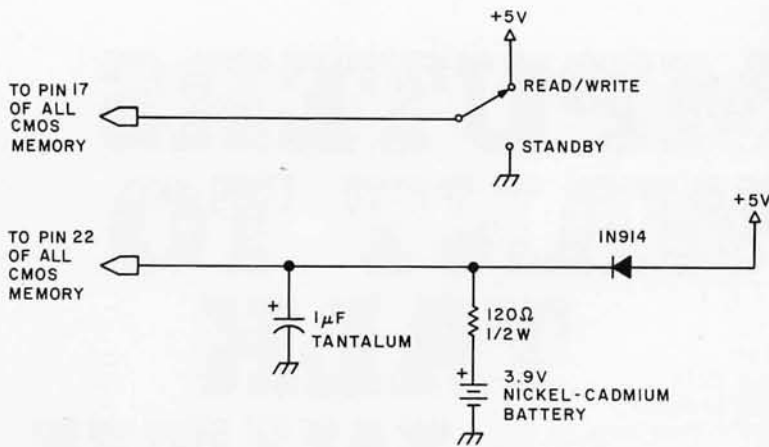


Figure 2: Memory data-retention circuit for CMOS memories. Do not use this circuit with a 2101-type memory. The nickel-cadmium battery cells charge during normal operation, and thereafter maintain data in the memory when main power has been turned off.

Text continued from page 214:

your 2101 devices with CMOS 5101 or CDP1822 memory. A small 3.9 V battery can allow data to be retained in CMOS memory even when the main power is off, thus keeping you from facing the exasperating job of toggle-loading 195 bytes every time you want to show off the Doodler.

If you can locate a 3.9 V nickel-cadmium battery, the circuit in figure 2 can be built and then forgotten about. The ni-cad will charge while the power is on, and keep memory alive when power is off. If you

operate your ELF at least a few hours per month, the battery will never fully discharge.

Register Use

The Doodler program makes heavy use of the COSMAC general-purpose registers. A register-use summary is given in table 1 to keep everything straight while you are trying to understand the program's operation.

Where Is the Cursor?

It takes two pointers to specify a

cursor position on the screen. The *byte pointer* is the memory address of a single byte somewhere among the 256 bytes displayed on the screen.

The *bit pointer* is a byte stored in half of a general-purpose register. Only one bit of this byte ever contains a binary 1. This bit represents the position of the cursor within the byte indicated by the byte pointer.

The Doodler actually has two sets of pointers for its cursor. The permanent pointers contain the actual position of the cursor at any given time. The temporary pointers are modified during each scan of the toggle switches.

The toggle switches are read and separately tested by shifting bits out of the D register (COSMAC's accumulator). Each of the first five switches controls a program function. If the first toggle switch is actuated, the temporary bit pointer is shifted one bit to the right. If during this shift the bit crosses over into the next byte, the temporary byte pointer is incremented by one.

Actuating the second toggle switch shifts the bit pointer to the left, and decrements the byte pointer if the bit crosses the border into the next byte leftward. The third toggle switch adds the hexadecimal value 08 to the byte pointer. This does not affect the

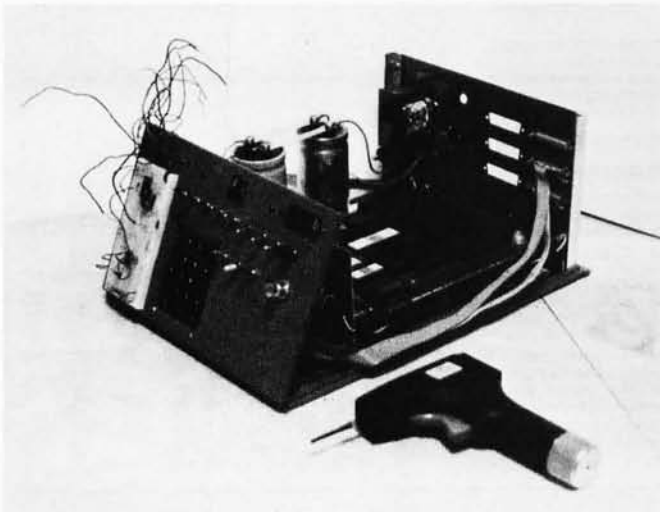


Photo 1: The author's homebrew COSMAC computer system. It contains 2560 bytes of memory and uses a full 16-bit address display. Important processor and input/output signals are brought out through the front panel for ease in breadboarding.

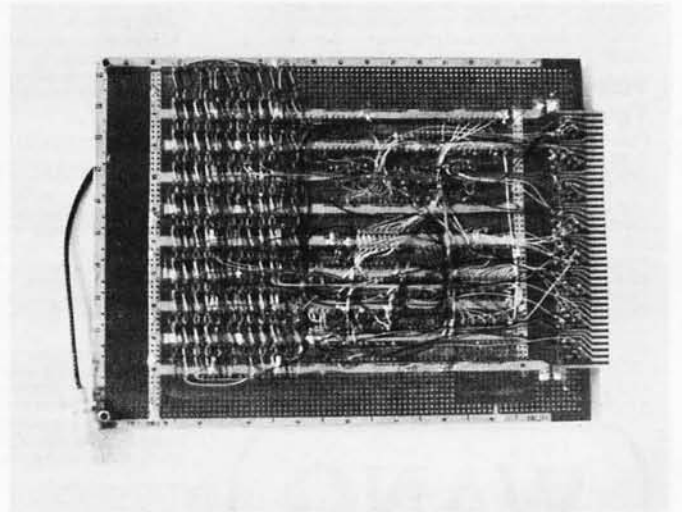
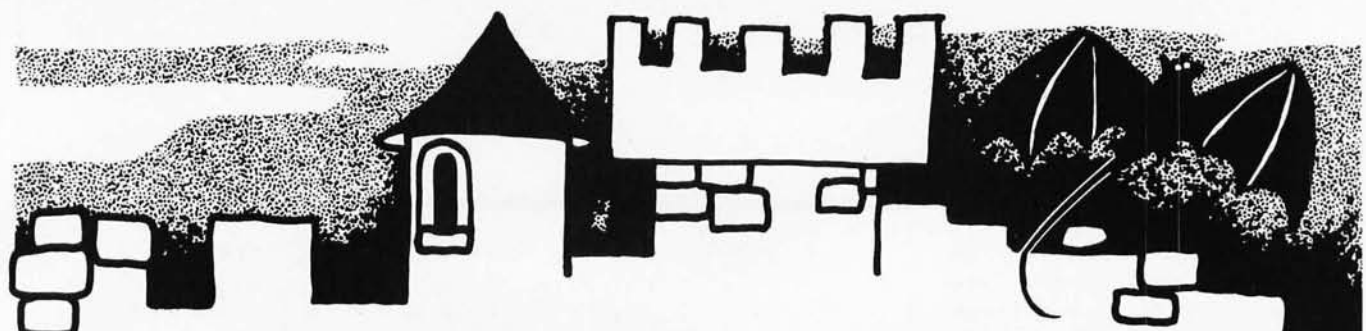


Photo 2: Bottom side of the processor board. Six weeks of even-ing work with an OK Tool Hobby Wrap wire-wrap gun and 150 feet of wire were needed to complete the connections.



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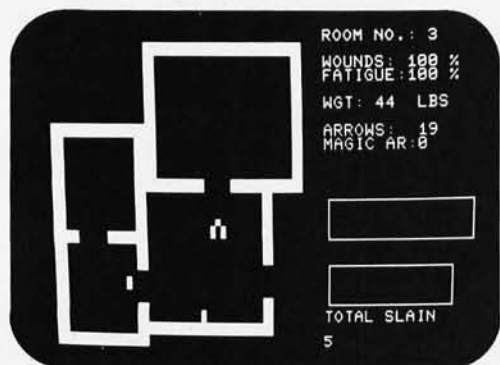
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Actual photo of screen during a Dunjonquest game. In Room 3 in the Temple of Apschai, our hero observes two treasures unattended by dragons, monsters or demons... for the moment. He is completely free of wounds; he is not at all fatigued. He carries 44 pounds of armor and 19 arrows in his quiver. He has already slain five demons. Will he capture the treasures before moving on... or before the forces of darkness intercept him?

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cursor's horizontal position (the bit pointer remains the same), but the cursor is moved down one row. Similarly, the fourth toggle switch subtracts hexadecimal 08 from the byte pointer. This makes the cursor move one row upward.

Only after the toggle switches have been completely scanned are the values in the temporary pointers transferred to the permanent pointers, and the cursor moved to its new position. This makes motion on the diagonal possible without visible up-and-across motion on the way to the new position. If all four toggles are actuated, the cursor does not move. The four motions cancel one another before any information is transferred to the permanent pointers.

The fifth toggle switch determines whether the bit written into the cursor position will be a white dot or a blank space.

Operation of Subroutines

Two subroutines accomplish the transfer of information from temporary to permanent pointers and the final writing of the cursor bit onto the screen. If the fifth toggle is actuated, subroutine BNKWRT does the job and writes a 0 (blank) into memory at the cursor position. If the fifth toggle

is not actuated, the job is done by DOTWRT, and the cursor leaves a white dot behind in memory and on the screen.

A third subroutine, DELAY, slows the process down so that you can direct the cursor intelligently on the

screen. The execution time for DELAY (and thus the speed at which things happen) is determined completely by the constant that begins at memory location 0046. You increase or decrease this constant to slow the program or speed it up.

Text continued on page 224

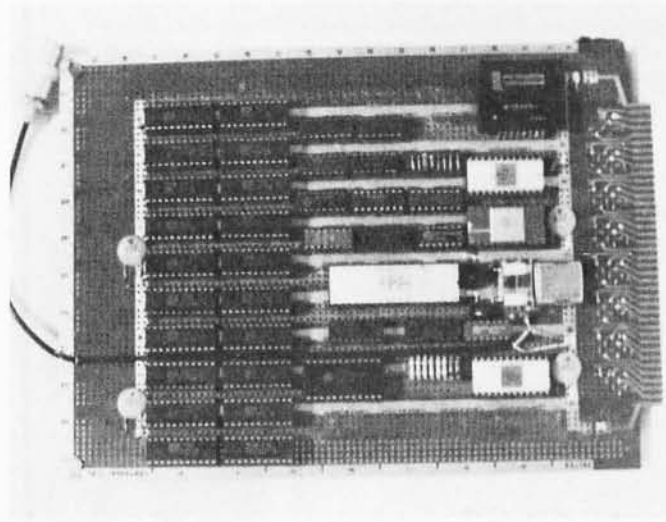


Photo 3: Component side of the processor board. The video signal is brought off the board by the miniature 75-ohm coaxial cable.

Register	High Byte	Low Byte
0	Direct-memory-access pointer	Direct-memory-access pointer
1	Interrupt program counter	Interrupt program counter
2	Stack pointer	Stack pointer
3	Main program counter	Main program counter
4		
5	BNKWRT program counter	BNKWRT program counter
6	DOTWRT program counter	DOTWRT program counter
7		
8	DELAY program counter	DELAY program counter
9	Temporary byte pointer	Temporary byte pointer
A	Inter-shift	Temporary bit pointer
B	D storage	Permanent bit pointer
C	Permanent byte pointer	Permanent byte pointer
D		Permanent bit pointer
E	Blanking pointer	Blanking pointer
F	Delay-timing constant	Delay-timing constant

Table 1: Use of COSMAC 1802 16-bit registers by Video Doodler program.



Photo 4: Display produced using the Video Doodler. The isolated dot at the center right is the winking cursor.

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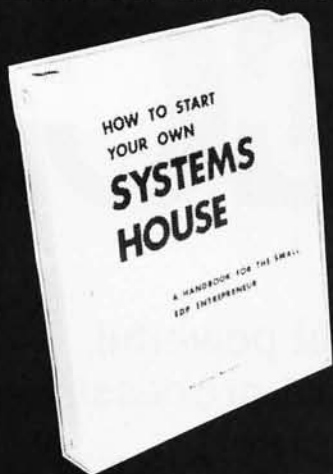
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Listing 1: Video Doodler program in machine code for the COSMAC ELF.

Address	Hexadecimal Code	Comments
00	F8 00 B1 B2 B3 B5	Initialize high-order registers and byte pointers
06	B6 B8 A9 AB	
0A	F8 01 B9 BB BD	
0F	F8 80 AC AA	Initialize bit pointers
13	F8 28 A1	Initialize interrupt PC
16	F8 FF A2	Initialize stack pointer
19	F8 66 A3	Initialize MAIN PC
1C	F8 5A A5	Initialize BNKWRT PC
1F	F8 4F A6	Initialize DOTWRT PC
22	F8 45 A8	Initialize DELAY PC
25	D3	Begin executing MAIN PC
INTERRUPT		
26	72 70	Restore D, X, & P
28	22 78 22 52	Push P, X, & D onto stack
2C	C4 C4 C4	NOP s for sync delay
2F	F8 01 B0 F8 00 A0	Re-point R0 to display page
35	80 E2	Prepare for first DMA cycle
37	E2 20 A0	DMA reset
3A	E2 20 A0	DMA reset
3D	E2 20 A0	DMA reset
40	3C 35	Test for refresh done
42	30 26	Go to return
DELAY		
44	D3	Return to MAIN
45	F8 07 BE	Load timing constant into RE
48	2E	Decrement RE
49	9E	Load RE.1 into accumulator
4A	3A 48	Loop again if not done
4C	30 44	Go to return
DOTWRT		
4E	D3	Return to MAIN
4F	89 AB	Update byte pointer
51	8A AC	Update bit pointer
53	EB	X = B
54	F1	Combine bit pointer & screen via OR
55	5B E2	Write dot to screen
57	30 4E	Go to return
BNKWRT		
59	D3	Return to MAIN
5A	89 AB	Update byte pointer
5C	8A AC	Update bit pointer
5E	FB FF	Inverts D via XOR IMMEDIATE
60	EB	X = B
61	F2	Combine bit pointer & screen via AND
62	5B E2	Write blank to screen
64	30 59	Go to return
MAIN		
66	E2 69	Turn CDP1861 on
68	3F 75	Skip clearing routine unless INPUT pressed
6A	F8 FF AD	Point RD to top of display page
6D	ED	X = D
6E	F8 00 73	Store 00 on screen & decrement pointer
71	8D	Load pointer into D
72	3A 6E	Loop again if not done
74	5D	Store 00 in last byte of display page
75	E2 6C	Input toggles
77	F6 33 89	Tests "move right" bit & branches
7A	F6 33 98	Tests "move left" bit & branches
7D	F6 33 A7	Tests "move down" bit & branches
80	F6 33 AF	Tests "move up" bit & branches
83	F6 3B B7	Tests dot/blank bit
86	7B	Turn Q on
87	30 B7	Go to EXECUTE
89	BA	Store D in RA.1
8A	8A	Fetch temporary bit pointer
8B	F6 33 92	Shift right and test for border cross

Listing 1 continued on page 224

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- Bidirectional printing at 150 cps.
- Tractor-feed forms, 3" to 15" wide.

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DEC LA 34

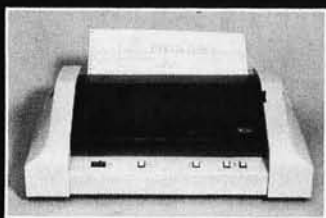
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Listing 1 continued:

8E	AA				Update bit pointer
8F	9A	30	7A		Put old D back in D & return to shift & test
92	19				Increment temporary byte pointer
93	76				Shift bit back into other end of bit pointer
94	AA				Update bit pointer
95	9A	30	7A		Put old D back in D & return to shift & test
98	BA				Store D in RA.1
99	8A				Fetch temporary bit pointer
9A	FE	33	A1		Shift left and test for border cross
9D	AA				Update bit pointer
9E	9A	30	7D		Put old D back in D & return to shift & test
A1	29				Decrement temporary byte pointer
A2	7E				Shift bit back into other end of bit pointer
A3	AA				Update bit pointer
A4	9A	30	7D		Put old D back in D & return to shift & test
A7	BA				Store D in RA.1
A8	89				Fetch temporary byte pointer
A9	FC	08			Add 08 to D & put sum in D
AB	A9				Update byte pointer
AC	9A	30	80		Put old D back in D & return to shift & test
AF	BA				Store D in RA.1
B0	89				Fetch temporary byte pointer
B1	FF	08			Subtract 08 from D & put difference in D
B3	A9				Update byte pointer
B4	9A	30	83		Put old D back in D & return to shift & test
EXECUTE					
B7	D5	D8	D6	D8	Generate one "wink" of cursor
BB	31	C0			Go to M(C0) if Q is on
BD	D6				Call DOTWRT & write on screen
BE	30	68			Go to test for clear
C0	D5				Call BNKWRT & write on screen
C1	7A				Turn Q off
C2	30	68			Go to test for clear

Text continued from page 220:

One novel effect may be produced by changing the sequence of bytes beginning at location 0046 to 01, AE, 2E, 8E. This permits the program to run at maximum speed. The cursor will streak across the screen almost too quickly for the eye to follow. As you flip the toggle switches up and down, it will paint a crazy-quilt pattern across the screen.

To clear the screen, simply hold INPUT depressed while flipping RUN up. This branches to a simple routine that writes zeroes consecutively in memory from the top of the displayed page on down.

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Book Reviews

TRS-80 Assembly Language Programming

William Barden Jr
Radio Shack, 1979
224 pages, softcover
\$3.95

"The goal of this book is to take a TRS-80 user

familiar with some of the concepts of programming in BASIC and introduce him to TRS-80 assembly language." With that statement in the preface, Mr Barden proceeds to do exactly that. He introduces the user of the Radio Shack TRS-80 computer to that mysterious element of programming called assembly language.

For you old-timers, *TRS-80 Assembly Language Programming* is a refreshing review of how we used to program way back in the good old days. For you novices, perhaps discouraged after trying to debug a BASIC program, this book is the change of pace you need. Throw away, or at least put aside, that BASIC

user's manual, type in "SYSTEM" when the prompt character appears, and load that Editor/Assembler or TBUG tape you just bought. Now you are going to see what computer programming is all about!

Although the author states that the Radio Shack Editor/Assembler package or its equivalent is not a requirement, you will miss half the fun of reading this book if you do not have it. Also, TBUG is recommended by the author in order to fully appreciate some material.

Barden has developed a unique presentation to introduce and explain the general concepts of the TRS-80 assembly language, the mnemonic system for the Z80 microprocessor. I say a unique presentation because this is the first assembly-language book which I have enjoyed reading. Barden is not averse to injecting a little humor into his writing. After all, who says that programming books should be all bits, bytes, and syntax restrictions?

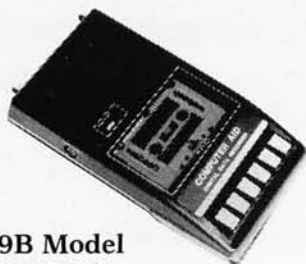
Barden begins with the architecture of the Z80, its instruction set, and its addressing modes. He then proceeds through the Editor/Assembler and the TBUG commands and formats in the first section of the book.

There is quite a bit of information packed within these first eighty-four pages, and it pays to read through Section 1 with a highlighting marker in hand. In fact, I skimmed through these pages for my first reading and then reread them more carefully the second time. This method tends to fix certain important details in your mind and will act as a referencing tool.

After you feel confident with the introductory material, move on to Sec-

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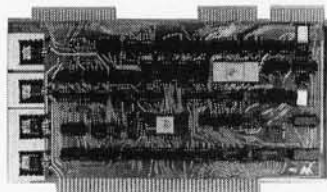
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tion 2. Barden not only explains the how and the why of assembly language, but does so with useful examples of assembly-language coding. When he explains how to move data, he does it by coding the instructions and discussing the pertinent background. Arithmetic and comparison operations, logical and bit operations, shifting, strings, and tables are explained and presented with appropriate coding. If you have TBUG

or Editor/Assembler, you can code along with the text and actually see the operations being executed. This interactive approach works well.

In *TRS-80 Assembly Language Programming*, Barden handles the discussion of input/output (I/O) operations in an easily readable, yet informative fashion. After you complete this phase of your education, the mystery of assembly language magically

evaporates, and you are ready to tackle some sophisticated assembly-language programming.

But that's not all. Barden ties together most of the loose threads by including some interesting and useful subroutines. If you want a quick routine to fill a block of memory with any given 8-bit value or move the contents of a block of memory from one area to another, you need only assemble the subroutines already coded

for you and presented in the book.

Some arithmetic subroutines are also given: adding or subtracting operands containing up to 256 bytes, and multiplying or dividing 16-bit numbers. The compare subroutine is useful since it compares two 8-bit operands in true algebraic fashion. A routine for converting an 8-bit value into two American Standard Code for Information Interchange (ASCII) characters is included, as is a search subroutine. Finally, three subroutines that operate in a manner similar to the SET, RESET, and POINT statements in BASIC are given in the book.

Barden offers four complete assembly-language programs to start your program library off on the right foot. These perform the functions of writing data to the screen (good for looking at the contents of memory locations), moving patterns at high speed (great for animated graphics), a graphic bubble sort (good for demonstrations), and a program to play music via the cassette output port.

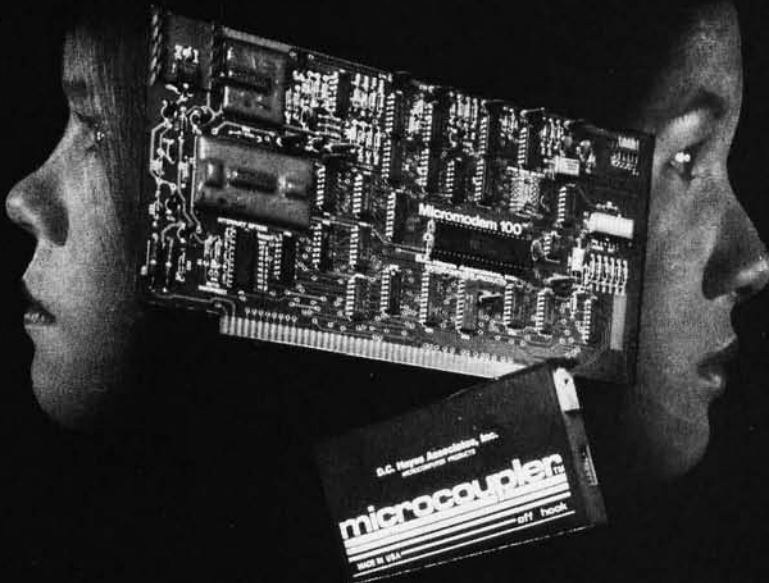
The appendices include a listing of the Z80 instruction set and a listing of the Z80 op codes. (For quick reference to Z80 mnemonics, Zilog offers the *Z80-CPU Programming Reference Card*, which I have found more convenient to use than flipping through the pages of a book.)

One further note: William Barden is also the author of *The Z80 Microcomputer Handbook* (Howard W Sams Co Inc, 1978), which takes the Z80 software a few steps deeper into the assembly-language forest.

So, what can you get for \$3.95 in addition to Barden's excellent introductory text dealing with Z80 assembly-language programming? Quite possibly you will get a hard-to-shake bite from the assembly-language bug. ■

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Clubs and Newsletters

Newsletter for Ohio Scientific Users

The OSI Users' Independent Newsletter is edited, published, and written by Charles Curley, 6061 Lime Ave, Number 2, Long Beach CA 90805. A year's subscription is \$10 for six issues. The newsletter includes

articles on software, hardware, bugs and fixes, and reviews of items of interest to OSI users. Articles are welcome from enthusiastic owners and users.

Salem, Oregon Area Computer Club

Club membership is open to all those that are in-

terested in using microcomputers for fun and business. Membership dues are \$5 per year. The club meets the first Monday of each odd-numbered month at McKinley Community School, 461 McGilchrist St, Salem, Oregon. On even-numbered months, they meet at Computer Pathways Unltd Retail Store, 831 Lan-

caster Dr, Salem, Oregon. A monthly newsletter is published. Each meeting features a presentation by a club member or invited guest. For information, contact Salem Area Computer Club, c/o Doug Walker, 4554 Jan Ree Dr NE, Salem OR 97303.

North London Hobby Computer Club (NLHCC)

The NLHCC has scheduled their meetings for the next 3 months. The theme for the May meeting is "Computer-Aided Instruction." The meeting will be held May 7 at 7 PM in the Students Common Room in the Polytechnic of North London. On June 4, the meeting is entitled "The House Computer." July third's meeting is on "The Personal Computer and Restel/Teletext." Contact NLHCC, Holloway, London N7 8DB, ENGLAND.

TRS-80 Users Group of Sacramento

The TRS-80 users group of Sacramento meets at the Sacramento Country Branch Library, 2443 Marconi Blvd (Marconi and Fulton), Sacramento, California, from 7 to 10 PM as called. For more information, contact the TRS-80 Users Group of Sacramento, POB 255704, Sacramento CA 95825.

University of New Hampshire Computer Services Newsletter

On Line is a well-produced newsletter covering software programs, schedules of events and other activities of interest to students in the computer programs. For more information, contact Computer Services, University of New Hampshire, Kingsbury Hall, Durham NH 03824.



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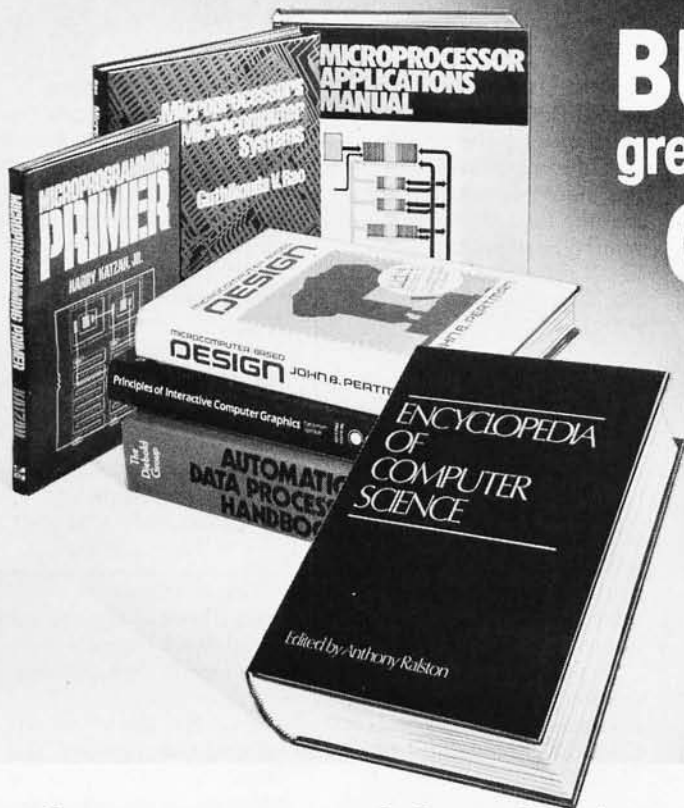
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786/585 Pub. Pr., \$14.95 Club Pr., \$11.95

HANDBOOK OF OPERATIONAL AMPLIFIER CIRCUIT DESIGN By D. F. Stout, edited by M. Kaufman
617/97X Pub. Pr., \$29.95 Club Pr., \$17.50

ANALOG SYSTEMS FOR MICROPROCESSORS AND MINICOMPUTERS By P. H. Garrett
786/496 Pub. Pr., \$18.95 Club Pr., \$14.95

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Edited by A. Ralston & C. L. Meek
769/01X Pub. Pr., \$60.00 Club Pr., \$39.95

MICROPROCESSOR AND MICROCOMPUTER SYSTEMS By G. V. Rao
783/659 Pub. Pr., \$24.50 Club Pr., \$19.50

THE Z-80 MICROCOMPUTER HANDBOOK By W. Barden, Jr.
784/914 Pub. Pr., \$8.95 Club Pr., \$7.60

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Central Oklahoma
Amateur Computing
Association (CENOACA)

CENOACA meets the second Saturday of each month at the OSU Technical Institute, 900 N Portland, Oklahoma City, Oklahoma, at 10 AM. Their purpose is to acquaint beginners with personal computing and increase their knowledge of special interest areas, including SwTPC and 6800 systems. Their newsletter, *CENOACA Newsbits*, is published on an irregular basis. Contact CENOACA, POB 2213, Norman OK 73070.

Another Group in Florida

The Space Coast Microcomputer Club meets on the fourth Thursday of each month at 7:30 PM in the Merritt Island Public Library Auditorium. They are affiliated with the JF Kennedy Space Center at

Cape Canaveral. The group publishes *Enterprise*, a monthly newsletter. The primary interests are Z80, 8080, and S-100 systems. Dues are \$5 per year, and inquiries should be sent to Ray O Lockwood, 315 Inlet Ave, Merritt Island FL 32952.

APL Newsletter

A quarterly newsletter describing tools, techniques, services, and containing general news of interest to APL users, is being published by Southwater Corp, 2348 Whitney Ave, Mt Carmel CT 06518. Subscriptions are \$6 annually and requests should be sent to *APL Market Newsletter*, at the above address.

Newsletters on the UCSD
Pascal System

The Institute for Information Systems is publishing

newsletters describing the UCSD Pascal System developed by the University of California, San Diego. For more information, contact the Institute for Information Systems, mail code C-021, University of California, San Diego, La Jolla CA 92093.

Apple Users Group

The Goldcoast Computer Apple II Users Club desires additional members. The group publishes a monthly newsletter with programming tips, and they have a library selection of over 1000 programs. Send for details: Florida's Goldcoast Computer Apple II Users Club, 133 Brenda St, Milton FL 32570.

Feedback From Fujitsu

Feedback From Fujitsu is a

newsletter from Fujitsu Limited, Japan's largest computer manufacturer. It contains items concerning discoveries and general business news of Japan's strides in the computer industry. For more information, contact *Feedback From Fujitsu*, Ruder and Finn Inc, 110 E 59th St, New York NY 10022.

Association for
Computers and the
Humanities

This international organization is devoted to the study of computer applications in language and literary studies, history, musicology, the visual arts, cultural anthropology, and other related social sciences. Members of the association are entitled to discount at the International Conference on Computers and the Humanities and the meetings of the Association for Literary and Linguistic Computing. The annual dues are \$15, and a quarterly newsletter is available for \$15 per year. For details, write Association for Computers and the Humanities, Queens College, Flushing NY 11367.

Computers and
Gambling Magazine

This quarterly magazine is oriented toward computer hobbyists interested in using computers for all types of handicapping systems, card counting systems, and techniques for stock and future markets investments. Articles describe products and techniques for the computerized gambler, and advertising of products and personal computers is included. Sample issues are available for \$1. Subscriptions are \$5 per year and may be obtained by writing to Joe Computer, 22713 Ventura Blvd, Suite F, Woodland Hills CA 91364. ■

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Observations from BYTE's Ongoing Monitor Box, The BOMB

As the card says, BYTE's BOMB is your direct line to the editor's desk. Ever since the third issue of BYTE (November 1975), BYTE's editors have used the BOMB as an important source of information on how readers react to our magazine. Therefore we thank the readers who have mailed the BOMB card to us and included their comments.

Occasionally we like to share with you some of the more interesting responses received on these cards. The most pictorial BOMB card in recent memory came from a reader in Hackensack, New Jersey, shown front and back in photos 1 and 2. It seems our friend in New Jersey was generally pleased with our January 1980 issue.

Regretfully not all of our readers have been as well pleased. On one February 1980 BYTE BOMB card

most of the articles were rated as being of poor quality, and a single word appeared in the "Comments" section: "PHOOEY." Yet another BOMB card for February said: "Your best issue in my 3 years!!" Clearly, a split decision.

If you have wondered when we stop accepting BOMB cards for a given issue, we cut off tabulation during the second week of the month after the cover date of an issue.

If you have never sent in a BOMB card, but intend to do so, please observe the following points. The card should be sent to our offices in Peterborough, New Hampshire. The card is presently not postpaid, but \$0.10 US postage will suffice for most readers. The card is intended to record your subjective opinion, so just write your reaction, and put any specific comments on the bottom of the card. You are free to remain anonymous, but you may put your name

and address on the card if you wish. In any case, letting us know your responses to our work helps us to work better. . . .RSS

The Largest Computer Store in America?

What is the largest personal computer store in America? The answer to that question is debatable, but on the East Coast, it's probably NEECO's (New England Electronics Company Incorporated) new facility in Needham, Massachusetts. The 9000-square-foot showroom was filled with a variety of hardware and software on our recent visit. President Robert Crowell told us about their new nationwide distribution subsidiary, called Microamerica, which was announced last fall and carries most of the major computer product lines.

We have noticed a marked increase in the

number of large computer stores like Bob Crowell's with diverse product lines. This supermarket-like approach can be beneficial to the industry when combined with personal service to customers—a vital ingredient to any store's success.

In the West, things are also humming in the personal computer store field. Micro-Age in Tempe, Arizona, is a good example. Run by Jeff McKeever and Alan Hald, Micro-Age has been expanding. We were favorably impressed by their facility and by their approach to the market during a recent visit. . . .CM

Texas Instruments Has an Award Winning Bubble Memory

Texas Instruments has been awarded the 1979 Information Product of the Year Award for its Model 763 Bubble-Memory Data Terminal and Model 765 Portable Bubble-Memory Data Terminal. Both terminals have a full, 128-character, alphanumeric keyboard. Up to 80,000 characters can be collected and stored in the nonvolatile bubble memory, then transmitted at rates from 110 to 9600 bits per second (bps) to a host computer system. Both units have a quiet 30-character-per-second (cps) print speed and built-in acoustic coupler modem.

A bubble memory is a small electromagnetic circuit that stores digital information by changing the magnetic polarity of a thin, crystalline film. The bubbles are cylindrical magnetic islands polarized in a direction opposite from that of the film. Bubble memory has no moving parts, and, because it works magnetically, retains information when the power is turned off. It offers higher access



Photo 1

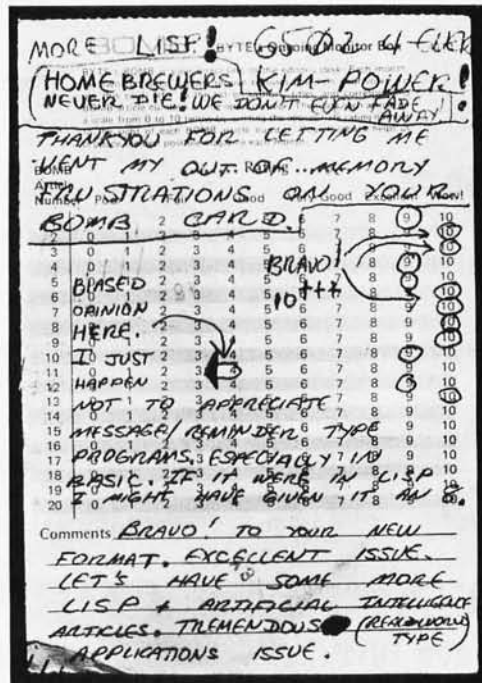


Photo 2

"THE CREATOR®"

By Complete Business Systems, Inc. Software Division

High level language program generator develops complete programs in "Basic".

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Now available for TRS-80®, TRS-80 Model II®, Apple II®, Tandy 10®, Adds System 70 or 75®.

IF you are one of the many who bought a micro-computer in the belief that with just a little studying you could write your own programs, you now know that you can't.

IF you, as a businessman, thought you could have stock software modified at a reasonable cost with reasonable results, you know that's not possible either.

IF you are a hobbyist getting tired of the untold hours it takes to write a program, only to find it takes more hours to debug than to write . . .

IF you are a skilled programmer you don't have to be reminded of the repetitious time spent on each new application.

IF you have left your micro-computer sitting somewhere gathering dust . . . meet **"THE CREATOR®"**.

"THE CREATOR®" is not just another data base generator!

"THE CREATOR®", at your direction, makes complete running programs that are thoroughly documented, easy to modify at any time by YOU!

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Q. After "THE CREATOR®" has produced a program, can it be modified?

A. Yes, the resulting program is modular, fully documented and readily accessible for alterations or deletions.

Q. Does the program created use so much disc space that there is very little space left for record storage?

A. No, the code produced is extremely compact despite complete documentation. If requested **"THE CREATOR®"** will even "pack" or compress information. You may even delete the "remarks" making it even more space efficient.

Q. Must I be expert or even conversant with Basic Language?

A. No, all questions to and answers from the operator require no computer language knowledge, simple every day English will do.

Q. What about math ability?

A. If you can count your fingers and toes, you'll have no problems.

Q. Will the programs which I produce with "THE CREATOR®" be bulky, slow or amateurish?

A. No, the resulting programs will be sophisticated and extremely fast operating. For example, should you create a mailing list or inventory program, the time for any record to be retrieved and displayed from a full disc would take a maximum of 1 second.

Q. Must the programs produced conform to a pre-determined format and file length?

A. No, you determine format and file size to fit your requirements. You may have as many as 22 fields or as few as 1.

Q. Can I develop my own business programs?

A. For the most part, yes.

Q. What are the limitations? What programs can I produce with "THE CREATOR®"?

A. Your own ingenuity and hardware limitations.

Q. Will future versions of "THE CREATOR®" make my present copy obsolete?

A. The purchase price includes your original diskette and user instructions. Your program is registered in your name. For a period of one year from the date of purchase you will be entitled to receive FREE any improvements or modifications. The only expense to you will be a new diskette charge (if applicable), packaging and mailing.

TECHNICAL ASPECTS

- Record access by a hashing algorithm guaranteeing fast record retrieval.
- Duplicate keys permitted.
- Record deletion automatically supported.
- Record access and file maintenance is user transparent.
- Minimal disc overhead since there is no special assembly language routine called. No "Basic" overhead.
- Programs produced can be transported between 6800, 6502, 8080, Z80, 8085, 8086 and Z8000 based systems.
- Can be used with Micro-Soft Basic and CP/M systems.
- On TRS-80 has automatic blocking for maximum number of records per disc.
- Complete file maintenance including up-date of any record in any field, delete and add new records even with duplicate key.

We are seeking qualified dealers and distributors to handle our growing software lines. Address inquiries, on your company letterhead, to: Complete Business Systems, Inc., Software Division, 9420 W. Foster Ave., Chicago, Illinois 60656.

Enclosed is my check (or money order) in the amount of \$250.00. Please send me my serial numbered, registered copy of **"THE CREATOR®"** as soon as my check clears. (No wait for Certified checks, bank checks or money orders.) Sorry, no credit cards accepted.

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 Computer make _____ Model _____

speeds, smaller size, and less weight and power consumption over paper-tape, cassette and floppy-disk systems. Bubble memory terminals can access any indexed record in memory in less than 15 ms (ie: 10 times faster than a floppy disk). If the data location is unknown, the character-string-search speed is 1000 cps, about 4 times the speed of a cassette search.

For more information, contact Texas Instruments, POB 1444, M/S 7784, Houston TX 77001.

The Fifth Annual California Computer Swap Meet

The Fifth Annual California Computer Swap Meet will be held on June 1, 1980, from 10 to 6 PM at the Santa Clara County Fairgrounds (344 Tully Rd, San Jose CA). Last year's event, held in September at the San

Mateo County Fairgrounds, was attended by over 3000 buyers.

Personal computing hardware and software will be sold by individuals, computer manufacturers, and computer stores. New software and hardware, as well as used, will be offered by vendors and individuals who have cleaned out their back rooms and garages for the event. Admission is free to buyers. Contact the Fifth California Computer Swap Meet, POB 52, Palo Alto CA 94302, or call 415-324-2404.

Inexpensive Communications Via Meteor Trails

The hundreds of millions of meteors that enter the earth's atmosphere every day leave in their wake a very inexpensive communications medium—the meteor trail. This band of ionized

particles is an effective alternative to satellites for communication. Meteor trails can be used to relay data concerning icebergs, pollution, earthquakes, and oil reserves, and can link remote villages with distant sources of supplies and emergency assistance.

Meteor burst transmission has proven reliable and cost-effective for the snow telemetry program operated by the US Department of Agriculture's Soil Conservation Service. By transmitting snowfall data from remote locations, the program has eliminated costly manual measurements.

Meteor burst transmission systems work in several stages. Remote sensors gather data while a microprocessor-controlled station emits a continuous radio signal, which bounces off a meteor trail whenever one occurs within range. When this signal reaches a transceiver at a remote site,

data is transmitted via the meteor trail to the central station.

For more information, contact SRI International, 333 Ravenswood Ave, Menlo Park CA 94025. ■

BYTE's Bugs

Escher's Nationality

I was interested in the February 1980 BYTE cover and in Carl Helmers' editorial concerning the Euler Problem of Königsberg. I immediately noticed when I received the issue the similarity of the cover painting to Escher's work. However, I must take argument concerning the statement that Escher was a Swiss artist.

Maurits C Escher was born on June 17, 1898 in Leeuwarden, Netherlands, and died March 27, 1972 in Laren, also in the Netherlands. He was in fact a Dutchman whose works are almost revered today in the Netherlands. I certainly commend artist Robert Tinney for combining two of Escher's more famous prints *Drawing Hands*, from January 1948, and *Reptiles*, from March 1943. However, the sequence of reptiles in Escher's original work came around and completed the cycle, by returning to the flat paper, whereas these "dragons" seem to disappear around the corner.

Naturally, the Towers of Hanoi did not go unnoticed either.

My commendation to Mr Tinney, but I think that the history of Escher, who may have been the world's greatest graphic artist, should be given correctly.

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Microprocessor Training Courses, Cudham Hall, Cudham, Sevenoaks, Kent, ENGLAND. Microprocessor familiarization, microprocessor applications for the equipment user and for the manufacturer, and microprocessor-based equip-

ment design and development are the courses being offered by the Sira Institute Limited. Write to Conference and Courses Unit, Sira Institute Ltd, South Hill, Chislehurst, Kent BR7 5EH ENGLAND.

May 1-2

Programming Language Technology and Ada, San Francisco CA. Conducted by Anthony Wasserman, the

conference will discuss concepts of programming languages including those which support Ada language definition and development activity. The course costs \$450. Registration information is available from Software Research Associates, POB 2432, San Francisco CA 94126.

May 5-7

Software Principles for Management, San Francisco CA. The course is intended for managers who need to understand what software is and how to utilize it properly. Registration is \$675, and

additional information is available from Technology Transfer Institute, POB 49765, Los Angeles CA 90049.

May 5-7

Data Communications, George Washington University Library, 2130 H St. NW, Washington DC. This course is intended to highlight major data communication services available, the basic choices in designing a data communications network, and essential engineering aspects of data communications. It is intended for systems analysts, engineers and managers. Contact the Director, Continuing Engineering Education, George Washington University, Washington DC 20052. The course fee is \$510.

May 6-10

The Eighth Annual Canadian Association for Information Science, Toronto, CANADA. Technology, commodity, and rights are the themes of this conference. Topics will cover information in the marketplace, information transfer and policy issues, right to access, new information technologies and applications, and other subjects. For more information, contact the Program Chairman, Eighth Annual CAIS Conference, Technical Information Centre, Bell Northern Software Research, 12th Floor, 522 University Ave, Toronto, Ontario M5G 1W7 CANADA.

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, 70 Main St, Peterborough NH 03458. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

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Data Communications, Worcester Polytechnic Institute, Worcester MA. This seminar is designed to help professionals develop an effective data communications system. Network design, requirements, software, diagnostics, and controls are some of the issues to be covered. The fee is \$375 which covers everything except hotels. For information, contact Office of Continuing Education, Worcester Polytechnic Institute, Worcester MA 01609.

May 13-15

Microprocessors: New

Directions for Mankind, Albuquerque NM. This symposium will deal with a variety of microprocessor applications. It is part of the Ideas in Science and Electronics Show. Contact J Arlin Cooper, Div 2331, Sandia Laboratories, Albuquerque NM 87185.

May 13-15

Electro/80 Show and Convention, Hynes Auditorium and Boston Sheraton, Boston MA. This show consists of presentations and exhibitions by computer industry manufacturers. Contact Electronic Conventions

Inc, 99 N Sepulveda Blvd, El Segundo CA 90245.

May 13-16

The Ninth Annual Conference of MUMPS Users Group, Islandia Hyatt House, San Diego CA. This meeting will bring together scientific, medical, and business professionals to discuss current research and application development. Areas of participation are paper presentations, workshops and tutorials, and vendor exhibits. Contact Dr Jack Bowie, MUG 80 Program Chairman, The Mitre Corp, Mail Stop 641,

1820 Dolley Madison Blvd, McLean VA 22102.

May 21-22

The Second Clemson Small Computer Conference, Clemson University, Clemson SC. This program will consist of presentations, discussions and an exhibition. Emphasis will be placed on business, industry, engineering, science, and education. For registration information, contact J K Johnson, Continuing Engineering Education, Clemson University, Clemson SC 29631. For general information, contact W J Barnett, Electrical and Computer Engineering Dept, Clemson University, Clemson SC 29631.

May 21-23

Business and Personal Computer Sales-Expo 80, Philadelphia Civic Center, Philadelphia PA. This show is aimed at a wide range of interests in business and any other area that has a need for computers and computer-related products. Exhibitors will be giving demonstrations of equipment. Contact Produx 2000 Inc, Roosevelt Blvd and Mascher St, Philadelphia PA 19120.

May 23

The Digital Computer Association, Annual Meeting, Pacifica Hotel, 6161 Centinela Blvd, Culver City CA. A slide show, followed by dinner and an evening program, are the main events of the meeting. The price is \$15 prepaid. Send reservations to Mary Rich, 731 Bayonne St, El Segundo CA 90245.

May 24-25

Amateur Radio and Computer Hobbyists Second Annual Convention, Cervantes Convention Center, St Louis MO. Speakers, presentations, equipment displays, and a flea market will be featured. For more information, contact the Gateway Amateur Radio Association Inc, POB 68, Marissa IL 62257.

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SIMULATION, Volume II (BYTE Publications): \$6.00

VALDEZ

Price: \$14.95 postpaid

A simulation of supertanker navigation in the Prince William Sound and Valdez Narrows. The program uses an extensive 256X256 element radar map and employs physical models of ship response and tidal patterns. Chart your own course through ship and iceberg traffic. Any standard terminal may be used for display.

BRIDGE 2.0

Price: \$17.95 postpaid

An all-inclusive version of this most popular of card games. This program both BIDS and PLAYS either contract or duplicate bridge. Depending on the contract, your computer opponents will either play the offense OR defense. If you bid too high the computer will double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and is an excellent learning tool for the bridge novice.

HEARTS 1.5

Price: \$14.95 postpaid

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.

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Price: \$14.95 postpaid

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.

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Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

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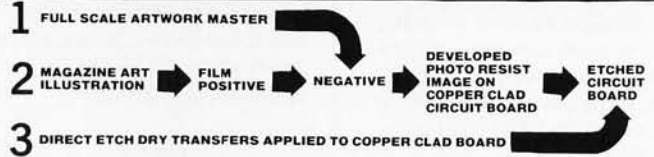


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May 31

Amateur Radio Fair, Minnesota State Fairgrounds, St Paul MN. The North Area Repeater Association is sponsoring this swapfest and exposition for personal computer enthusiasts and radio amateurs. There will be free overnight parking for self-contained campers on May 30. The admission is \$3. For information, write Amateur Radio Fair, POB 30054, St Paul MN 55175.

May 31-June 1

Microcomputers and the Physician's Office, Hyatt Regency Hotel, San Francisco CA. This seminar will provide a realistic look at microcomputer applications in the private practice. Contact Medical Data Systems, POB 193, Ojai CA 93023.

JUNE 1980

June 2-4

Improving Productivity and Distributed Data Entry,

Sheraton Center, New York NY. The conference and seminar schedule includes discussions on word processing, data processing, future directions of data entry, improving data entry productivity, automated offices, installing a data-entry incentive system, and more. Contact Data Entry Management Association, POB 3231, Stamford CT 06905.

June 4-5

Microprocessors: Hardware, Software, and Application, Holiday Inn, Boston MA. This course is recommended for technical professionals who need an understanding of microprocessors in relation to their corporate and business careers. Contact Office of Continuing Education, Worcester Polytechnic Institute, Worcester MA 01609.

June 4-6

Salon de l'Ordinateur Computer Show, Place Bonaventure, Montreal, CANADA. This exhibition will feature

over eighty manufacturers' hardware and software.

For more information, contact Industrial Trade Shows of Canada, 36 Butterick St, Toronto, Ontario M8W 3Z8 CANADA.

June 9-13

Microcomputer Workshop, Carnegie-Mellon University, Pittsburgh PA. Engineers, research scientists, educators, and managers will benefit from this course. It covers all aspects of microcomputers and software. Hands-on-training will be provided. The tuition is \$585 and housing can be arranged. Contact the Post College Professional Education, Carnegie-Mellon University, Pittsburgh PA 15213.

June 14

Microcomputers in Business and The Professions: Systems Selection, Butler University, 4600 N Sunset Ave, Indianapolis IN. This seminar will cover various types of hardware and soft-

ware, how to evaluate the kinds and performances of computers, and their applications in business and home use. The registration fee is \$75. For information, contact College of Business Administration, Butler University, 4600 N Sunset Ave, Indianapolis IN 46208.

June 15-18

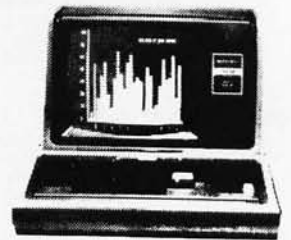
International Summer Consumer Electronics Show, McCormick Place, McCormick Inn, Pick-Congress Hotel, Chicago IL. The Consumer Electronics Show (CES) will feature exhibits from many companies; seminars and discussions; and items ranging from televisions, tape recorders, telephones, and translators, to computers, component systems, auto sound systems, and electronic games will be displayed. Attendance is limited to dealers and the press. Contact Consumer Electronics Shows, Two Illinois Center, Suite 1607, 233 N Michigan Ave, Chicago Il 60601.



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June 16-20

Data Flow Concepts in Computer Language and Architecture, Massachusetts Institute of Technology (MIT), Cambridge MA. MIT's program will cover principles of data flow computer organization and programming language design and applications. Certain architectures will be covered and techniques will be discussed. Familiarity with languages and architecture is a prerequisite. The tuition is \$750. Living arrangements can be made through the school. Contact the Office of the Summer Session, Room E19-356, MIT, Cambridge MA 02139.

June 17-19

Data Comm, Palais des Expositions, Geneva, SWITZERLAND. Data communications and distributed-data processing are the main themes of this conference and exhibition. Software development and tools, computer languages, managing data-communications systems, and definitions,

concepts, and applications of data communications and distributed-data processing are some of the topics that will be covered in the conference.

For more information, contact Industrial and Scientific Conference Management Inc, 222 W Adams St, Suite 999, Chicago IL 60606.

June 18-21

Association for Computational Linguistics, University of Pennsylvania, Philadelphia PA. The meeting will cover theoretical and methodological problems of computational linguistics, speech acts, analysis of multisentence texts, dialogue, machine translation, and computational semantics. For further information contact Don Walker, Artificial Intelligence Center, SRI International, 333 Ravenswood Ave, Menlo Park CA 94025.

June 20-22

The Fifth Annual Computerfest, Franklin Universi-

ty, Columbus OH. Sponsored by the Midwest Affiliation of Computer Clubs, this is a gathering of interested hobbyists, professionals, and business-oriented computer users. Workshops and discussions are the main features of the conference. Contact James Crowley, 4008 Rickenbacker Ave, Columbus OH 43213.

JULY 1980

July 7-11

Computers and Related Products, Hyatt Regency Hotel, Seoul, KOREA. This show is limited to approximately forty firms for exhibition. For details, contact Robert Wallace, Rm 6015A, US Dept of Commerce, Industry and Trade Commission, Washington DC 20230.

July 14-16

Diagnostic Software: Planning and Design, Sheraton-Lexington Motor Inn, Lexington MA. The seminar is for design, test, and

diagnostic engineers. Design examples, lectures, informal sessions, and programming are part of the course. The fee is \$450. Contact Professor Donald French, Institute for Advanced Professional Studies, One Gateway Center, Newton MA 02158.

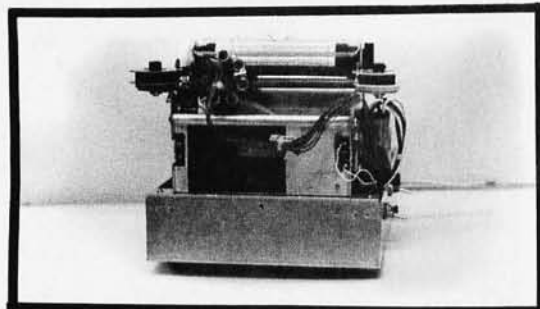
July 14-18

SIGGRAPH '80, Seattle Center, Seattle WA. Panel discussions and readings will be included in this conference. The topics will include graphic displays, animation/dynamics, cartography, input techniques, video and color hardware, and more. For general information, write to SIGGRAPH '80, POB 88203, Seattle WA 98188.

July 22-24

Microcomputer Show, Wembley Center, London, ENGLAND. New products will be exhibited, along with presentations of papers. For information contact TMAC, 680 Beach St, Suite 428, San Francisco CA 94109. ■

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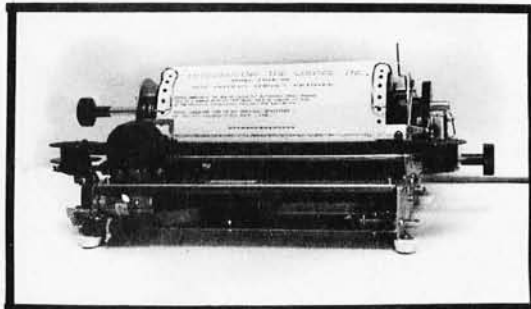


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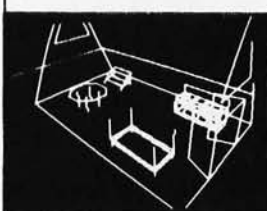
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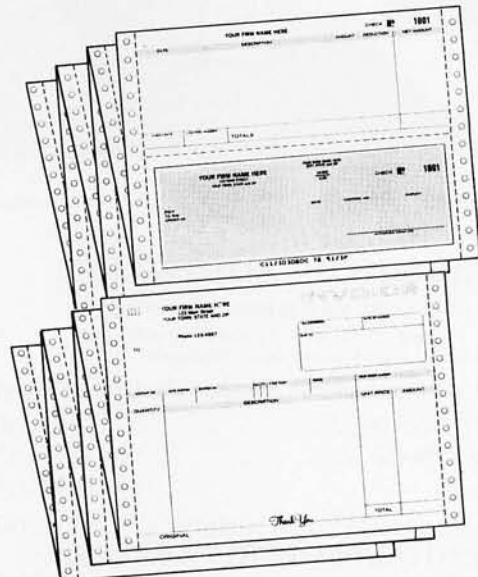


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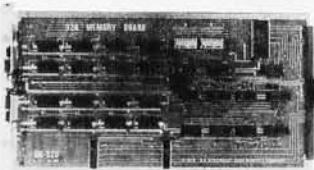
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An active error-checking and correcting system can go a long way toward solving the occasional problems that hamper the usefulness of low-cost data-storage devices (such as audio-cassette recorders). It offers a means of improving reliability in problem-plagued situations, and in cases where the error frequency is already sufficiently low, the checking and correcting system allows increased data densities and transfer rates with an overall gain in storage system performance. In a well-designed system, error detection and correction schemes can lead to marked reductions in loading times due to higher average data rates.

Figure 1 shows the connection of the active error-checking and correcting apparatus between the computer and the peripheral data-storage device.

The theoretical development of error-trapping and correcting codes is largely due to the efforts of Richard W Hamming, a mathematician who first published on the subject in the *Bell System Technical Journal* early in 1950. (See reference 1.) Now, thirty years later, *Hamming codes* still represent one of the more practical approaches to the error-correcting problem.

A particularly important aspect of

Hamming's work focused on his formulation of the concept of *code distance* (indicated by the letter D). This relates the uniqueness of (or "distance between") meaningful codes to the number of *simultaneous* errors (indicated by the Greek theta, θ) that can be detected and corrected.

Definition of Hamming Distance

The Hamming distance between any two words is defined as the number of bit positions in which they differ. In terms of logical processes this is merely the total number of bits set to logic 1 following an exclusive-OR operation between the two words, as shown in figure 2. Simple binary coding has a Hamming distance of 1. This unitary distance is precisely the source of the problem, because any given code value appears to be as valid as any other.

Normally, as a processor receives binary data from a peripheral device, no mechanism is present which can correct a bit inversion. If a bit is read erroneously, it will either invalidate the check sum and cause an error trap, or it will be loaded into main memory without detection, thus propagating the error. It may or may not be a critical fault.

Consider the following 4-bit code:

Symbol	Encoded Form bit 3210
0	0001
1	0010
2	0100
3	1000

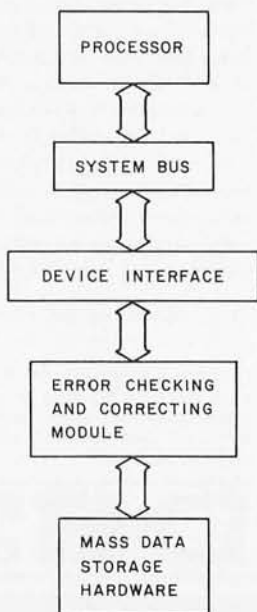


Figure 1: Block diagram showing interconnection of error-checking and correcting system with the computer.

This limited shifting pattern generates a code format with a Ham-

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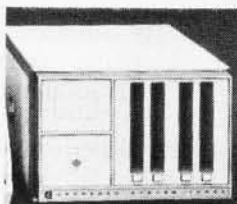
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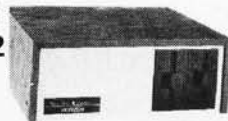
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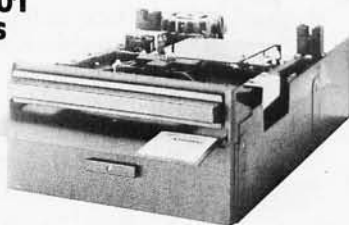
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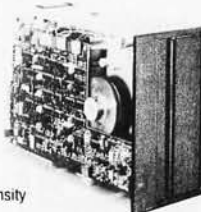
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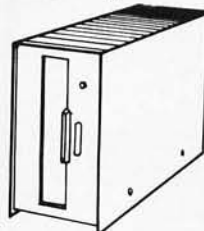
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01001111	}	10100110
11101001		
00000000	}	00000001
00000001		
00000000	}	11111110
11111110		
01010101	}	11111111
10101010		

Figure 2: The logical exclusive-OR function produces the output bytes shown in the right column from the input bytes shown in the left column. For each bit, the output bit is a 1 if and only if one of the input bits is a 1.

Hamming Distance (Minimum)	Capabilities
1	code uniqueness
2	single-error detection
3	single-error correction
4	single-error correction/double-error detection
5	double-error correction

Table 1: Minimum Hamming code distances necessary to obtain the listed properties in a particular coding scheme. Capabilities increase directly as Hamming distance increases (for small distances). Correction of an arbitrary number of errors requires a Hamming distance of at least twice the number of errors plus 1.

ming distance of 2. It is impossible to invert a single bit position and create any one of the other three valid words.

Symbol	Encoded Form
3	1000
	↓
INVALID	1100

However, if a dual error occurred, the code's error-detection capability would fail:

Symbol	Encoded Form
3	1000
	↓
2	0100

As indicated above, when the Hamming distance increases, the allowable number of simultaneous errors, θ , also rises. Errors can be trapped effectively as long as θ does not equal or exceed the Hamming distance minus 1 ($D - 1$). This should be clear, any sequence of

($D - 1$) errors will result in the generation of a meaningless code word if the distance between code words is given by D . No series of ($D - 1$) errors will produce a meaningful code.

Correcting Errors

Error-correction capability necessitates a larger Hamming distance, as shown in table 1. Any pattern of θ errors can be corrected if, and only if the Hamming distance D is greater than or equal to $(2\theta + 1)$. In this case, any received data word with θ errors differs from the transmitted, correct word in θ positions, but it also differs from all other meaningful words in at least $(2\theta + 1 - \theta)$, that is, $(\theta + 1)$ positions.

The erroneously received word therefore lies closer to the correct transmitted word than to any other possible word. Thus, it is possible to reconstruct the proper coding and recover the correct data word. To illustrate this point, the 4-bit code from the previous example does not meet the criterion of D greater than or equal to $(2\theta + 1)$, and is therefore uncorrectable. A single bit error in either of the two positions can lead to the same erroneous code:

Symbol	Encoded Form
3	1000
	↓
INVALID	1010
	↑
1	0010

Examination of the invalid code (1010) yields no information concerning what the correct pattern was initially. This meaningless value (1010)

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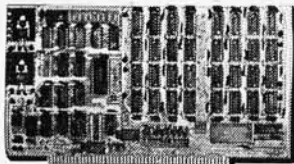
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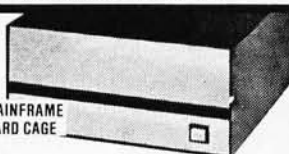
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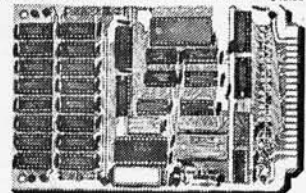


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could have been generated from an originally encoded 3 (pattern 1000), with an error in bit 1, or from an encoded 1 (pattern 0010) with an error in bit 3. Without any additional information, it is impossible to distinguish between these cases. Once an error occurs, although it can be trapped by searching for invalid codes, it cannot be corrected.

Now consider the correctable code:

Symbol	Encoded Form
0	00000
1	11101
2	11010
3	00111

Examination of this new code reveals a minimum Hamming distance (D) of 3 between the various states, permitting single error correction. (See table 1.) The inefficiency of

this code is obvious; however it should be clear that any single error can be detected and *located* using this scheme.

Symbol	Encoded Form
0	00000
	↓
INVALID	00001

The erroneous pattern could only be the result of encoding a 0 with an inversion in the least significant bit. Given the word 00001, the original, correct coding could be restored. This can be attributed to the fact that even the invalid, meaningless patterns display a limited uniqueness, and are directly traceable to specific *valid* codes subject to a small number of errors.

Uses of Parity

Clearly, coding efficiency is hampered as the Hamming distance is increased and as the requirements for trapping and correcting power are made more stringent. It becomes a matter of systematically generating a code that displays enough "correcting power" to handle data words of a useful length, without creating an excessive code-redundancy overhead. Here, the concept of *parity* plays an important role. Parity is established in a data word through the setting of an *additional* bit, such that the total number of bits set to logic 1 is either always odd or always even.

The operation of simple parity encoding and decoding is easy to understand. Assume, for example, that a data word 4 bits wide undergoes an odd-parity test across the entire word:

```

┌ 1010
└
1 1010

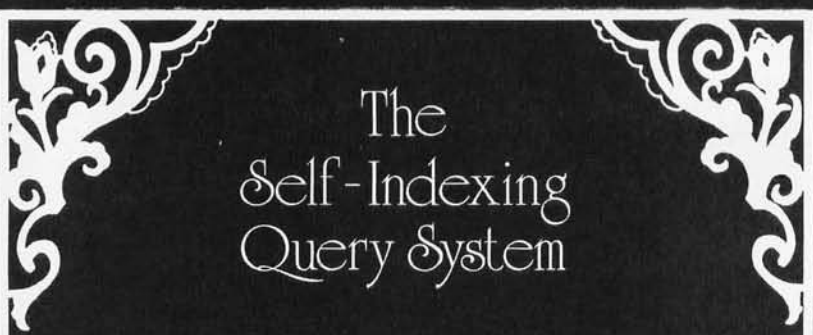
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During encoding in this example, the fifth bit (the parity bit) is set to establish *odd* parity. Upon decoding, if the parity bit is included in an identical parity check, namely odd parity across the entire word (now 5 bits wide), the output of the parity test will be a logic 0.

If at some point between encoding and decoding, an error forces an inversion in a single bit (eg: with an error in bit 3, input to the decoder will be 10010), the odd-parity test will

Symbol	Binary Form	7-bit Encoded Form
00	0000	1110000
01	0001	1000001
02	0010	0100010
03	0011	0010011
04	0100	0000100
05	0101	0110101
06	0110	1010110
07	0111	1100111
08	1000	0011000
09	1001	0101001
10	1010	1001010
11	1011	1111011
12	1100	1101100
13	1101	1011101
14	1110	0111110
15	1111	0001111


Table 2: Sixteen different logical entities or symbols can normally be represented by a 4-bit code. Use of a unique 7-bit encoding increases the Hamming distance to 3 and allows a single-bit error correction.



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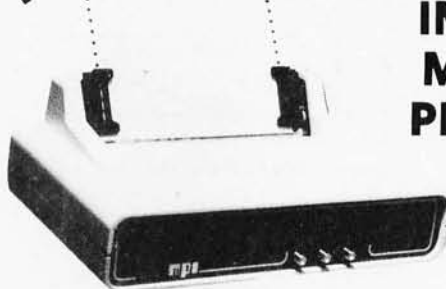
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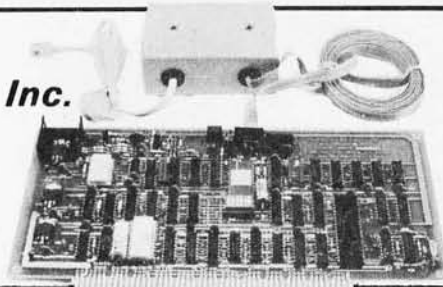
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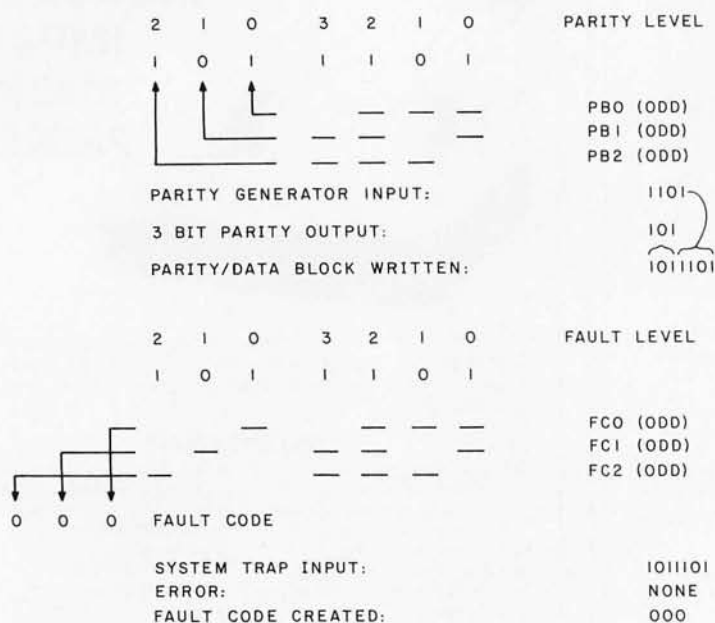


Figure 3: Sixteen different logical states may be represented in a 7-bit code with a Hamming distance of 3. Single-bit errors may be detected and corrected. Encoding in 7 bits is accomplished by performing three distinct parity checks on 4 data bits. Table 4 shows the possible fault codes. The fault code of 000 indicates that no error was detected in decoding.

fail and produce a logic 1 signifying an error.

Operation of Hamming Codes

Certainly this mechanism can be fooled by multiple errors, but it is possible to construct *multiple-level* parity checks which will trap a surprising number of errors. This is precisely how the Hamming codes operate. Fundamentally, Hamming's algorithm performs multiple-level parity generation on a data word at the data source. This parity code is then transmitted along with the data, and the entire code block (data plus parity code) is subsequently decoded under an analogous process. Any bit errors occurring during transmission will be detected.

Clearly, the efficiency of this error trap will approach 100% only in very simple cases. Several parameters have direct bearing on the trapping success: total word length N, number of data bits K, number of parity bits M ($M = N - K$). The ultimate goal, of course, is to realize the ideal where the quantity N/K approaches 1, and M is minimized without sacrificing trapping and correcting capability.

A 4-bit binary code is normally capable of representing sixteen different states with a Hamming distance equal to 1. Momentarily setting aside questions of efficiency, the same sixteen states can also be represented in a 7-bit code at triple the Hamming distance, as shown in table 2. Again, referring to table 1, a Hamming distance of 3 facilitates single-error correction. Encoding in 7 bits is accomplished by performing three distinct parity checks on the 4 data bits. Details of the three parity checks are summarized in table 3 and diagrammed in figure 3.

It should be understood that the actual encoded form of each symbol is irrelevant and need not be known. When no error is present, decoding of the 7-bit word will reset all three parity checks to logic 0, and will restore the data to its original form. The error-handling process is demonstrated in figure 4. With an error in the third data bit, the parity-decoding procedure flags a fault code of 110, which in table 4 is seen to correspond uniquely to an error in data position 3.

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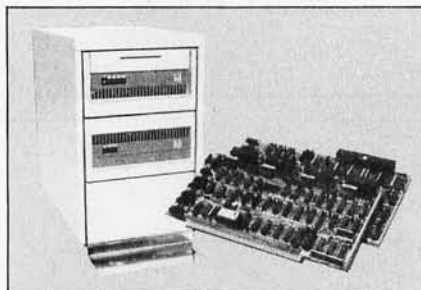
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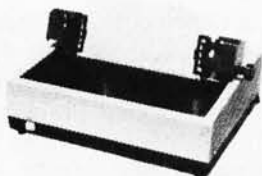
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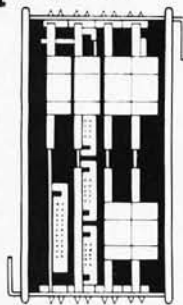
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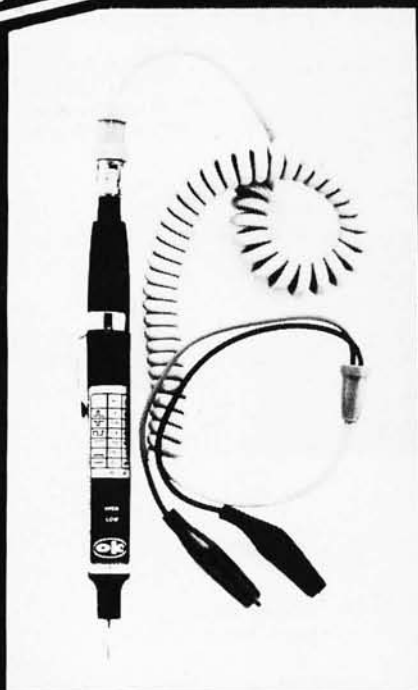


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Admittedly, this does not constitute a true Hamming code, in the sense that the fault code does not display the binary form of the error-bit position within the word. This feature is convenient to implement for the shorter codes, but need not be attempted in the more comprehensive

correction schemes where fault-code interpretation can be readily handled in a read-only memory.

Practicality of Use

An overhead of three parity flags for every 4 data bits is undesirable. These techniques become useful only

for larger word lengths. Initially, performance increases as the data word length becomes longer, up to $N = 31$. It is possible to correct single-bit errors in words with 8 data bits and four additional parity flags, an overhead of 50%. Single-error correction of 16 bits requires five flags, an overhead of 32%.

In the case of an 8-bit system, an overhead of 50% may seem exorbitant, but it can pay off rapidly. Assuming that with correcting logic in operation, single errors are virtually nonexistent, it may well be possible to realize a decrease in loading time by a factor of 2, 5 or even 10. It is true that 1.5 times as many bits are being moved into and out of the storage medium, but if the data rate merely doubles, loading times will fall to

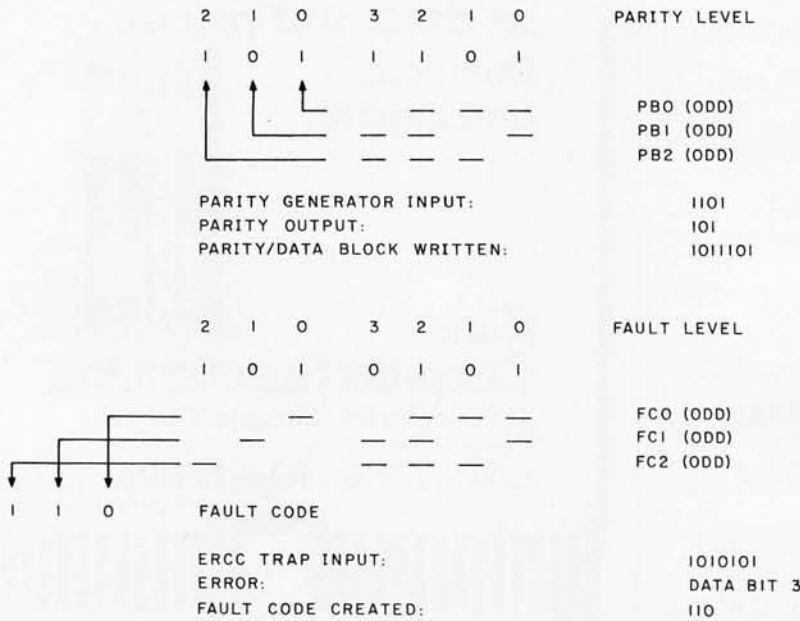


Figure 4: Another example of encoding and decoding data composed of 4 bits in a 7-bit word. In this case an error has been detected; the fault code of 110 indicates an error in data bit 3.

Check Bit	Data Positions
0	0,1,2 (odd)
1	0,2,3 (odd)
2	1,2,3 (odd)

Table 3: Encoding 4-bit data into 7 bits is done by performing 3 distinct parity checks on the 4 data bits. Each of the 3 check bits corresponds to the parity value of the data positions shown here.

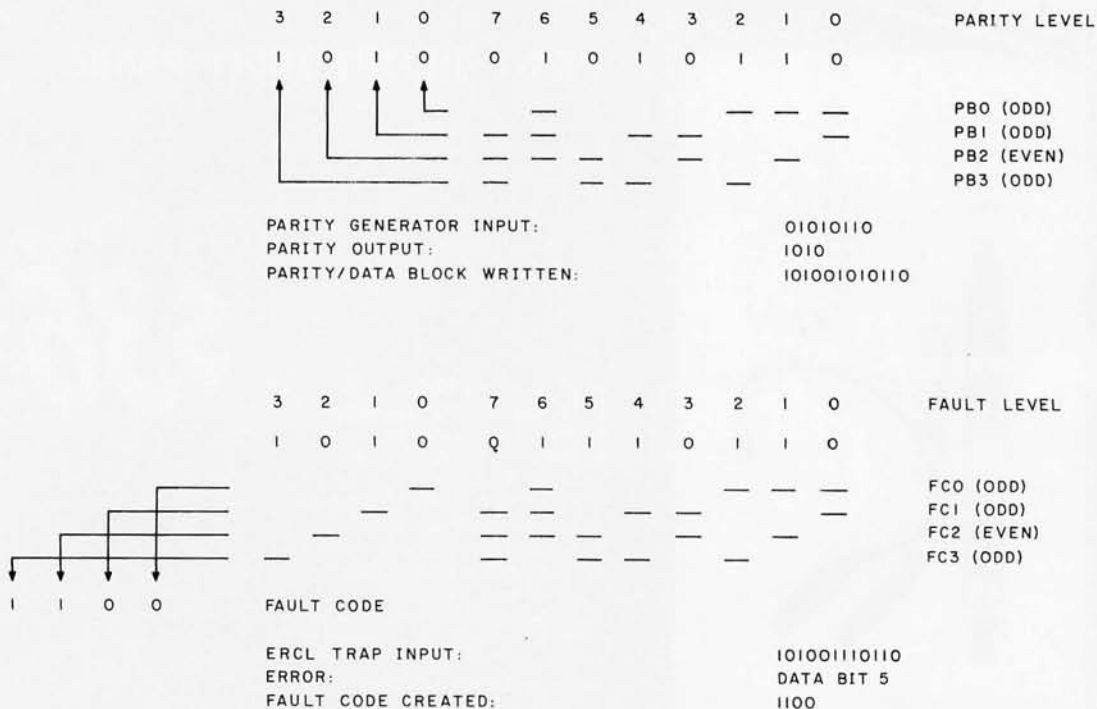


Figure 5: Encoding and decoding for data consisting of an 8-bit byte. Four bits are used for error checking; the possible fault codes are given in table 6.

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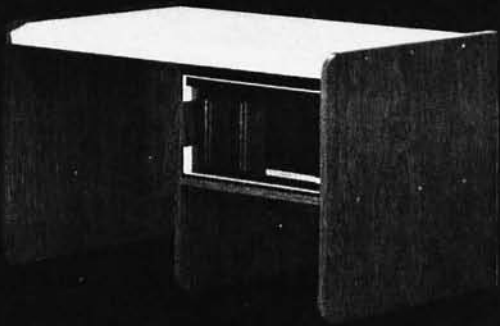
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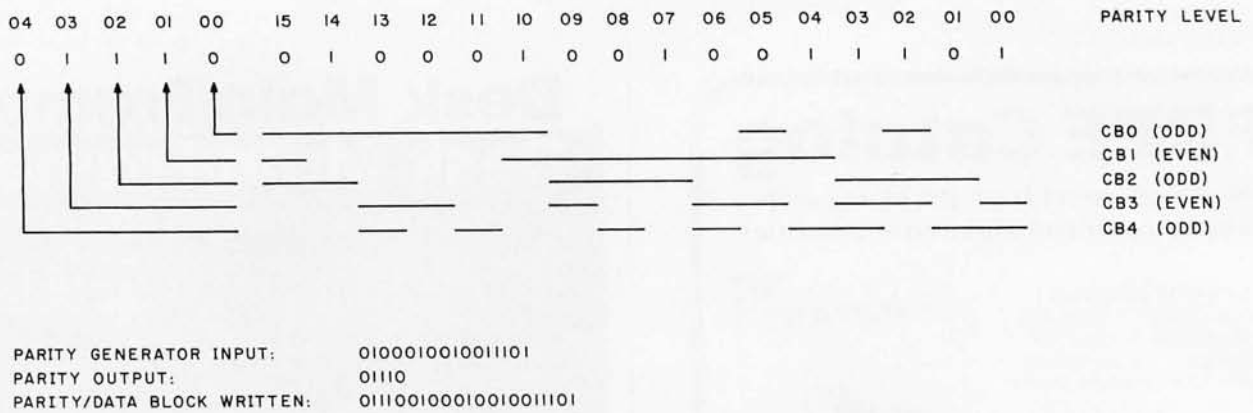


Figure 6a: Encoding of 16-bit data using five bits for error checking; this results in a 21-bit data word being written to the peripheral device. Check bits based on even parity are set to 1 if there are an even number of 1s in the corresponding data-bit group; an odd-parity check bit is set to 1 if the number of 1s in its data-bit group is odd. This figure, figure 6b, and table 8 originally appeared in slightly different form in *Electronics magazine*, November 13, 1975, page 135. Copyright © McGraw-Hill Inc, 1975.

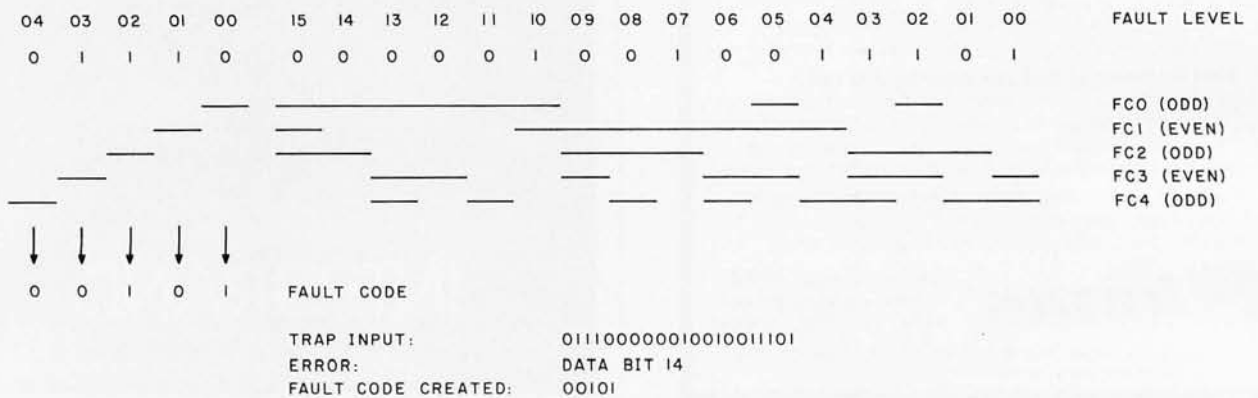


Figure 6b: Decoding and checking the 16-bit data, 5-bit parity-check word from figure 6a. Bit 14 has been transmitted erroneously; therefore a fault code of 00101 (reading from check bit 04 to bit 00) is generated. A complete list of possible fault codes is given in table 8 (in reverse order, reading from check bit 00 to bit 04).

Fault Code	Error
000	no error detected
001	check bit 0
010	check bit 1
011	data bit 0
100	check bit 2
101	data bit 1
110	data bit 3
111	data bit 2

Table 4: Look-up table of fault codes used by the 4-bit into 7-bit encoding scheme. The fault code tells the error-correcting logic where the error has occurred.

Encoding for 8 and 16 bits is shown in figures 5 and 6. The detailed parity tests for these appear in tables 5 and 7 respectively. The fault-code look-up tables are shown as tables 6 and 8. This 16-bit system was developed by the Data General Corporation. It will correct single-bit errors throughout the entire word, and will reportedly trap an average of 97% of the multiple faults that occur. Eight-bit coding logic has been verified in macro-assembler routines on a DECsystem 10 by my associate Stephen J Gross, who is now at Stanford University.

Check Bit	Data Positions
0	0,1,2,6 (odd)
1	0,3,4,6,7 (odd)
2	1,3,5,6,7 (even)
3	2,4,5,7 (odd)

Table 5: Encoding of 8-bit data requires the use of four parity bits to allow single-bit error correction. The correspondence of each check bit to specific bits within the 8-bit data byte is shown here.

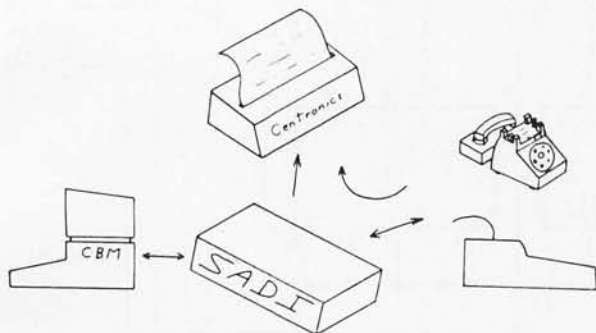
75% of the initial value. A ten-fold increase in data rate decreases loading time by 85%. Sixteen-bit systems are even better suited to the use of error checking and correcting systems (ERCC), though the majority of microprocessors in use today operate with an 8-bit data word.

Error-Reducing Hardware

Hardware implementation utilizes standard 7400 series transistor-transistor logic (TTL). Schematic diagrams are shown in figures 7 and 8. Parity encoding and decoding is accomplished with 9-bit parity trees (using a 74180 parity generator/tester).

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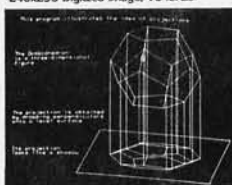
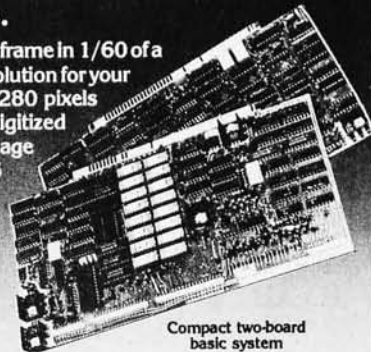
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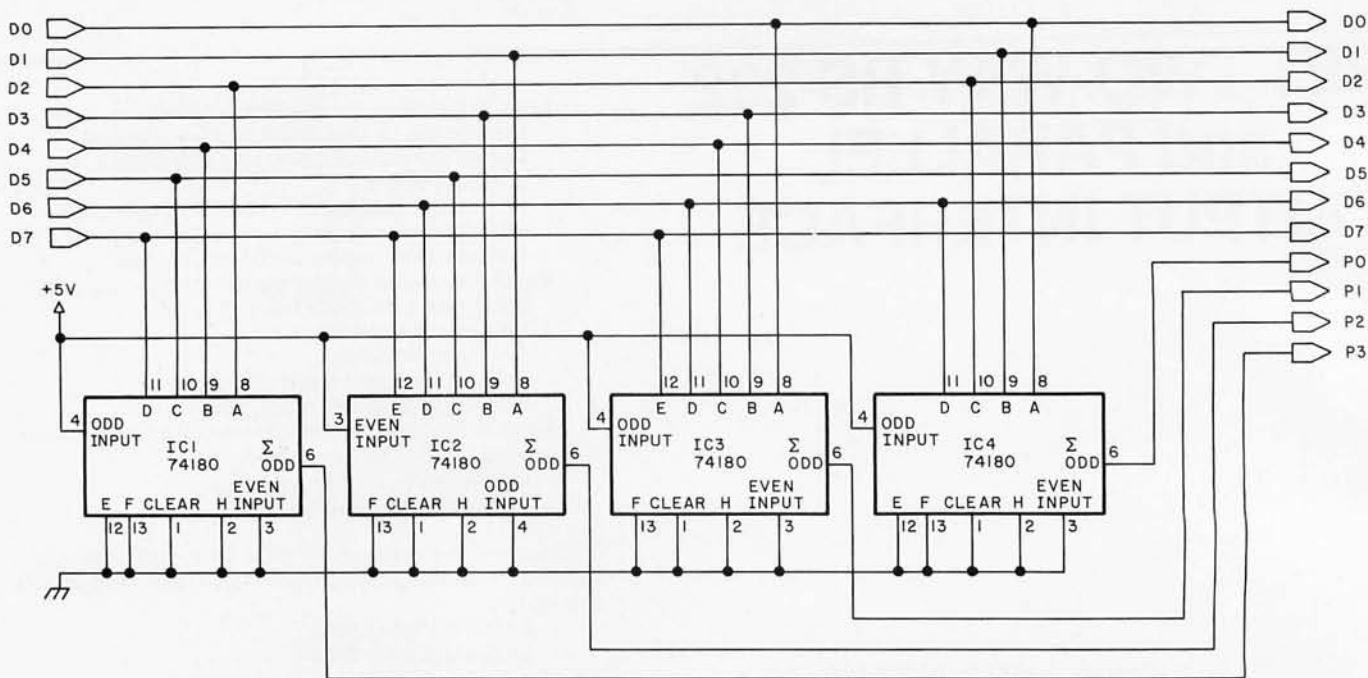


Figure 7a: Schematic diagram of electronic logic that encodes 8-bit data. Unused input pins on the 74180 parity-generator and tester devices are connected to ground.

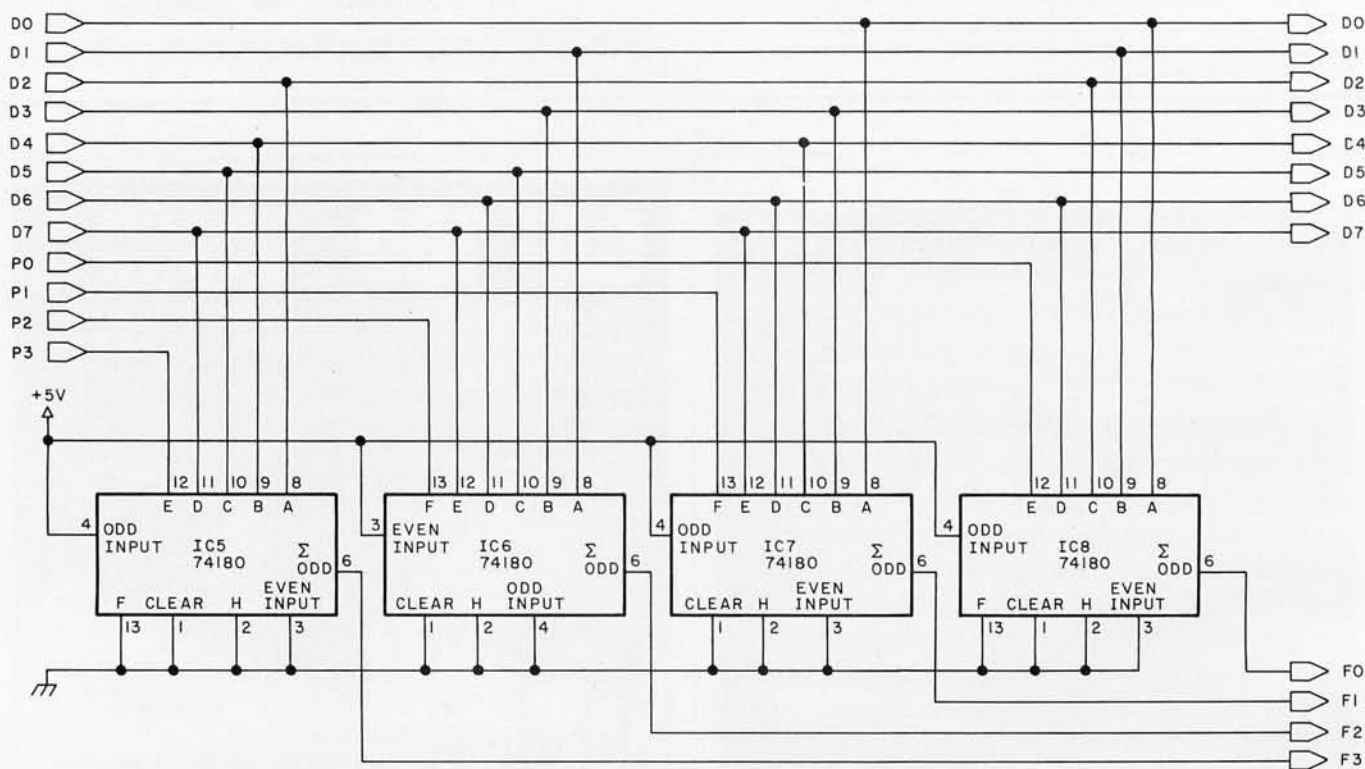


Figure 7b: Schematic diagram of circuit for trapping errors in the 8-bit data encoded by the circuit in figure 7a. The 12-bit word received from the peripheral device is separated into 8 bits of meaningful data and 4 bits of parity-checking data. Unused inputs on the 74180s are grounded.

of the error checking and correcting apparatus is rapid enough to make it entirely transparent to the processor and the system bus.

Though the underlying theory requires the writing of additional parity

bits, the generation and interpretation of these flags are contained entirely within the error-processing system. (See figure 9.) The parity bits do not appear on the bus and are not seen by the processor; therefore no

interface modification is necessary. Additional data-transfer logic is required to deal with the parity bits. The circuits in figures 7 and 8 create parallel data which must undergo a

Text continued on page 274

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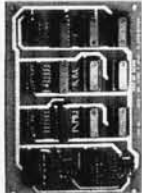
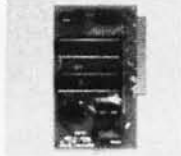
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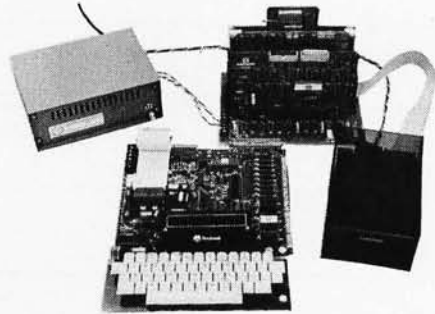
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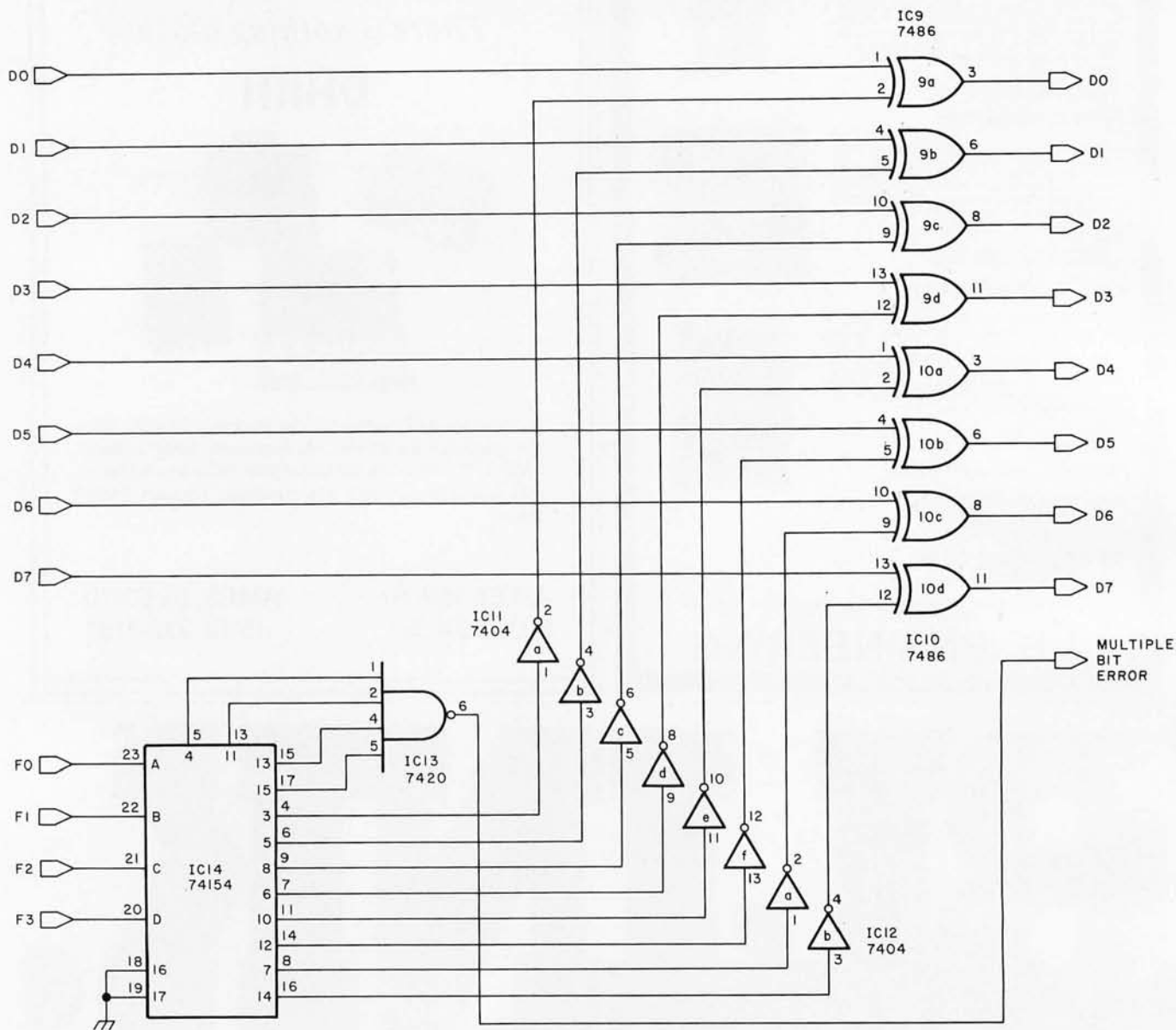


Figure 7c: Schematic diagram of the circuit which corrects single-bit errors trapped by the circuit of figure 7b. Multiple-bit errors are made known to the processor, but cannot be corrected using this scheme.

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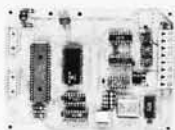
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	(Bytes)	(Sec)			(Bytes)	(Sec)	
SORT	16K	33		SORT	340K	1081	
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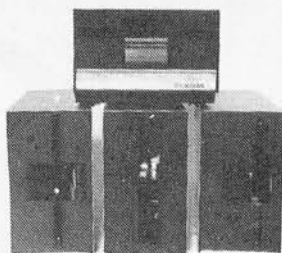
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Fault Code	Error
0000	no error detected
0001	check bit 0
0010	check bit 1
0011	data bit 0
0100	check bit 2 *
0101	data bit 1
0110	data bit 3
0111	data bit 6
1000	check bit 3
1001	data bit 2
1010	data bit 4
1011	all data and parity set to logic 0
1100	data bit 5
1101	multi bit error
1110	data bit 7
1111	multi bit error

Table 6: Look-up table of fault codes used by the 8-bit to 12-bit encoding scheme. Setting of the check-bit-2 fault code (indicated by an asterisk) shows that all data and parity bits are set to logic 1.

Check Bit	Data Positions
0	2,5,10,11,12,13,14,15 (odd)
1	4,5,6,7,8,9,10,15 (even)
2	1,2,3,7,8,9,14,15 (odd)
3	0,2,3,5,6,9,12,13 (even)
4	0,1,3,4,6,8,11,13 (odd)

Table 7: The 16-bit encoding scheme uses 5 parity bits that enable single-bit error correction. Each parity-check bit performs its check operation upon the data-bit positions shown here.

Fault Code	Error
00000	no error detected
00001	error in check bit 4
00010	error in check bit 3
00011	error in data bit 0
00100	error in check bit 2
00101	error in data bit 1
00110	multiple-bit error
00111	error in data bit 3
01000	error in check bit 1
01001	error in data bit 4
01010	all data and parity set to logic 1
01011	error in data bit 6
01100	error in data bit 7
01101	error in data bit 8
01110	error in data bit 9
01111	multiple-bit error
10000	error in check bit 0
10001	error in data bit 11
10010	error in data bit 12
10011	error in data bit 13
10100	error in data bit 14
10101	all data and parity set to logic 0
10110	error in data bit 2
10111	multiple-bit error
11000	error in data bit 10
11001	multiple-bit error
11010	error in data bit 5
11011	multiple-bit error
11100	error in data bit 15
11101	multiple-bit error
11110	multiple-bit error
11111	multiple-bit error

Table 8: Look-up table of fault codes used by the 16-bit to 21-bit encoding scheme. The codes are shown here in order from check bit 00 to bit 04, reversed from the representation in figure 6.

Address Input	Data Output						
	7	6	5	4	3	2	1 0
00000	0	0	0	1	0	0	0 0
00001	0	1	0	1	0	0	0 0
00010	0	1	0	1	0	0	0 0
00011	0	0	0	0	0	0	0 0
00100	0	1	0	1	0	0	0 0
00101	0	0	0	0	0	0	0 1
00110	0	0	1	1	0	0	0 0
00111	0	0	0	0	0	0	1 1
01000	0	1	0	1	0	0	0 0
01001	0	0	0	0	0	1	0 0
01010	1	1	0	1	0	0	0 0
01011	0	0	0	0	1	1	0
01100	0	0	0	0	0	1	1 1
01101	0	0	0	0	1	0	0 0
01110	0	0	0	0	1	0	0 1
01111	0	0	1	1	0	0	0 0
10000	0	1	0	1	0	0	0 0
10001	0	0	0	1	0	1	1
10010	0	0	0	0	1	1	0 0
10011	0	0	0	0	1	1	0 1
10100	0	0	0	0	1	1	1 0
10101	1	0	1	1	0	0	0 0
10110	0	0	0	0	0	1	0
10111	0	0	1	1	0	0	0 0
11000	0	0	0	0	1	0	1 0
11001	0	0	1	1	0	0	0 0
11010	0	0	0	0	1	0	1 0
11011	0	0	1	1	0	0	0 0
11100	0	0	0	0	1	1	1 1
11101	0	0	1	1	0	0	0 0
11110	0	0	1	1	0	0	0 0
11111	0	0	1	1	0	0	0 0

Table 9: Truth table which is programmed into a program-mable read-only memory for use in the electronic circuit of the 16-bit error-checking and correcting system.

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IC4	74180	14	7
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IC6	74180	14	7
IC7	74180	14	7
IC8	74180	14	7
IC9	7486	14	7
IC10	7486	14	7
IC11	7404	14	7
IC12	7404	14	7
IC13	7420	14	7
IC14	74154	24	12
IC15	74180	14	7
IC16	74180	14	7
IC17	74180	14	7
IC18	74180	14	7
IC19	74180	14	7
IC20	7404	14	7
IC21	74180	14	7
IC22	74180	14	7
IC23	74180	14	7
IC24	74180	14	7
IC25	74180	14	7
IC26	7488	16	8
IC27	74154	24	12
IC28	7404	14	7
IC29	7404	14	7
IC30	7404	14	7
IC31	7486	14	7
IC32	7486	14	7
IC33	7486	14	7
IC34	7486	14	7

Table 10: Power supply connections for integrated circuits used in electronic logic described in this article.

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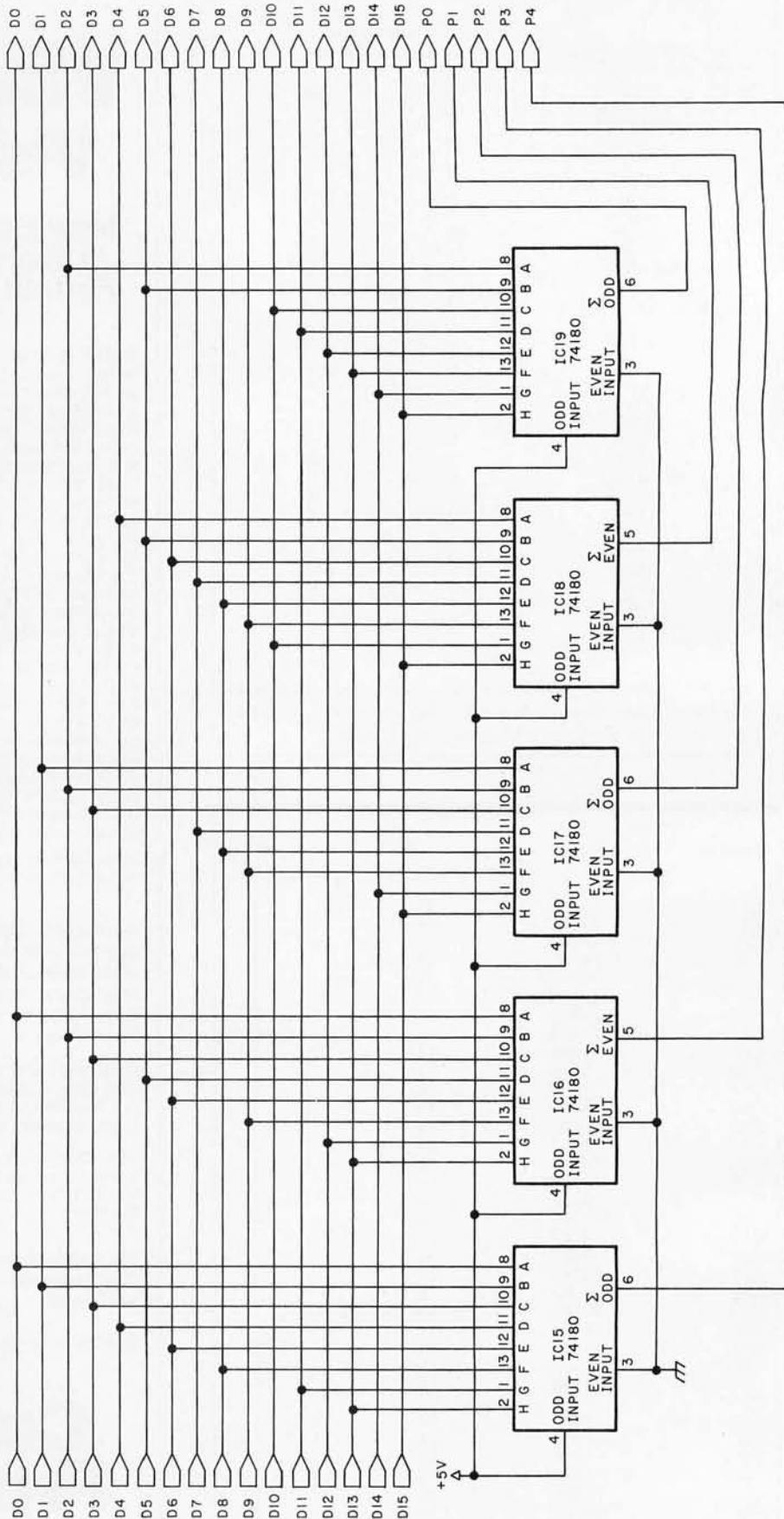


Figure 8a: Schematic diagram of the circuit to encode 16-bit data into 21-bit words containing 5 parity bits.

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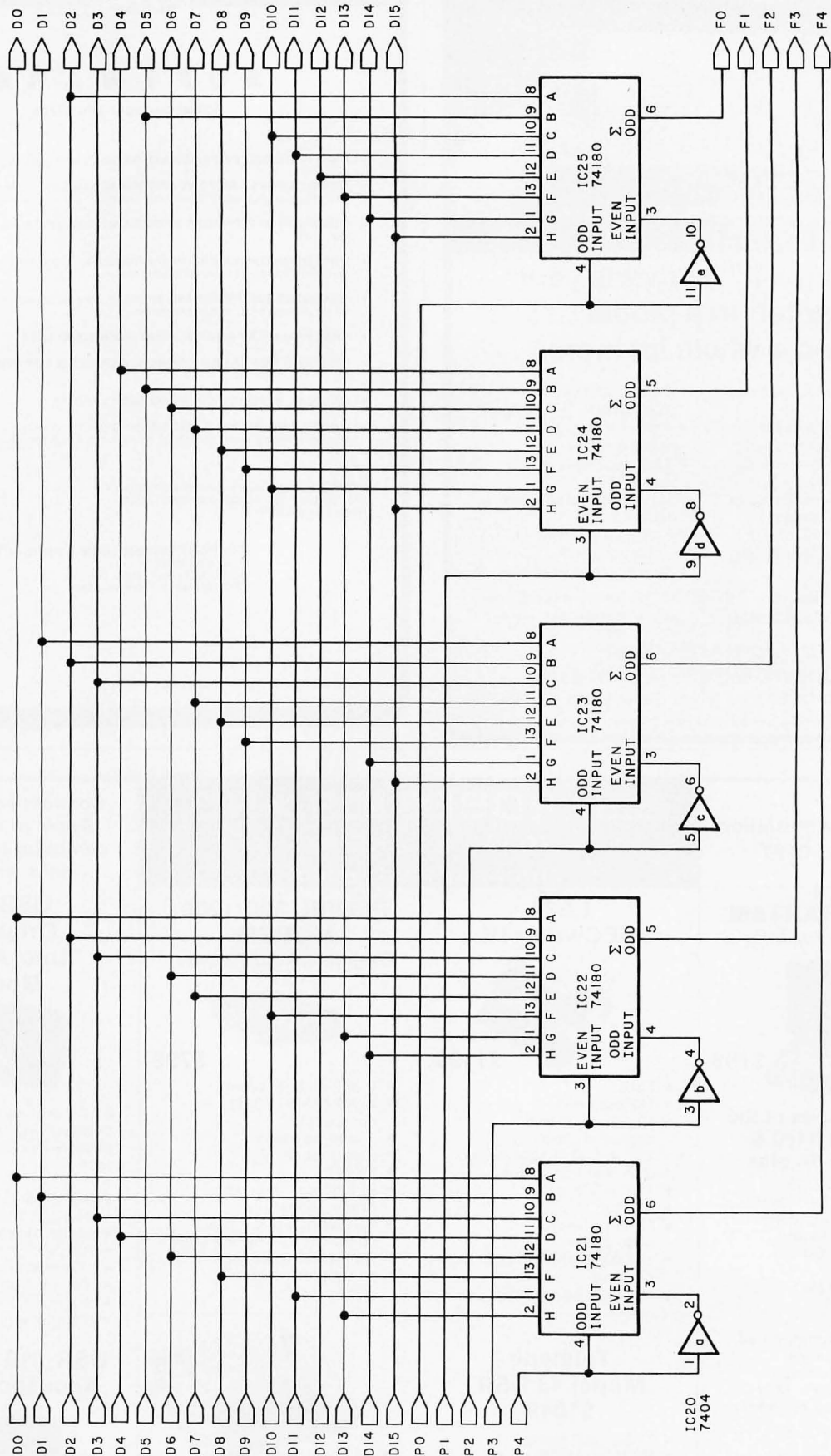
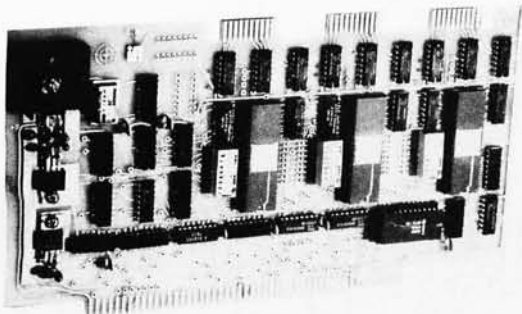


Figure 8b: Schematic diagram of the circuit which traps errors from the encoded 16-bit data. Five error-detecting bits are sent to the error-correcting circuit of figure 8c.

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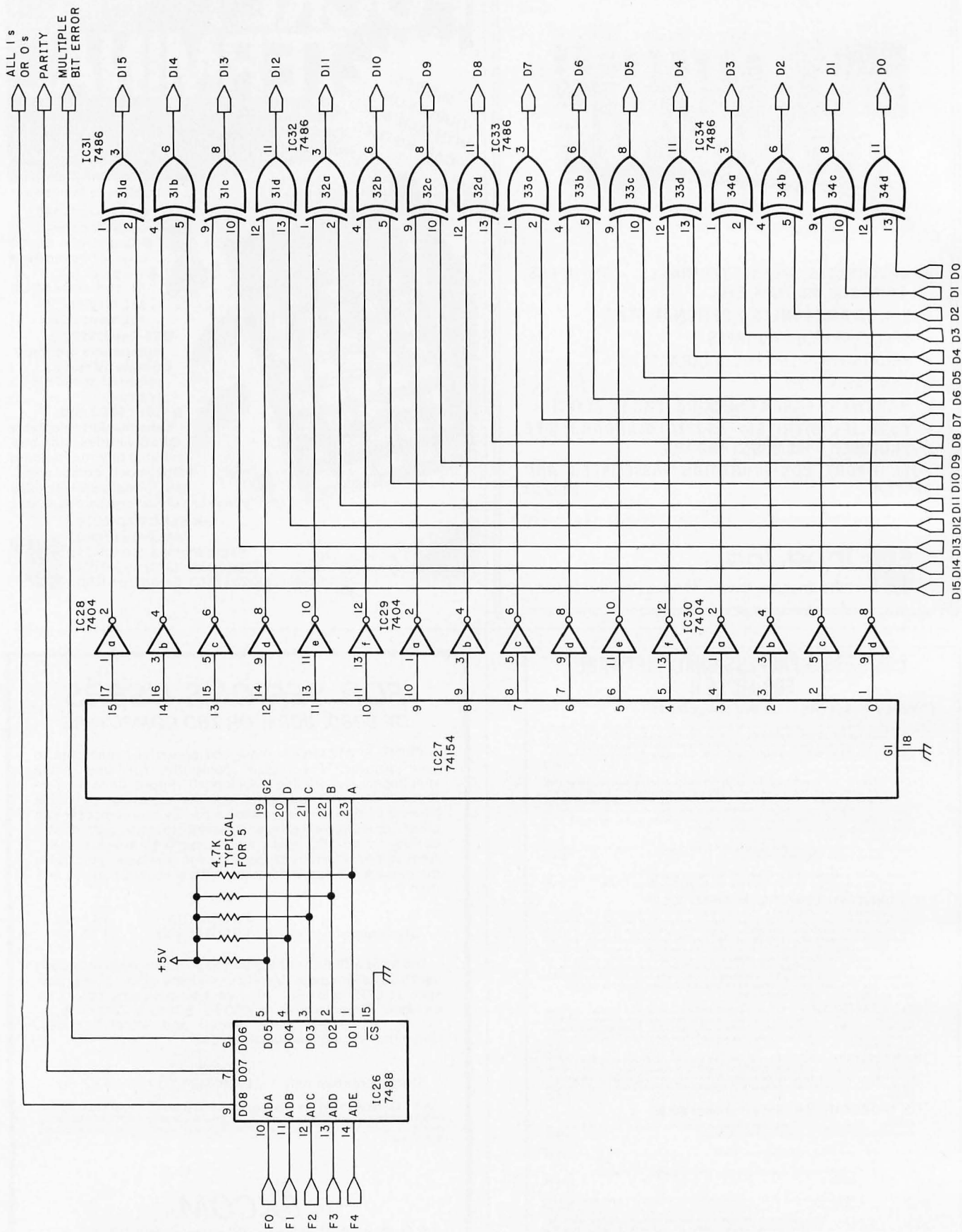


Figure 8c: Schematic diagram of electronic logic that corrects errors in 16-bit data.

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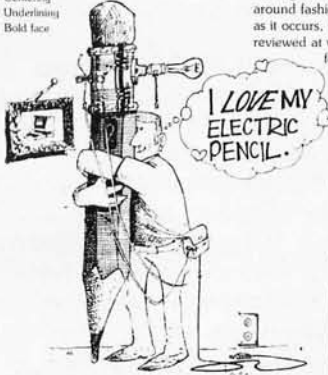
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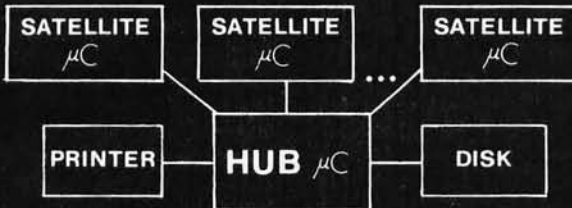
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Text continued from page 262:

parallel-to-serial conversion during a write operation, and a serial-to-parallel conversion during a read pro-

cess. Details of this hardware will depend upon the actual data-transfer logic present in existing systems.

Locating single errors is accom-

plished by interpreting the fault code generated by the error-detection logic. This interpretation is done by use of an 8-bit by 32-word programmable read-only memory (8223/7488) which produces a binary output corresponding to the error-bit position in the data word. Error correction is achieved by loading the binary pointer into a 4-to-16 line demultiplexer that flags the proper bit line and corrects the fault with an exclusive-OR inversion. (See figure 10.) With an 8-bit system, the inconvenience of programming the read-only memory may be avoided by loading the fault code directly into the demultiplexer and then "picking off" the corresponding output.

Treatment of Multiple Errors

Although single-bit errors are far more common, multiple failures within one data word can and do appear. For all intents and purposes, these are uncorrectable—particularly in longer data words. Prohibitively extensive logic would be required to locate multiple-fault bits; therefore, these errors are simply trapped to cause a processor interrupt. The

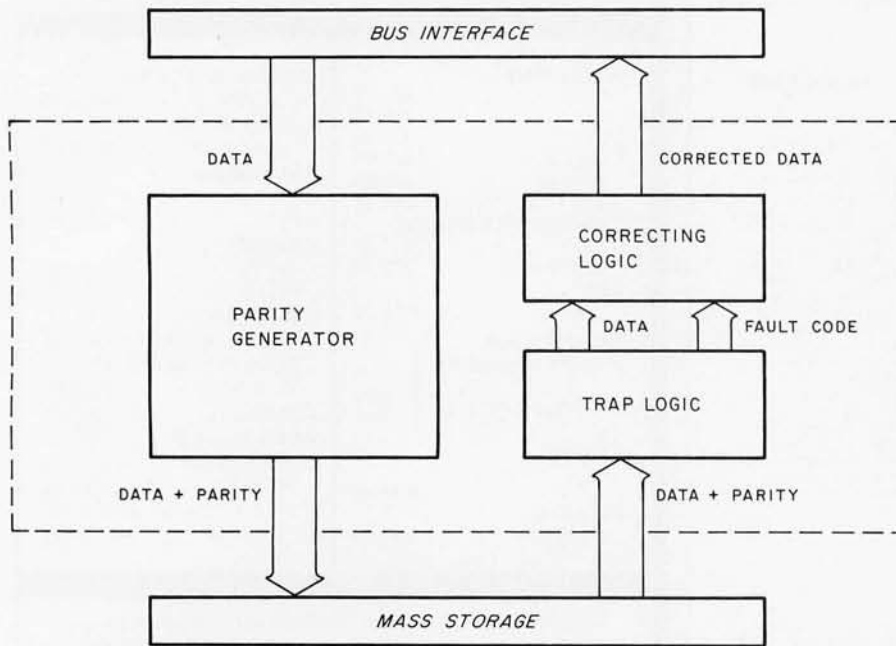


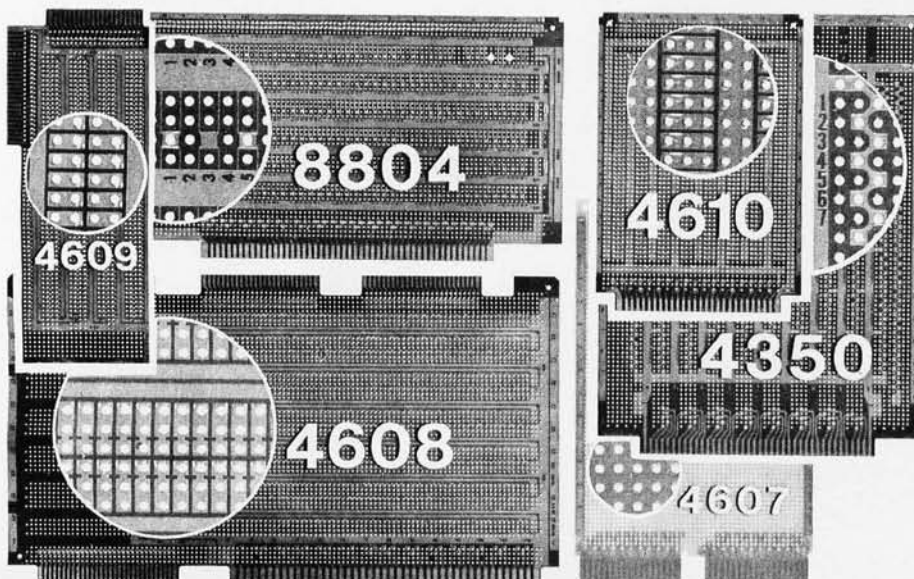
Figure 9: Block diagram of data flow through the error-checking and correcting system. The extra parity bits are never seen by the processor, and make the system transparent from the point of view of the system bus.

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Theoretical Advances

As reviewed by Peterson and Weldon, the Hamming algorithm falls in the category of *cyclic codes*. (See reference 3.) In cyclic codes, executing a one-unit right-shift

operation on any symbol in the complete code set will produce a binary bit pattern identical to that of one of the *other* members of the code set. Since Hamming's initial publication, an extensive array of cyclic codes has been derived. Perhaps the best known are the Bose-Chaudhuri-Hocquenghem (BCH) codes, which are related to the Hamming algorithm.

The BCH codes actually represent a generalized expansion that is particularly suited to coping with multiple-bit errors. None of these newer solutions offer major advantage over the basic Hamming check when correcting an 8-bit data word. Several mathematical difficulties are encountered when attempting to derive more effective encoding procedures. Not only is word length relatively short in these systems, but it can be shown that code redundancy overhead can be minimized to a tolerable level in only a small number of cases.

The alternative method, which is not unreasonable, would be to encode and decode entire data blocks, as opposed to individual data words. This would take advantage of the increased coding efficiency found for the longer codes, but would probably require a software implementation to minimize hardware design and expense. Such an approach would certainly increase system reliability, but it would defeat the purpose of increasing the speed and efficiency of data transfer to and from mass storage, since the processor would spend considerable time encoding and decoding the parity and data blocks before and after each data transfer. ■

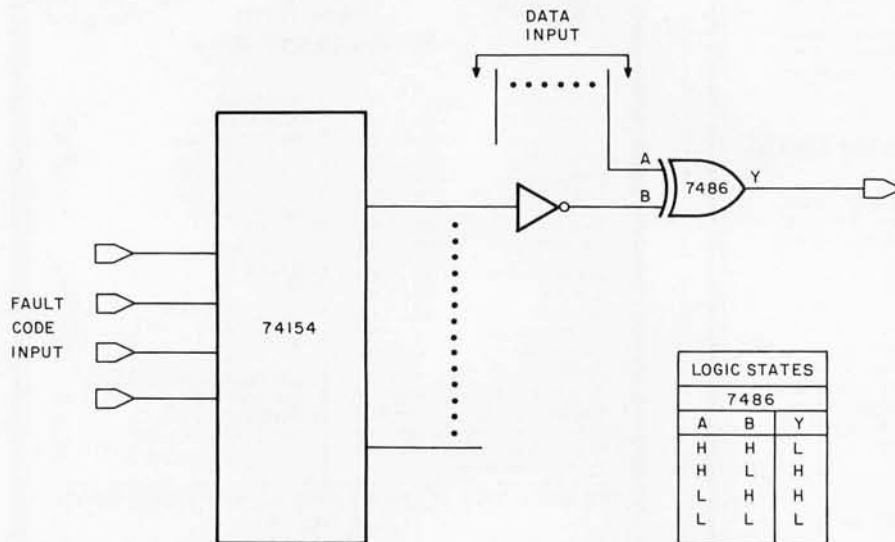


Figure 10: Detail of the error-correcting logic. Error correction is achieved by loading a binary pointer into a 4-to-16 line demultiplexer that flags the proper bit line and corrects the fault with an exclusive-OR inversion. Eight-bit systems may load the fault code directly into the demultiplexer and avoid the use of a read-only memory.

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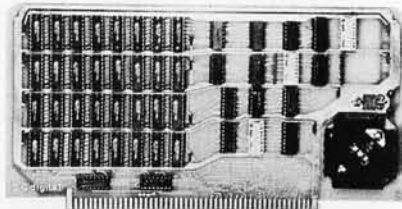
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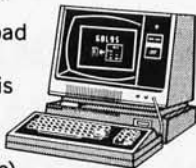
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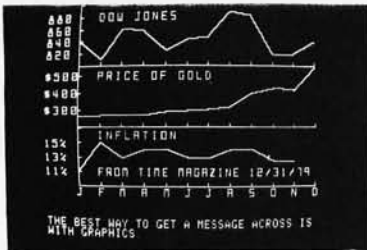
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The NCC: New Emphasis on Personal Computing

What's happening in personal computing? The American Federation of Information Processing Societies, Inc (AFIPS) is banking that you'll find out at the National Computer Conference's Personal Computing Festival, to be held on May 20-22 in Anaheim, California at the Anaheim Convention Center. In the 3 years that personal computing has had a separate exhibit area at the NCC, the number of exhibitors has increased from 76 to 154. Over 20% of those who came to the NCC last year registered specifically for the Personal Computing Festival, and over half of the 60,000 plus attendees visited the Festival.

The booming show-attendance figures reflect the fast growth of the personal-computing industry as a whole. Highlights include the Apple Computer Company's expectations to triple its

sales by the end of 1980. Commodore International computer sales may increase by a factor of 2 during the first quarter of 1980, and Radio Shack expects similar increases. According to industry estimates, the market value of personal-computer software sold in 1980 could surpass \$150 million.

Judging from the attendance at last March's West Coast Computer Faire in San Francisco (approximately 20,000), there is an ever-increasing interest in personal computing among a wide variety of people. We expect to see a trend toward more sophisticated software at the 1980 NCC Personal Computing Festival. There will be a flood of new Pascal packages, new simulation programs, the appearance of new Forth software (look for the special section on the Forth language in the August

1980 BYTE), as well as intriguing new hardware like Microsoft's new Z80 processor circuit card for the Apple computer that allows Apple owners to use programs written to run under Digital Research Corporation's CP/M operating system. Word-processing and small-business software are two other rapidly growing areas that will be well represented at the conference.

Will some major consumer electronics companies enter the personal computer market? Is there a move toward some standardization in the microcomputer industry? Will Japanese companies make any major moves into personal computing? [Nippon Electric Company (NEC) is rumored to be unveiling a new computer at the show]. We'll keep our eyes open at the show to find out! ■

Personal Computing Festival Preliminary List of Exhibitors

ABC Computer Inc
American Word Processing Co
Apple Computer Co
Applied Digital Data Systems Inc
Artex Electronics Inc
Atari

BASF Systems
Benwill Publishing Corp
BYTE Publications Inc

California Computer Systems
Cardamion Co
Centronics
Comprint
Compucolor Corp
Compucorp
Computer City
Computer Textile
Computerworld
Computhink
Control Data Corp
Corvus Systems Inc
Creative Computing
Cromemco Inc

Diablo Systems Inc
Dilithium Press

Electronic Data Systems-Evolution I

Executive Information Systems Inc
Exidy Inc

Findex Inc

Harris Technology
Hayden Book Co Inc
H & E Computronics
Heath/Zenith
Hewlett-Packard Co

Industrial Micro Systems
International Memories Inc (IMI)

Jade Computer Products

Leedex Corp
Lobo Drives International
LRC/An Eaton Co

3M-Data Recording Products Div
MAS (Micro Application Systems Inc)
Memory Media Products
MicroAge
Microamerica Distributing Co Inc
Microcomputer Technology Inc
Micromail
MicroPro International Corp
Microsette Co
Microsoft

NEC America Inc
North Star Computers Inc

Omni Magazine
Osborne/McGraw-Hill

Personal Software
Priam
Prodigy Systems Inc

RCA MicroComputer Products
Radio Shack
Realizations Etudes Electroniques (R2E)
Rockwell Microelectronic Devices

SD Systems Inc
Sharp Electronics Corp
Smoke Signal Broadcasting
Spectra Logic Corp
Sybex Inc

TEI Inc
TSA Software

Xymec

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NCC Personal Computing Festival May 20-22, Disneyland Hotel

So great is the interest in personal computing, so dynamic is the personal computer industry, that this year's Personal Computing Festival is again being held separate from the rest of NCC, at the Disneyland Hotel.

The 3-day festival features its own impressive roster of exhibitors plus over 50 learning sessions on every aspect of personal computers and their use.

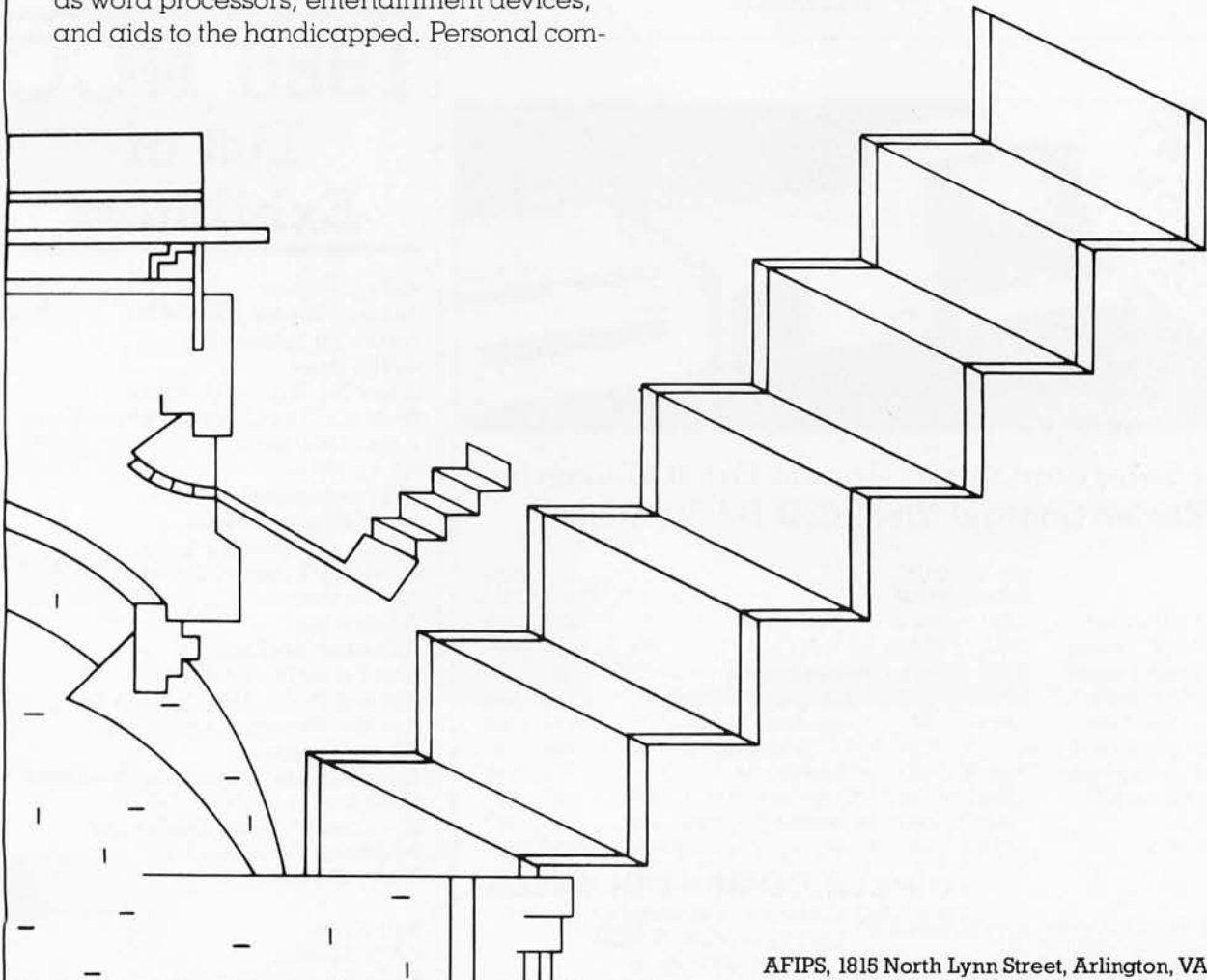
Personal computers at home, at school, and in the executive suite. Personal computers as word processors, entertainment devices, and aids to the handicapped. Personal com-

puter operating systems, programming languages, and software evaluation.

In addition, we've set aside a special area where demonstrations of personal computers will be conducted throughout the show. And we're awarding prizes for the most interesting use of personal computers.

If you're coming to NCC '80, be sure to make The Personal Computing Festival part of your visit.

Who knows—you may even win a prize.



AFIPS, 1815 North Lynn Street, Arlington, VA 22209

Personal Computing Festival Program Schedule

May 20 - Tuesday - 10:00 AM

High-Level Languages

Pascal Part I

Jim Gagne

Word Processing

Shopping by Objectives

Bill Radding

Portable Personal Computing

Jim Flournoy

1:00 PM

Higher-Level Languages

Pascal Part II

Jim Gagne

Computer Hardware Considerations & Applications

L Silvern

Forth Business Applications

Jim Flournoy

2:30 PM

Networks You Can Access With Your

Personal Computer

Cliff Barney

May 21 - Wednesday - 10:00 AM

Using Computers to Overcome Dis-

ability Handicaps

Part I

Jeff Moyer

Mary Anne Glicksman

The Future of Personal Computing

Panel

Verne Kallejian

Operating Systems

Roger Vass

1:00 PM

Using Computers to Overcome Dis-

ability Handicaps

Part II

Computer Networks-Technical

Craig Vaughn

Software Evaluation

Tom Williams

2:30 PM

Computer Music

Carl Helmers

May 22 - Thursday - 10:00 AM

Medical Computing for

Microprocessors

Jim Gagne

Data Base Management

Doug Seeley

Computers In Education

Chris Morgan

1:00 PM

Use of Computers in Kindergarden

thru Ninth Grade

Flora Russ

Business Applications

Nancy Leeper

Computers In Education Panel

Chris Morgan

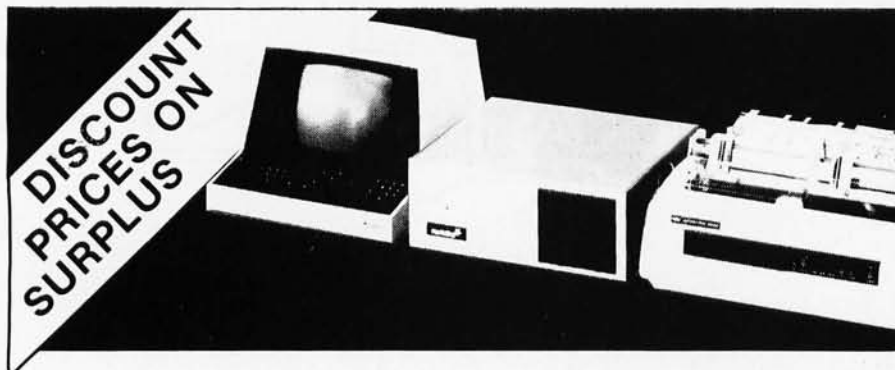
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Programming Potpourri

1980 NCC List of Exhibitors

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Alpha Micro
AM International
Amco Engineering Co
American Magnetics Corp
American Terminal Leasing
Ampex Corp
Anadex Inc
Anderson Jacobson Inc
Ann Arbor Terminals Inc
Applied Digital Data Systems Inc
Applied Magnetics Corp
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Horizon-2-64K-Double	3830	3195	Hi-Pad Digitizer	795	669
NorthStar 32K RAM	739	599	T1810 w/CP,FLC,FUL	2195	1989
North Star 16K RAM	499	399	Thinkertoys Discus-2	1149	1099
North Star 18MB Hard Disk	...	Call	CP/M 2 for Discus	150	140
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NEC Tractor Feed	220	199	PET 8K Graphics, Lg KB	795	695
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NCC Main Conference Proceedings

During each of the 4 days of the NCC, there will be discussions and papers related to the following major topics. A detailed schedule of events will be available at the conference.

Computer Architecture

Covers design of equipment and supporting technologies, and distribution through networking. Includes decisions relating to supersystems, survivability systems and data-base installation.

Applications of Computer Technologies

Explores the use of computers in entertainment, microcomputers and their impact, management of the computing tool and staff, and the role of inhouse and academic education and training.

Data Base Management & Communications

State-of-the-art, user-oriented sessions on the storage, retrieval, and transfer of data. From hardware considerations to natural-language access to a data base.

Office Automation

Every computer-related aspect of this explosive growth area, including electronic mail. How computers are used, managed, and integrated in an overall automated office.

Simulation Technologies

Where we've been, where we are, and where we're going with computer modeling. Its value to small and large businesses and its role in decision support will be discussed. Special sessions on solar energy-simulation modeling will be included.

Software Engineering Technologies

Sessions on programming standards, software quality assurance, languages, and requirements engineering. Emphasis upon the needs and responsibilities of the user.

Social Dynamics and Special Topics

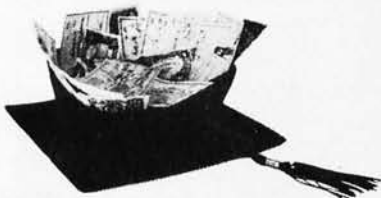
A broad spectrum of critical subjects: data security, legal issues, transborder data flow, societal impact, voice communications, venture capital and its effect upon technology.

Image Processing and Computers in Medicine

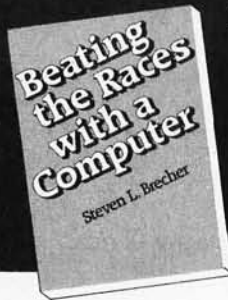
How image processing is used and will be used in industry and medicine. Trends in facsimile data coding, compression, and standards. How doctors use image-analysis display.

Professional Development Seminars

Full and half-day seminars for the professional who wants to come away with solutions and ideas he can implement now. Half-day seminars tie in with regular program sessions.



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— CONTENTS —

If I'm So Smart, Why Ain't I Rich? • Horse Racing is a Stochastic Process: "Darkness likely tonight, increasing chance of lightness towards morning..." • What We Need to Know to Bet: Don't Expect the Expected • Multiple Regression: Declarations of Dependence • The Database: Telling the Computer What Happened • Data Weighting and Normalization: 1 Apple + 1 Orange = 1 Fruit Salad • Generation of the Model Equations: Getting Involved in Meaningful Relationships • The Kelly Criterion for Bet Sizing: If You Lose You Can Always Go Out and Work to Get Even • Simulated Wagering Tests: "Even if I made as little as a million a day, then..." • Getting Started: For Do-It-Yourself Types • Regression Coefficients and Statistics • Annotated Bibliography

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BYTE Publications
70 Main Street,
Peterborough, NH 03458
Attn: Back Issues

What's New?

MISCELLANEOUS

RS-232C-Compatible Paper-Tape Reader



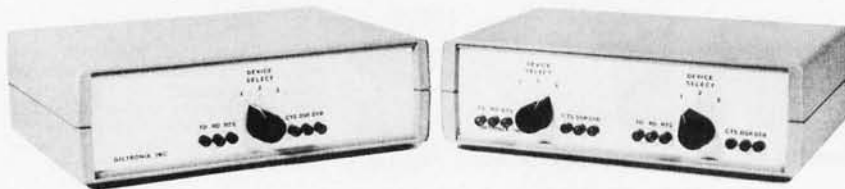
The Model 612 stand-alone paper-tape reader has the ability to read five- to eight-level tape and to transmit seven to eleven frames per character at 50 to 9600 bits per second (bps). It also features starting and stopping on character at all speeds, manual control or automatic on and off, 90 to 260 VAC, 50 to 60 Hz, and even, odd, or no parity. RS-232C, current loop, or parallel outputs are available. The price of the 612 is \$656 to \$854. Contact Add-master Corp, 416 Junipero Serra Dr, San Gabriel CA 91776.

Circle 562 on inquiry card.

Bidirectional Interface for the PET

This interface package is a combination of hardware and software that enables any model of the Commodore PET to send and receive data on printers, terminals, and other peripherals. ASCII/ISO-7 characters are sent from the PET in serial or parallel mode but are received in serial mode only. Serial speeds are selectable at rates up to 240 characters per second (cps). The interface is available for either 20 mA current loop or transistor-transistor logic (TTL) serial or parallel. The machine-language program may be stored anywhere in programmable memory; the code used to terminate a message is selectable. The price for the package is £70 (approximately \$160). Further details from Allen Computers, 16 Hainton Ave, Grimsby, South Humberside, ENGLAND.

Circle 563 on inquiry card.



Centronics-Compatible Switching and Monitoring Units

Gitlonix Inc, 450 San Antonio Ave, Suite 44, Palo Alto CA 94306, has introduced a family of switching and monitoring units. The GRS 232 units are used for interfacing, configuring, and monitoring computer terminals, printers, and other peripherals that comply with the RS-232 and the IEEE-488 specifications. The new family consists of four models: the GRS 232-P24, -S24,

-2P24, and -2S24. Each unit consists of a standard three-way switching system and an optional interface monitor. All the units can be cascaded and thereby allow interfacing of more than five devices. The systems can be ordered with signal monitoring capability. The units are priced at approximately \$130.

Circle 564 on inquiry card.

Large Capacity Winchester Backup from Corvus

This backup system, the Mirror, employs a standard video cassette with a total capacity of 100 megabytes. In less than ten minutes, the 10 megabytes of data on the Corvus 8-inch hard disk can be transferred to a Mirror cassette. The video cassette should be of the VHS, Beta, or U-Matic format. If a larger data capacity is required, a reel-to-reel videotape recorder can be used. This approach to storage embodies standard television technology and proven cassette reliability. The Mirror uses the same Z80 and Corvus interface bus as the Corvus disk. The Mirror will interface to the Apple II, TRS-80, S-100, and LSI-11 computers. Data format in the Mirror is fully compatible with the standard NTSC signal. For error detection, the Mirror contains cyclic redundancy check (CRC) detection hardware. If unattended or remote operation is desired, a low-cost option is available to interface the Mirror to the Panasonic Omnivision NV-8200 cassette recorder allowing archival storage files to be created without operator interaction. The price of the Mirror is \$790. Write Corvus Systems, 900 S Winchester Blvd, San Jose CA 95128.

Circle 565 on inquiry card.



What's New?

MISCELLANEOUS

Speechlink Voice Recognition for S-100 Computers

Heuristics has announced its Model 20S-64 Speechlink 64-word voice input unit for S-100 bus computers. The 20S-64 is a speaker-programmed, isolated word-recognition device that recognizes up to 64 words at each instant. Vocabulary sets may be stored away and recalled when needed. This system will produce a usable vocabulary of several hundred words for data entry and system control applications. Word recognition is completed in 200 ms. Successive words must be separated by at least 100 ms of silence. Preprogramming of the Speechlink is necessary. The unit requires 2 K bytes of programmable memory for programs, and 64 bytes for each word in the vocabulary, up to a maximum of 4 K bytes. The price is \$299 including board, microphone, and manual. Contact Heuristics Inc, 1285 Hammerwood Ave, Sunnyvale CA 94086.

Circle 441 on inquiry card.

Hardware and Software for Homebrewers

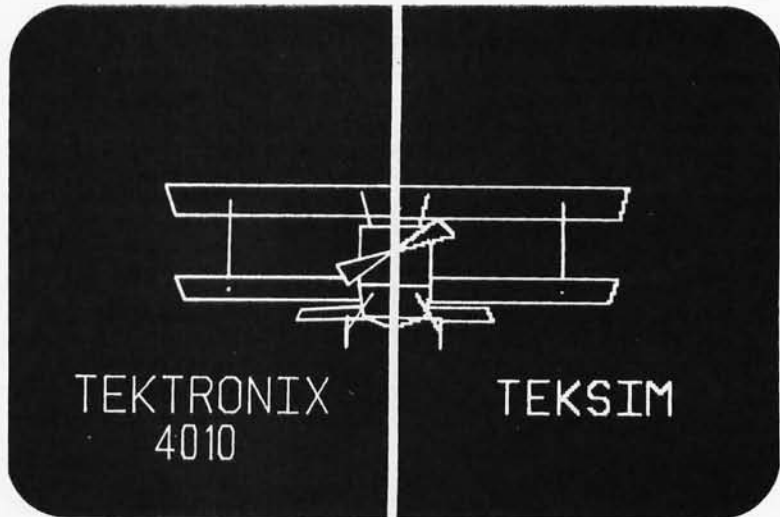
Snow Micro Systems Inc, POB 1704, Silver Spring MD 20902, provides low-cost hardware and software to personal computer users and clubs. Their bare boards are sold with schematics, layout drawings, and component lists. They are

CP/M Package for the STD Bus

Micro/sys has developed a CP/M system for the STD Bus microcomputer card system. The Micro/sys package consists of two STD Bus-compatible cards, the SB8500 Floppy Disk Controller, the SB8420 Dual Serial Interface, and an eight-inch floppy disk containing the CP/M system. The SB8500 can control up to four floppy disk drives from a single STD Bus slot. The SB8420 provides communication with a console device, and a second serial port that can be used for printers and other devices. The cards are compatible with 8085 and Z80 microprocessors.

CP/M provides a disk file management, a text editor, and an 8080 assembler, a dynamic debugger, and various utilities. Price of the Micro/sys CP/M package is \$695. For more information, contact Micro/sys Inc, 1353 Foothill Blvd, La Canada CA 91011.

Circle 444 on inquiry card.



Graphics Terminal Emulator for Apple IIs

TEKSIM, the Tektronix Simulator, employs distributed processing in its programming approach and uses the Apple's high-resolution plotting capabilities to emulate Tektronix 4010-series graphics terminals. No modification to the program in the remote computer is required to display

or input graphic data. The TEKSIM-Apple combination features multi-colored displays, selective erase, and a standard video output that lets any television set used with an RF converter function as a monitor. The suggested price for the plug-in device is \$795, and it is available from ABW Corp, POB M 1047, Ann Arbor MI 48106.

Circle 442 on inquiry card.

unassembled and come without parts. The company offers a troubleshooting service, if necessary. Some of their products include a front panel interface card, the Golem-80 S-100 Troubleshooter, a Station Controller Card, and more. Snow Micro software

includes AMS-80 Version 5.8 debug packages, object code and source code, and other AMS-80 software related items. For prices and information, contact Snow Micro Systems at the above address.

Circle 443 on inquiry card.

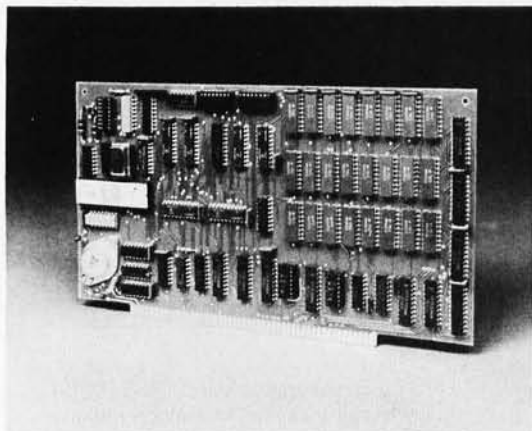


What's New?

MISCELLANEOUS

Video Graphics for S-100 Bus Systems

A single-card, high-density, computer-display system is being offered for the S-100 bus by International Product Development Incorporated (IPDI). The VG100 is designed for text-oriented applications. It has programmable fonts allowing any set of up to 256 characters to be defined in programmable memory with available software. The system can generate a combination of 16 gray levels or 16 colors, or combinations of both. The



character field is 9 by 16 (or 144) pixels with a raster scan of 621 pixels. The entire character field can be changed at one time for fast animation. Adjoining character fields of any shape can be combined to create large continuous characters. The VG100 is configured in 12 K bytes of programmable memory and is selectable in three 4 K-byte blocks. The price is \$645. For details, contact IPDI, 1708 Stierlin Rd, Mountain View CA 94043.

Circle 589 on inquiry card.

Serial Interface Card for Apple II Computers

California Computer Systems' 7710A Asynchronous Serial Interface card enables the Apple II to communicate with all RS-232C serial devices. It is fully compatible with Apple Pascal. The card features selectable data rates from 50 to 19,200 bits per second (bps), 8- or 9-bit character transmission, and optional odd, even, or no parity. Software programmable interrupts, double buffered data input/output (I/O), and full handshaking are included. It is available in kit form or fully assembled and tested. The price for the card is \$159.95. For more information, contact California Computer Systems, 250 Caribbean, Sunnyvale CA 94086.

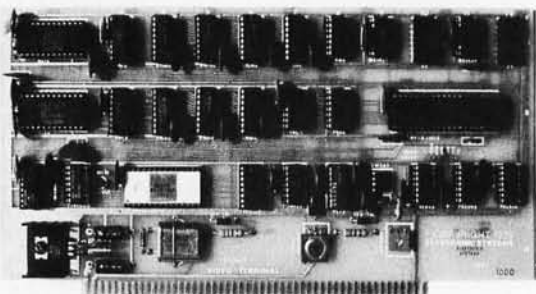
Circle 592 on inquiry card.

Percom Board Interfaces Speak & Spell to Computer

Percom Data Co, 211 N Kirby, Garland TX 75042, has announced production of a printed circuit board which will interface the Texas Instruments Speak & Spell learning aid to a computer. The "Speak 2 Me 2" allows communication with a Speak & Spell in BASIC, so a computer can talk using the words and phrases of a Speak & Spell unit. The board is installed in the battery compartment. Installation involves disassembly and some modification of the Speak & Spell unit. The board with instructions, TRS-80 driver software, and a TRS-80 cable sells for \$69.95. The cable connects to the printer port and may be adapted for other computers.

Circle 593 on inquiry card.

Video Terminal Board



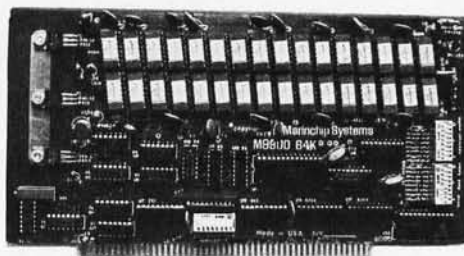
This board features full uppercase and lowercase, 5 by 7 dot matrix, 16 lines with 64 columns, and serial RS-232 input and output with parallel keyboard input. The data rate generator has a range from 75 to 1200 bits per second (bps) and is jumper-selectable. The board has 1 K byte of memory and an SFF96364 processor integrated circuit. The device is S-100 compatible. It requires ± 16 VDC at 100 mA and 8 VDC at 1A. The price is \$199.95 in kit form. Contact Electronic Systems, POB 21638, San Jose CA 95151.

Circle 590 on inquiry card.

64 K Byte Memory for Heathkit/Digital H11

The CI-1103 memory module is designed for the Heathkit/Digital H11, LSI 11/2, and PDP 11/03 computers. The product uses 200 ns cycle time, type-4027, 4 K by 1-bit dynamic memory parts or 200 ns, type-4116, 16 K dynamic memory devices. The CI-1103 is available with either on-board distributed refresh or external refresh control logic. Data access time is 300 ns and cycle time is 525 ns. On-board memory-select is available in 2 K increments up to 128 K words of memory. Power consumption is under seven watts. The 8 K by 16 board is \$390 and the 32 K by 16 board is \$750. For information, contact Chrislin Industries Inc, 31352 Via Colinas #102, Westlake Village CA 91361.

Circle 591 on inquiry card.



Head-Cleaning Floppy Disks from Lifeboat

Lifeboat Associates, 2248 Broadway, New York NY 10024, has an important product for floppy-disk systems: head cleaning disks. The head-cleaning floppy disks are manufactured by attaching a lint-free nylon mat to a mylar substrate. The design avoids damaging abrasion, which keeps head wear to within industry standards for normal magnetic media. The disk is used by inserting it into the drive in the same manner as a floppy disk, and loading the head for 30 seconds. It is recommended that this procedure be used once per day as prevention against oxide build-up. The disks are available in 5 1/4- and 8-inch sizes for \$20 each, or \$45 for three. Each disk is suitable for three months of daily use.

Circle 594 on inquiry card.

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What's New?

PUBLICATIONS

Hardside Announces Expanded New Catalog

Hardside, a mail-order hardware company in Milford, New Hampshire, has announced the release of an expanded version of the Hardside catalog. Hardside features Radio Shack computer products at a discount price and also peripherals from other manufacturers which are suited to work with the TRS-80. The company specializes in computers and related hardware. The Hardside catalog is free from Hardside, 6 South St, Milford NH 03055.

Circle 572 on inquiry card.

Monthly Newsletter Covers the Office Computing Industry

Entitled the *Office Computing Industry Report (OCIR)*, this monthly newsletter focuses on small-scale data processing, word processing, and data communications systems. OCIR also covers the merging of EDP and Business Machine distribution systems and support activities and the relationship of these new office computing systems to network-based information systems and distributed data processing. News analysis, market forecasts, new product reviews, vendor profiles, and technology forecasts are included. The *Office Computing Industry Report* is available from Vantage Research Inc, 2680 E Bayshore Rd, Mountain View CA 94043, for \$195 per year in North America and \$225 in Europe and Asia.

Circle 566 on inquiry card.

Supplies Catalog from Diablo

A 25-page brochure from Diablo Systems Inc, 24500 Industrial Blvd, Hayward CA 94545, illustrates and describes the variety of print wheels and ribbon cartridges designed for use on the company's Series 1640 and 1650, HyType, HyTerm, and matrix printers and terminals. The brochure contains a sample type line from all of the plastic and metallized daisy-wheel print elements. For copies of the brochure and the name of the nearest Diablo dealer, call (800) 227-2076, except in California where the number is (415) 443-2273.

Circle 567 on inquiry card.

S-100 Magazine Being Published



S-100 Microsystems is a new publication directed towards users of S-100 microcomputer systems. It is a forum on such S-100 topics as interfacing, CP/M, Pascal, Assembler, FORTRAN, and BASIC software. The magazine will also cover 16-bit microprocessors, multiprocessors, multitasking, time-sharing, word processing, system development, data base management, scientific, and other applications and issues. It will be concerned with S-100 systems such as Cromemco, North Star, Intersystems, IMSAI, Poly Morphics, Processor Technology (Sol), Xitan, and others.

S-100 Microsystems is edited by Sol Libes. Sol has written 13 books, many magazine articles, and has edited several newsletters. He is the founder and past president of the Amateur Computer Group of New Jersey, the largest personal computer organization in the world. The first issue of *S-100 Microsystems* includes the complete proposed Institute of Electrical and Electronics Engineers (IEEE) S-100 Standard, the first part of a tutorial on CP/M, an article on modifying the SDS Video Board for Pascal editor functions, the source code for an 8080 disassembler, a directory of Computerized Bulletin Board Systems (CBBS), and more. *S-100 Microsystems* will be published six times a year. A sample copy is \$2. For subscriptions and additional information, contact *S-100 Microsystems*, POB 1192, Mountainside NJ 07092.

Circle 568 on inquiry card.

Short Form Catalog and Price List

Sara-Tech Electronics Inc, POB 692, Venice FL 33595, has published a catalog which includes systems and peripherals from Cromemco, North Star, Centronics, Heath, and many more companies. They also have a listing for computer-paper forms for all systems. Sara-Tech sells systems, peripherals, and software of most major companies.

Circle 569 on inquiry card.

A Book on Computerized Typesetting

Donald Knuth, author of *The Art of Computer Programming*, has written *TEX and METAFONT, New Directions in Typesetting*, which describes new techniques in typesetting. Dr Knuth explains how TEX, originally designed for use in setting technical and mathematical text, can be applied to all computerized typesetting. METAFONT is a system for the design of alphabets. It is suited for implementation on raster-based devices that print or display text. With it, computers can draw new fonts of characters in seconds. TEX and METAFONT represent improvements in typesetting that will benefit the scientific and technical community. The book consists of three parts. The first is a lecture on mathematical typography; the two other parts describe TEX and METAFONT. The book costs \$12 and is available from Dept TM:X, Digital Press, Educational Services, Digital Equipment Corp, 12-A Esquire Rd, N Billerica MA 01862.

Circle 570 on inquiry card.

Software Catalog for Heath Users

The Heath Users' Group has published a catalog of programs written by Heath users for all Heath computers. The programs described include games, financial applications, utilities, computer-assisted education, and amateur radio. The catalog lists the language and designated computer next to the program. Prices are given, along with services of the Users' Group. For more information, contact Heath Users' Group, Hilltop Rd, St Joseph MI 49085.

Circle 571 on inquiry card.

What's New?

SYSTEMS

Intellivision from Mattel

Mattel Electronics is introducing six cartridges for its home computer system, Intellivision Intelligent Television.

Soccer, Golf, Skiing, Boxing, Tennis, and Sea Battle join the existing fourteen cartridges, which range from sports and games to children's learning. Intellivision's Master Component contains a 16-bit microprocessor that delivers simulated sound effects, three-part harmony, and color reproduction. Two 12-button, hand-held controllers, each with four play-action keys, and a 16-directional control knob for movement of screen objects are included. The unit attaches to any television set.

The Keyboard Component uses programmed cassettes and features a keyboard and a digital cassette system with fast-forward and tape search.

Its programs include Physical Fitness, Speed Reading, Stock Analysis,

and Guitar Lessons. The Master Component will retail for approximately \$300 or less. The Keyboard Component will cost around \$550 and the cartridges will cost approximately \$30, with the cassettes priced slightly under \$30. For information, contact Mattel Electronics, 5150 Rosecrans Ave, Hawthorne CA 90250.



Circle 586 on inquiry card.

Computer System from NNC

NNC Electronics, 15631 Computer Ln, Huntington Beach CA 92649, has released the System 80 computer. The System 80 uses a 4 MHz Z80 microprocessor and features a floppy-disk controller and two dual-density, 8-inch disk drives, 32 K bytes of programmable memory, two serial ports, and the CP/M operating system. The eight-slot S-100 card cage has five slots available for expansion. The desktop unit weighs less than 29 kg (65 pounds) and retails for \$3995.

Circle 587 on inquiry card.

Altos Announces a Hard-Disk System

The Altos Systems ACS8000-6 can take advantage of as much as 58 megabytes of hard disk storage. The system can control up to four 14.5-megabyte Shugart disks using Winchester-type technology. Altos designed the ACS8000-6 series so that it handles up to four

floppy-disk drives. The floppy units could accommodate another 4.0 megabytes of on-line storage. The ACS8000-6 family comes with input/output (I/O) control to support two serial and two parallel ports in addition to the four serial ports to which the users are connected. The hard-disk controller features direct memory access (DMA) operation; firmware address checking; a high-speed first-in, first-out (FIFO) buffer; and intelligent sequencing. The controller firmware contains a routine that automatically double-checks all addresses before performing any disk writes. The FIFO enables the system to transfer data at a 7 million bits per second (bps). The system will support asynchronous, bisynchronous, and networking communications protocols and configurations. Prices range from \$9450 for a single-user system with two floppy-disk drives and one 14.5-megabyte hard disk, to \$14,260 for the four-user, 29-megabyte system with two dual-sided floppy-disk units. For details, contact Altos, 2338A Walsh Ave, Santa Clara CA 95050.

Circle 588 on inquiry card.

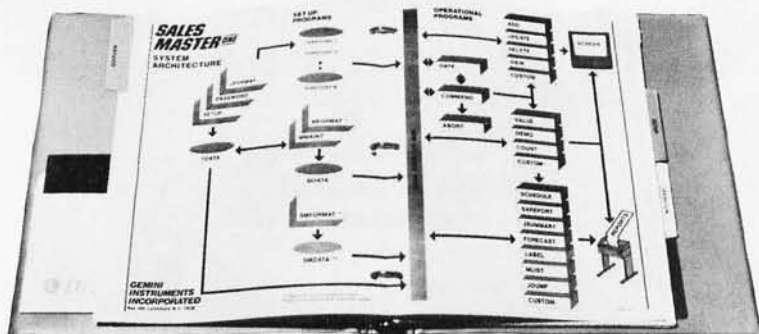


What's New?

SOFTWARE

A North Star Program for Salesmen

The Sales Master One is a collection of 22 programs designed by salespeople for salespeople. The Sales Master One is territory-oriented, allowing users to pinpoint selling activities to a particular location. The system generates reports on sales activities,



forecasts, and schedules. Various other reports assist in daily selling efforts. The system has room for 400 jobs on one 5¼-inch floppy disk. The package contains a program that allows modifications to be made without the need to refer to the operations manual. A customized disk-operating system allows the package to be run on Cromemco, Dynabyte, and Processor Technology computers. Sales Master One comes on a 5¼-inch floppy disk with a manual for \$375. Contact Gemini Instruments Inc, POB 205, Larchmont NY 10538.

Circle 573 on inquiry card.

Software from Compucolor

Compucolor Corp, POB 569, Norcross GA 30091, has released several software programs for the Compucolor II system.

The BASIC Editing package features six programs including FRED (Friendly Editor), RENUM (Renummer), MERGE, COMPAC, REMPAC (Deletes Remarks), and BASSRC (BASIC-to-Source Conversion). FRED, the most

useful of the programs, allows the user to edit any line, move existing lines, delete a range of lines, and to search for the occurrence of any string, variable, or command within a program. The package comes on a floppy disk and costs \$29.95.

Statistics is a series of three disks that is useful for engineering applications. The floppy disks are entitled *Statistics I, II, and III*. Each disk contains five programs including plot, stat, polreg (polynomial regression), index, and

more. Common to all three packages is a file manager program that generates, maintains, and displays files for use by other programs. *Statistics I* sells for \$24.95. *Statistics II* and *III* sell for \$29.95 each.

Compucolor has also released Soundware. This program includes the software and hardware necessary to create sounds on the Compucolor II. It is written in BASIC, with a range of two to three octaves. The price is \$49.95.

Circle 574 on inquiry card.

TLC-LISP for Z80 Systems

The LISP Company has announced its version of the LISP language for the Z80. TLC-LISP allows manipulation of functions as data objects; promotes object-oriented programming style; defines functions with a variable number of parameters; includes structured iteration and nonstructured escape mechanisms; contains complete string and character processing capabilities; and includes fixed- and floating-point arithmetic. The language system also contains a table-driven scanner; com-

prehensive error control, an autoload feature that "virtualizes" infrequently used functions and constants to disk files, freeing programmable memory; and execution speeds comparable to a KA-10 running MACLISP. Over 150 utility functions are provided. TLC-LISP is available for Z80 CP/M systems and other versions will be available soon. A detailed manual is \$15, and the system on 5- or 8-inch floppy disks is \$150. Write The LISP Co, POB 487, Redwood Estates CA 95044.

Circle 575 on inquiry card.

Software Catalog for TRS-80 Level II

National Software Marketing Inc, POB 6195, Hollywood FL 33021, has announced a free catalog of software for the TRS-80 Model II. The software described includes accounts receivable and payable, general ledger, payroll, inventory, rental management, and a variety of financial and mathematical programs. These systems will operate on the 64 K-byte model with the built-in disk. The programs have list prices of \$15 to \$100.

Circle 576 on inquiry card.

A Gomoku Program

Five Stones Software, POB 1369, Station B, Ottawa, Ontario, K1P 5R4, CANADA, has released a Gomoku program for North Star Horizon disk-operating systems and CP/M-based systems. The program features a book of openings with 200 entries, the ability to take back moves, a 19 by 19 board, recent moves displayed along with the board, and the ability to customize to different screen sizes. The program requires a minimum of 32 K bytes of programmable memory and is available on 5-inch floppy disks for \$29.95.

Circle 577 on inquiry card.

PLMX — A Language That Communicates with All 8- or 16-bit Microprocessors

PLMX is a universal high-level language for microprocessors. It can be used with all 8- or 16-bit microprocessors and was designed primarily for use in microcomputer product development systems and in real-time process-control applications. PLMX syntax is identical to PL/M, so the entire library of existing PL/M programs can be compiled under PLMX. PL/M programs may be used on microprocessors other than the 8080 through

the PLMX compiler. PLMX is a true compiler, allowing fast compiling times — useful for real-time applications. It has been developed as a user-oriented language. There are no arbitrary formatting rules or line numbers. Comments may occur anywhere in the source text, except within reserved words, identifier names, and numbers. PLMX is priced at \$1000, which includes an 8-inch compiler floppy disk and instruction manuals. To obtain additional information, write Systems Consultants Inc, Product Development Group, 4015 Hancock St, San Diego CA 92110.

Circle 578 on inquiry card.

What's New?

SOFTWARE

High-Speed Sort Utility for Ohio Scientific

BPSort is a high-speed, assembly language, sort/merge utility program for Ohio Scientific floppy and hard disk systems. It is capable of sorting 20 K bytes in ten seconds. Files can be an entire hard or floppy disk in length. BPSort handles fixed length records. Five keys can be specified for ascending and/or descending sequence. Sort parameters are established using a BASIC program. BPSort is OS-DMS compatible and is supplied as part of the BPS, an interactive data management system. It is sold in single-user licensed copies for \$124. Earlier versions can be updated for \$25. Order from BPS, 322 W 57th St, New York NY 10019.

Circle 579 on inquiry card.

Microsoft Announces TRS-80 Model II Software

Microsoft is selling TRSDOS-compatible versions of its COBOL and BASIC compilers for the TRS-80 Model II. Both compilers provide complete facilities for commercial or in-house software development, including

Microsoft to Market muLISP and muMATH

Microsoft has become the distributor for muLISP-79 and muMATH-79, which were written by the Soft Warehouse of Honolulu, Hawaii. muLISP offers all of LISP's programming features, including 83 LISP functions, flexible program-control structures, and infinite precision integer arithmetic in any desired radix (2 to 36). The modular muMATH symbolic mathematics package is useful for scientific and engineering applications. The muMATH routines are written in muSIMP, which is included in the

Microsoft's macroassembler and linking loader. The COBOL-80 compiler is an ANSI-74 implementation of COBOL. The BASIC compiler produces object code that runs faster than interpreted BASIC programs. All Microsoft BASIC language features are supported. The BASIC compiler is also available in a version for the TRS-80 Model I. Microsoft is the author of Radio Shack's BASICs. The BASIC compiler is \$395, and the COBOL-80 compiler is \$750. Contact Microsoft, 10800 NE Eighth, Suite 819, Bellevue WA 98004.

Circle 580 on inquiry card.

package. Both programs run with CP/M systems. The muLISP program costs \$200 and the muMATH/muSIMP-79 program is priced at \$250. Contact Microsoft, 10800 NE Eighth, Suite 819, Bellevue WA 98004.

Circle 581 on inquiry card.

Six Programs for TRS-80 Level II and Disk-Operating System

International Data Services has developed Microsketch III, a graphics program for the Level II with 16 K bytes of programmable memory for \$7.95. Freakout is a keyboard-generated graphics and sound program for the Level II with 4 K bytes of programmable memory for \$3.95. The number-base conversion program converts any base to any other base between 2 and 16. It is priced at \$3.95. Three other programs are available for disk BASIC with 16 K bytes of programmable memory. BASIC to Electric Pencil file conversion, machine language to BASIC data statement conversion, and mail-list file uppercase to uppercase-and-lowercase conversion programs all cost \$3.95. Contact IDS, 340 W 55th St, New York NY 10019.

Circle 582 on inquiry card.

RCA's BASIC I Compiler/Interpreter for COSMAC Development System

RCA's BASIC I Compiler/Interpreter CDP18S834 is a software package that can accelerate program development on the COSMAC DOS Development System CDP18S007. The package gives the user the option of developing and running programs in BASIC I or converting the programs to object code. The output of the compiler is assembled by the COSMAC macroassembler to produce the executable object code. Some of the features of the compiler/interpreter include: 70 characters per line, variable designation by a single capital letter, and fixed-point arithmetic. BASIC I functions include MOD, AND, OR, XOR, and USR. The USR function extends BASIC I by means of machine-language subroutines. Some of the statements available to the programmer are REM, LET, GOTO, IF, INPUT, WFLN, and NEW. With a manual, the package is priced at \$300. Contact RCA Solid State Div, POB 3200, Somerville NJ 08876.

Circle 583 on inquiry card.

A Data Base System for the TRS-80

V R Data Corp, 777 Henderson Blvd, Folcroft PA 19032, has announced a Data Base system for the TRS-80 Models I and II. The Data Base system provides the capability to define and create customized records for various applications. Records may contain up to 25 user-defined variable-length fields and up to 250 characters per record. A dictionary of the fields and their characteristics is maintained by the system. Records may be added, deleted, and extended; field contents may be changed, and fields may be removed or added to the record or renamed at any time. Records may also be linked logically. The records may be sorted by any combination of fields in ascending or descending order. Reports are fully user-definable and may be routed to a printer or the video display. This four-program BASIC system requires 48 K bytes of programable memory, a minimum of two disk drives and a line printer for the TRS-80 Model I, with 300 records per disk. Programs are available for the Model II with 950 records per disk.

Circle 584 on inquiry card.

Machine-Language Program for TRS-80 Disk Systems

The ST80-111 machine-language program is written for the TRS-80 Level II system. This package includes programs that allow users to talk to a time-sharing computer, transfer files to and from the central computer, and customize the ST80-111 system. Some of the programs included in the system are a BASIC program that creates translation tables, one that tells if a file is American Standard Code for Information Interchange (ASCII) or binary, a binary-to-ASCII conversion program, and one that changes machine-language programs to binary. The ST80-111 has been run on HP2000, IBM 370 and 360, PDP-11, Burroughs, Apple, and North Star systems. The minimum requirements for the system are the TRS-80 Level II with one disk drive and 16 K bytes of memory, an RS-232C board, and a modem. The package is produced by Small Business Systems Group, Main St and Lowell Rd, Dunstable MA 01827, and is priced at \$150.

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First word processor specifically designed for the TRS-80 that uses disk storage for text. Written in BASIC. No special hardware and text limit. Use for letters, manuals & reports. 32K version features upper/lower case without hardware change and multiple input text files

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* **\$100 CORE SALE:** Brand new, tested Ampex core. See article "IT'S TIME FOR CORE" (9/79 Kilobaud p. 34) which describes an easily built interface between this core and an S-100 machine. But ignore the prices in the article! Sale priced, including large documentation pkg. 8K boards \$99 16K boards \$230. Add \$4 for schematics of core.

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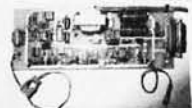
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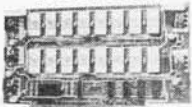
MT. HARDWARE Double the utility of your S-100 bus computer with a real-time clock that keeps time in 100µS increments for over 273 years. Program events for the entire period with real time interrupts...without derailing the system. Maintain a log of computer usage, time and date transaction printouts, call up lists...virtually any activity where time is a factor. On-board battery backup. MHPX004—\$249.95

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Originate, RS-232 and 20 mA compatible, Full duplex, and half duplex, direct connect or acoustic coupled, on board power supply, carrier detect light, DB25 plug, 300 BAUD, Type 103 compatible frequencies, Bare board Part No. 2000, \$19.95, Kit Part No. 2000A, \$99.95.

16K EPROM



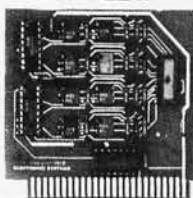
Uses 2708 EPROMs, memory speed selection provided, addressable anywhere in 65K of memory, can be shadowed in 4K increments. Board only \$24.95 part no. 7902, with parts less EPROMs \$49.95 part no. 7902A.

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There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection. Board only \$15.00. Part No. 120, with parts \$69.95. Part No. 120A.

VIDEO TERMINAL



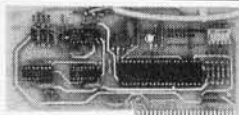
16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • Serial RS-232 in and out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & -16 VDC at 100mA, and 8VDC at 1A. Part No. 1000A \$199.95 kit.

PARALLEL TRIAC OUTPUT BOARD FOR APPLE II



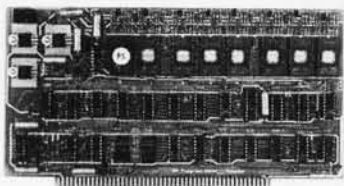
This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only \$15.00 Part No. 210, with parts \$119.95 Part No. 210A.

APPLE II SERIAL I/O INTERFACE



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• Programs 2708's address relocation of each 4K of memory to any 4K boundary • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software in 1 2708 EPROM \$25. Bare board \$35 including custom coil, board with parts but no EPROMS \$139, with 4 EPROMS \$179, with 8 EPROMS \$219.

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Fully S-100 bus compatible including 16-bit machines and 4 MHz processors. • Two software selectable Baud rates—300 Baud and a jumper selectable speed from 45 to 300 Baud. (110 standard). Supports originate and answer modes. • Direct-connect Microcoupler. This FCC-registered device provides direct access into your local telephone system, with none of the losses or distortions associated with acoustic couplers and without a telephone company supplied data access arrangement. • Auto-Answer/Auto-Call. The MICROMODEM 100 can automatically answer the phone and receive input; it can also dial a number automatically. • Automatic Reset and Disconnect. • Software compatible with the D.C. Hayes Associates 80-103A Data Communications Adapter. Micromodem-DCHA32625—\$379.95

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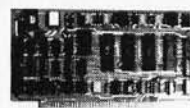
8080, 8085, or Z-80 System monitor for use with the TIDMA board. There is no need for the front panel. Complete with documentation \$12.95.

RS-232/TTY INTERFACE



This board has two active circuits, one converts RS-232 to 20 mA, the other converts 20 mA to RS-232. Requires +12 and -12 volts. \$9.95 Part No. 600A Kit.

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Four Serial I/O RS-232 ports. S-100 Bus, Software or jumper selectable baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19,2K), on board Xtal baud rate generator, Addressing, switch selectable, Parity or no parity (odd or even) switch selectable, 1 or 2 stop bits, 5 to 8 bits/character. Board only \$29.95, Part No. 7908. With parts (kit) \$199.95. Part No. 7908A.

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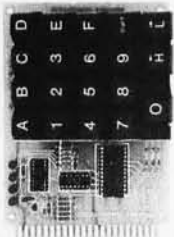


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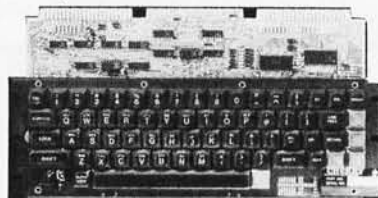
This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for \$249.95. Part No. TA 1000C

ASCII KEYBOARD

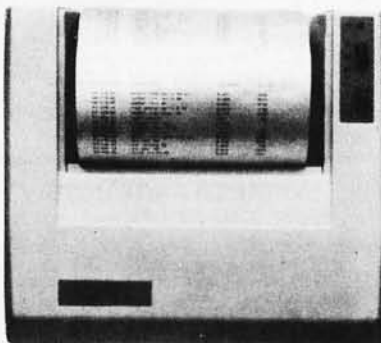
53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. \$59.95 Kit.

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TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. \$119.95.



COMPRINT PRINTER



Printing Characteristics: 225 characters/second (170 lines/minute) throughput • 9 horizontal x 12 vertical matrix • 96 ASCII character set with upper and true lower case • 80 characters/line • 5.8 lines/inch

Buffer Memory: standard 256 bytes; optional; 2,048 bytes (buffer memory option designated as Model 912-2K), add \$149.95.

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Model 912-S Interfacing: serial interface RS232 and 20 mA current loop • BAUD rates 110, 150, 300, 600, 1200, 2400 and 4800 are strap selectable.

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T.V. INTERFACE



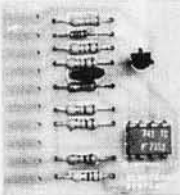
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple • Power required is 12 volts AC C.T., or +5 volts DC • Board only \$7.60 part No. 107, with parts \$13.50 Part No. 107A

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Upper/lower case display • Numeric keypad & cursor keys • Protected fields, 1/2 intensity display • RS 232 interface & aux. port. IQ120—\$799.95 • IQ140 Detachable keyboard—\$1199.95

RS-32/TTL INTERFACE



• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin edge connector; kit \$9.95 Part No. 232A 10P edge connector \$3.00 part No. 10P.

DC POWER SUPPLY

• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only \$12.50 Part No. 6085, with parts excluding transformers \$42.50 Part No. 6085A



TAPE INTERFACE



• Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board only \$7.60 Part No. 111, with parts \$29.95 Part No. 111A

MODEM



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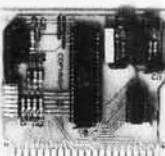
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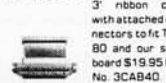
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- Can input into basic
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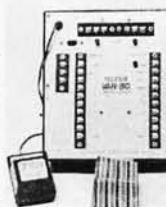
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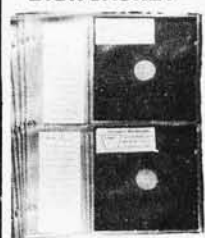
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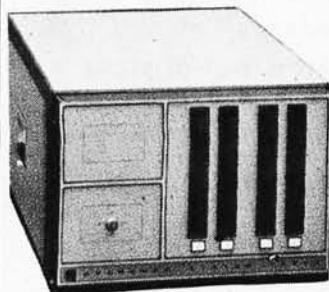
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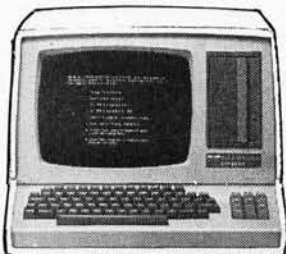
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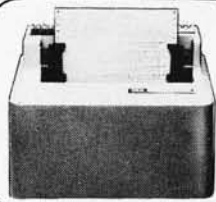


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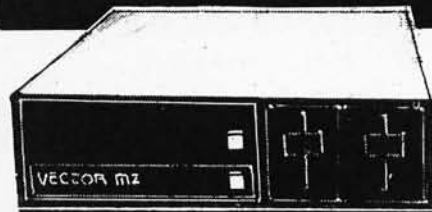
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The Super Elf includes a ROM monitor for program loading, editing and execution with SINGLE STEP for program debugging which is not included in others at the same price. With SINGLE STEP you can see the microprocessor chip operating with the unique Quest address and data bus displays before, during and after executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

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A 1K Super ROM Monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with

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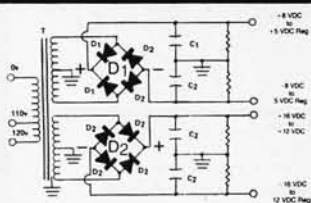
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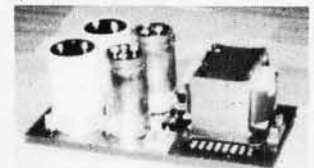
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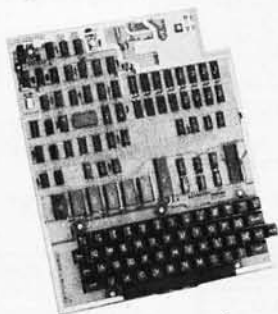
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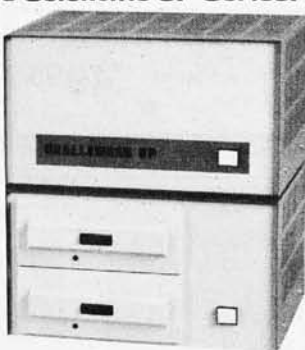
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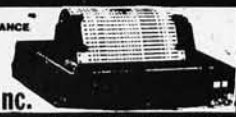
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Vacuum based light duty vise for precision handling of small components and assemblies.
Rugged ABS construction. 1 1/2 in. wide jaws, 1 1/2 in. travel for maximum versatility. Also features screw lugs for permanent installation.
VV-1.....\$3.49

EPROM (5 Volt) \$29.90
2716

SD Systems KITS

27001	ExpandRAM Kit - Expandable RAM Board Kit (No RAMs)	\$220
27002	Versafloppy Flexible Disk Drive Controller Kit	250
27003	SBC-100 Single Board Computer Kit	295
27004	Z80 Starter Kit	340
27007	ExpandEPROM Kit	175
27010	Add-on RAM (16K Devices) 4116 (250ns) (package of eight devices)	165
27011	VDB-8024 Video Display Board Kit	370
27012	ExpandRAM II Expandable RAM Board Kit (16K RAM)	460
27013	Versafloppy II Flexible Disk Drive Controller Kit	350
27014	PROG-100 PROM Programmer Board Kit	200
27015	MPB-100 Z80 Central Processing Unit Board Kit	250
27017	Add-on RAM (16K devices) 4116 (200ns)	250
27018	SBC-200 Single Board Computer Kit	320
27024	ExpandRAM II Expandable RAM Board Kit (No RAMs)	230

NEW HICKOK LX 304 DIGITAL MULTIMETER
Compact Accurate Dependable **\$8995**

Light Emitting Diode ED95 Red-Orange and Green
Color mixing possible due to separate anode terminals. **ONLY \$1.60**

SD Systems ASSEMBLED

38001	ExpandRAM (16K of on-board RAM)	\$ 480
38002	ExpandRAM (32K of on-board RAM)	620
38003	ExpandRAM (48K of on-board RAM)	760
38004	ExpandRAM (64K of on-board RAM)	900
38005	Versafloppy Flexible Disk Drive Controller	335
38006	SBC-100 Single Board Computer	350
38007	Z80 Starter System	450
38010	ExpandEPROM	245
38011	Cable for 8" Disk Drives	80
38013	VDB-8024 Video Display Board	470
38016	Cable, 8th, 26 Pin Edge Connector (see end)	50
38017	Cable for SD-100/SD-200 Interface Texas Instruments 810 Printer	80
38018	Cable, same as above (Internal)	120
38019	Cable, same as above (External)	80
38020	ExpandRAM II (16K Population)	610
38021	ExpandRAM II (32K Population)	840
38022	ExpandRAM II (48K Population)	1070
38023	ExpandRAM II (64K Population)	1300
38024	Versafloppy II Double Density Flexible Disk Drive Controller	430
38025	PROG-100 PROM Programmer	265
38026	MPB-100 Z80 Microprocessor Board	325
38028	SBC-200 Single Board Computer	400

Flasher LED
FRL-4403 Red LED and Flasher IC Chip **92c ea.** in One Package

Universal Oscilloscope Probe
\$36.00

SWITCHABLE X1 and X10 ATTENUATION FACTOR
KEY ADDITIONAL FEATURES: • 100 MHz bandwidth • Heavy duty tip • Break resistant center conductor • Slender, flexible cable • 6 ft. length • Wide compensation range • Fits all scopes • Ground reference can be activated at tip • Includes SPRUNG HOOK, I.C. TIP, BNC ADAPTOR, INSULATING TIP and TRIMMER TOOL accessories

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Radio Hut
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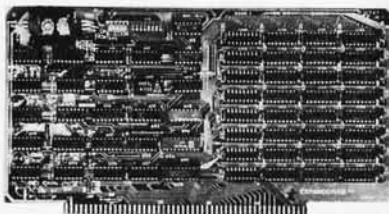
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ORDERING INFORMATION & TERMS: Orders under \$15.00 add 75c handling. No C.O.D. We accept Visa, MasterCard, and American Express cards. Tex. Res. add 5% tax. Foreign orders (except Canada) add 20% P&H. 90 Day Money Back Guarantee on all items. Add 5% P&H, maximum \$5.00.
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The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the invisible on-board refresh, and IT WORKS!

- Bank Selectable
- Phantom
- Power 8VDC, +16VDC, 5 Watts
- Lowest Cost Per Bit
- Uses Major Brand 16K RAMS
- PC Board is doubled solder masked and has silk-screened parts layout
- Extensive documentation clearly written

SD EXPANDORAM



- Complete kit includes all Sockets for 64K
- Memory access time: 375ns, Cycle time: 500ns.
- No wait states required
- 16K boundaries and Protection, via Dip Switches
- Designed to work with Z-80, 8080, 8085 CPU's

EXPANDORAM 64K Kit (16K Ram)

16K	\$239.95
32K	309.95
48K	379.95
64K	449.95

SD'S PROM 100 PROM Programmer Board
The PROM-100 Programmer is a development tool for S-100 Bus computer systems. The Zero Insertion Force Programming Socket extends above the card cage height for easy access to PROM devices. Software verifies PROM erasure, verifies program loading and provides for reading of object file from Disk or PROM and programming into PROM/EPROM. Features include: On-board generated 25vdc Programming pulse, TTL compatible, maximum programming time for 16,389 bits is 100 seconds. Programs: 2708, Intel 2758, 2716, 2732 and TI 2516. DIP Selectable EPROM type.

PROM-100 Board Kit \$149.95

SD'S SBC-200 SINGLE BOARD COMPUTER Kit \$289.95
S-100 Bus compatible and based on the powerful Z80 microprocessor, the SBC-200 meets the needs of a Z-80 CPU board with many additional features. Ideal for Industrial and control applications. All of the same features that have made the SBC-100 famous, PLUS 4MHz OPERATION. • S-100 Bus Compatible • Z80 Central Processing Unit • 1024 Bytes of Random Access Memory • 8K Bytes of PROM using 2716 • Serial Input/Output Port (with Asynchronous and Synchronous Operation) • Parallel Input and Output Ports • Four Channel Counter/Timer (Z80-CTC) • Software Programmable Baud Rate Generator • No-Front Panel Required for Operation • 4 MHz Operation.

SD'S VERSAFLOPPY II
• IBM 3740 Compatible Soft Sector Format for Single Density Drives • Operates with Single and Dual Sided Drives, Single or Double Density Drives and 5" & 8" Drives — in any combination of two simultaneously • Drive Select and Side Select Circuitry • S-100 Bus Compatible • Vectored Interrupt Operation Optional • Phase Locked Loop Data Recovery Circuit • Operates with Z80 CPU's • Uses FD1791-1 Controller Chip • The Versafloppy II incorporates all the possible features of a flexible disk drive into one board. Capable of handling four drives simultaneously, combinations of any variety are possible, such as 5" single sided, 8" dual density dual sided, 5" dual density single sided. Most popular drives are controlled directly with the Versafloppy II. The operating system for the Versafloppy II is the extremely powerful SDOOS available for SD Systems. Diagnostic and control software available to complete your disk system.
KIT \$335.95

SD'S VDB-8024 VIDEO DISPLAY BOARD
The VDB-8024 features its own on-board Z80 microprocessor. This gives the capability of using software (included in ROM) to control functions and enhancements without interference with the computer's CPU. Included in the special features: 80 characters by 24 lines display, keyboard power and interface, composite and separate video output, 2K on-board RAM, a total of 256 available characters, full cursor control, forward and reverse scrolling, underlining, field reverse, field protect enhancements, programmable characters.
KIT \$329.95 A&T \$389.95

SD'S "VERSAFLOPPY I" KIT
FEATURES: IBM 3740 soft sector compatible, S-100 BNS Compatible for Z-80 or 8080. Controls up to 4 drives (single or double sided). Directly controls the following drives: Sugart SA400/450 Mini Floppy • Shugart SA800/850 Standard Floppy • PERSCI 70 and 277 • MFE 700/750 • CDC 9404/9406
\$189.95

SD'S SBC-100 SINGLE BOARD COMPUTER
The SBC-100 provides a complete micro-computer on a single board! The Z80 microprocessor is used as the heart of the SBC-100. The SBC-100 meets all the requirements of a Z80 CPU board with the added features of I/O ports, counter/timer channels, on board RAM, provisions for PROM/ROM and a software programmable baud rate generator. S-100 Bus compatible, the SBC-100 features are: 8K bytes of available PROM, 1024 bytes on-board RAM, Serial I/O with both synchronous and asynchronous operation, Parallel I/O ports, Operational Vectored Interrupts, and Four Counter/Timer Channels. SD Monitor available for RS-232 and Video Terminals. Disk based system software also available.
SBC-100 KIT \$249.95

TARBELL FLOPPY DISK INTERFACE
Compatible with Z80 & 8080. S-100 Bus. Uses CPM operating system. Plugs directly into your IMSAI or ALTAIR • Fastest transfer rate
KIT \$190.00 Assembled & Tested \$260.00

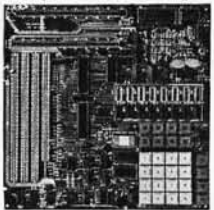
SSM CB2 Z-80 CPU Board Kit \$186.00
Operates at 2 MHz or 4 MHz by DIP switch selection and includes two sockets for 2716 or 2732 EPROMs or TMS 4016 2K RAMs. Jumper options generate the new IEEE S-100 signals.

SSM VB3 80 Character Video Board Kit \$299.95
• 80 char. per line, up to 51 lines • Graphics up to 160 x 204 matrix • Up to 256 user defined symbols (optional EPROM) • Composite video.

PB1 2708/2716 Programmer & 4K/8K EPROM Board Kit \$124.00
• S-100 bus • 2 separate programming sockets for 2708 or 2716 (5V) EPROMs • Programming voltage generated on board — no need for an external power supply • Software control of 2708/2716 programming selection • LED indicator for programming mode and an on-off switch for programming voltage • 4 sockets for 4K of 2708 or 8K of 2716 EPROMs • Unused EPROM sockets do not enable data bus drive so the board is never committed to the full 4K or 8K of memory • Jumper selectable wait states (0-4) for fast or slow EPROMS

TARBELL CASSETTE INTERFACE
Plugs directly into your IMSAI or ALTAIR • Fastest transfer rate • Extremely reliable • Phase encoded • 4 extra status & control lines
KIT \$99.95

Z80 STARTER KIT
Kit: \$279.95 Assembled & Tested \$349.95
SD System's Z80 Starter Kit enables the novice to build a complete microcomputer on a single board. Featuring the powerful Z80 microprocessor, the Z80 Starter Kit features • Keyboard and Display • Audio Interface • PROM Programmer • Expansion and Wire Wrap Area • On Board RAM • 4 Channel Counter/Timer • Z-BUG Monitor in PROM • I/O Ports.



NOVATION CAT ACOUSTIC COUPLER/MODEM \$189.00
Let your computer communicate with other computers. Bell Systems 103 compatible 300 baud, answer or originate.

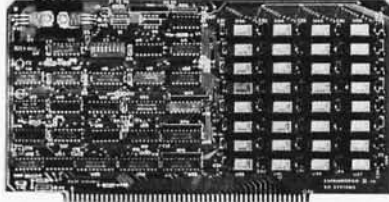
SYM-1
Reg. \$269.00
NOW \$219.00
• KIM-1 Compatible
• 4K ROM Monitor
• 1K Bytes 2114 RAM
• 65K Memory Expansion
• User EPROM 2716

I04 2 Parallel/2 Serial I/O Board Kit \$126.00
• S-100 bus • 2 serial I/O ports (2 in & 2 out) • Independent baud-rate selection from 55 to 9600 baud • Regulated +5V, +12V & -12V outputs provided on both serial headers • 2 latched parallel I/O ports (2 in & 2 out) • Independent DIP switches for setting address • Interrupt capability provided for on serial and parallel I/O ports • +8V @ 0.95A, +16V @ 0.6A, & -16V @ 80mA typical **SSM**

VB1B VIDEO BOARD KIT \$124.00
• S-100 bus • 64 or 32 characters per line (DIP switch selectable), 16 lines • Graphics 128x48 matrix • Upper case, lower case, Greek characters, symbols and numbers • 7x9 dot character matrix • Black-on-white or white-on-black • Timing 60Hz vertical rate, 16.2KHz horizontal rate, Crystal 12.44MHz • Parallel and composite video output (US TV signals), separate video, horizontal and vertical sync **SSM**

- S-100 Bus Compatible
- Up to 4Mhz Operation
- Expandable Memory from 16K to 256K
- DIP Switch Selectable Boundaries
- Uses 16K (4116) or 64K (4164) Memory Devices
- Page Mode Operation Allows up to 8 Memory Boards on Bus
- Operates with Z80 CPU's
- Phantom Output Disable
- Invisible Refresh (Synchronized with Wait States)

SD'S EXPANDORAM II The Random Access Memory



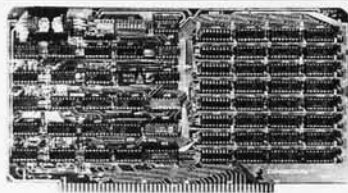
SD Systems' ExpandoRAM II is a dynamic RAM board with capacities from 16K bytes (4116) to 256K bytes (4164). It operates on the industry S-100 Bus. The design allows 8 boards to operate from the same S-100 Bus. The ExpandoRAM II is compatible with most S-100 CPU's based on the Z80 microprocessor.

EXPANDORAM II KIT

16K	\$295.95
32K	369.95
48K	444.95
64K	519.95

JADE. INFLATI FOR THE 80's.

OPENING BOUT



EXPANDORAM

Expandable to 64K Using 4116 RAMS

Interfaces with most popular S-100 boards
Bank selectable; PHANTOM provision
Draws only 5 watts fully populated
Designed to work with Z-80, 8080, and 8085 systems
No wait states required
16K boundaries & protect via dip switches
Kits come with sockets for full 64K
Invisible refresh

MEM-64133K 64 K KIT	\$399.95
MEM-64133A A&T	\$449.95
MEM-48132K 48K KIT	\$334.95
MEM-48132A A&T	\$384.95
MEM-32131K 32K KIT	\$269.95
MEM-32131A 32K A&T	\$319.95
MEM-16130K 16K KIT	\$204.95
MEM-16130A 16K A&T	\$259.95

Sale Price \$475.00

32K STATIC RAM

Expandable 8K/32K, 2/4MHz, KIT/A&T

Switchable 2 or 4 MHz

THE JADE BIG Z

Z-80A CPU with Serial I/O Port

This CPU can accommodate a 2708, 2716, or 2732 EPROM in SHADOW mode, allowing you to use a full 64K of RAM. The MWRITE signal is generated automatically if you use the board without a front panel. There's also an independent on-board USART to control the RS232 serial port at baud rates from 75 to 19,200.

We've sold thousands of these high quality S-100 CPU boards at \$159.95; but now, in a brief fit of financial insanity, we're offering them to you for only \$135.00!

Don't pass this one up!

CPU-30201K (KIT)	\$135.00
CPU-30201A (A&T)	\$199.00
CPU-30200B (BARE BOARD)	\$35.00

S D Systems

EXPANDORAM II

4 MHz RAM Board Expandable to 256K

S-100 bus compatible, up to 4 MHz operation
Expandable memory from 16K to 256K
Dip switch selectable boundaries
Page-mode allows up to 8 boards on the same bus
Invisible refresh; PHANTOM output disable
Designed to operate in Z-80 based systems

MEM-64633K 64K KIT	\$509.95
MEM-64633A 64K A&T	\$559.95
MEM-48632K 48K KIT	\$439.95
MEM-48632A 48K A&T	\$489.95
MEM-32630K 32K KIT	\$359.95
MEM-32630A 32K A&T	\$409.95
MEM-16630K 16K KIT	\$279.95
MEM-16630A 16K A&T	\$329.95

Solid State Music

PB-1

EPROM Programmer for 2708 or 2716

MEM-99510K (KIT)	\$125.00
MEM-99510A (A&T)	\$175.00

JADE DOUBLE-D

Double Density Disk Controller

Read/write single or double density, 8" or 5 1/4" drives
On board Z-80 insures reliable operation
CP/M compatible in either single or double density
Density is software selectable

Up to 4 single or double sided, single or double density drives may be mixed on the same system
EIA level serial printer interface on board-up to 9600 baud (perfect for despooling operations)

All the hard work of disk access is done by the on board Z-80A and 2K memory, leaving your host CPU free for its normal duties

Uses IBM standard formats for proven reliability

THIS BOARD REALLY WORKS!!!!!!

IOD-1200K (DOUBLE-D KIT)	\$285.00
IOD-1200A (DOUBLE-D A&T)	\$349.00
IOD-1200D (MANUAL ONLY)	\$15.00

Terminal Sale

ADDS REGENT

Our Finest Line of Terminals

REGENT 20 \$795.00

24 lines X 80 characters, EIA and 20ma current loop interfaces, 110 to 9600 baud, 96 ASCII codes plus 32 control codes, both upper and lower case, 8 X 8 dot matrix, reverse video, auxiliary EIA serial interface, and addressable cursor.

REGENT 25 \$850.00

All the features of the Regent 20 plus an 18 key numeric and cursor control pad.

REGENT 40 \$1195.00

All the features of the Regent 20 plus a 14 key numeric pad, 8 function keys, 5 cursor control keys, auxiliary port control key, reverse video, underline, blinking, plus full, half, and zero intensities, 8 X 8 dot matrix, 11 special line drawing symbols, reverse scrolling, and send/receive capability using the Regent 40's bi-directional interface.

REGENT 60 \$1495.00

All the features of the Regent 40 plus Print Local, Editing, and Transmission Mode keys, business graphics, bar charts, histograms, and graphics, ability to insert or delete characters or lines, buffered mode reduces software needs, and can transmit data at baud rates other than rate received.

Special Package Price

RS-232 SET-\$6.50

1 Male DB-25, 1 Female DB-25, 1 Cover

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Magnificent Magnetic Media™

5 1/4" single sided, single density, box of 10	
MMD-5110103 (SOFT SECTOR)	\$29.95
MMD-5111003 (10 SECTOR)	\$29.95
MMD-5111603 (16 SECTOR)	\$29.95
5 1/4" double sided, double density, box of 10	
MMD-5220103 (SOFT SECTOR)	\$39.95
8" single sided, single density, box of 10	
MMD-8110103 (SOFT SECTOR)	\$34.95
8" single sided, double density, box of 10	
MMD-8120103 (SOFT SECTOR)	\$55.95
8" double sided, double density, box of 10	
MMD-8220103 (SOFT SECTOR)	\$57.95

S D Systems

VERSAFLOPPY

Versatile Floppy Disk Controller

IBM 3740 soft sectored format
S-100 Z-80 or 8080 compatible
Controls up to 4 single or double sided drives
Compatible with all popular disk drives
CP/M compatible
Listings for control software included

IOD-1150K (KIT)	\$239.00
IOD-1150A (A&T)	\$289.00

S D Systems

Z-80 STARTER

Complete Z-80 Microcomputer

On-board keyboard, display, EPROM programmer, cassette interface and S-100 interface

Wire-wrap area and room for 2 S-100 connectors

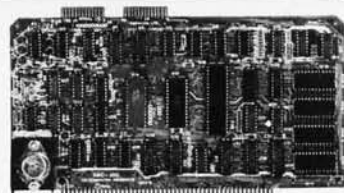
Two 8-bit parallel I/O ports, 4 channel CTC,

5 programmable breakpoints

Examine & change memory, I/O ports, or register

CPS-30010K (KIT)	\$239.95
CPS-30010A (A&T)	\$299.95

TITLE MATCH



S D Systems

SBC-100/200

2 or 4 MHz Single Board Computer

S-100 bus compatible Z-80 CPU

1K of on-board RAM

4 EPROM sockets accommodate 2708, 2716, or 2732

One parallel and one serial I/O port

4-channel counter timer chip (Z-80 CTC)

Software programmable serial baud rates

CPC-30100K (2 MHz KIT)	\$239.95
CPC-30100A (2 MHz A&T)	\$289.95
CPC-30200K (4 MHz KIT)	\$259.95
CPC-30200A (4 MHz A&T)	\$309.95

Coming Soon

NEW JADE P/S I/O

Parallel Serial Interrupt Board

Z-80 SIO, PIO, 2 CTCs, expands to 2 SIOs, 4 CTCs

4 serial ports (async, sync, bisync, SDLC/HDLC)

2 parallel ports with full handshake

Software baud rate generators, interval timers, counters,

and generates 32 vectored interrupts

Designed especially for MP/M multi-user multi-

tasking operating systems. For use with Z-80 only

IOI-1045B (BARE BOARD)	\$55.00
IOI-1045K (KIT)	\$169.95
IOI-1045A (A&T)	\$224.95

Solid State Music

I/O-4

2 Serial & 2 Parallel I/O Ports

IOI-1010K (KIT)	\$149.95
IOI-1010A (A&T)	\$199.95

ON FIGHTER ROUND #2.

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S D Systems VERSAFLOPPY II Double Density Disk Controller

Single or double density floppy disk controller
985600 bytes on 8" double sided diskettes
259840 bytes on double sided 5 1/4" diskettes
S-100 bus (IEEE) standard compatible
IBM 3740 format in single density
8" and 5 1/4" drives controlled simultaneously
Operates with Z-80, 8080, and 8085 CPU's
Controls up to 4 drives
Vectored interrupt operation optional
100-1160K KIT \$299.95
100-1160A A&T \$349.95

TKO CHAMPS

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Don't Miss Out on Our Special Sale Price

At last there is a machine designed to give serious competition to Apple and Radio Shack. This computer contains many advanced technical features such as: built in RF modulator for use with a standard TV; 8K of internal RAM (expandable to 48K), 8K BASIC language included; extremely sharp high-resolution color graphics; and built-in peripheral I/O ports. Software is available in plug-in paks and cassette tapes, with many programs available in the areas of entertainment, education, and business/home management.

Available accessories include a printer, disk drives, game controller paddles, and memory expansion cartridges.

And JADE has the Atari 800 in stock at a special introductory price.

ATARI 800	.....	\$825.00
810 DISK DRIVE	.....	\$575.00
820 PRINTER	.....	\$550.00
16K RAM EXPANSION KIT	.....	\$169.95
CX30-04 PADDLE CONTROLLER	.....	\$19.95
CX40-04 JOYSTICK CONTROLLER	.....	\$19.95
ATARI 400	.....	\$599.95

We Think It's Superior SDOS

A New Disk Operating System

SDOS is a disk operating system which will run any program that runs under CP/M*. It is designed specifically for use with the SBC-100/Versafloppy (I or II) board set by S.D. Systems. SDOS actually has more functions than CP/M, including file attributes, disk label, and read/write logical blocks. It provides additional protection features and is expandable to a multi-user realtime system. And if that doesn't impress you, SDOS also contains S.D.'s ASSEMBLER/EDITOR/LINKER package and CBASIC 2!

SFX-55001002M (5 1/4" W/MAN)	.....	\$150.00
SFX-55001006F (8" W/MAN)	.....	\$150.00
SFX-55001000D (MANUAL ONLY)	.....	\$ 15.00

*CP/M is a trademark of Digital Research

Textool

ZIP* DIP II SOCKETS

16 PIN ZIP* DIP II	.....	\$5.50
24 PIN ZIP* DIP II	.....	\$7.50
40 PIN ZIP* DIP II	.....	10.25

* ZERO INSERTION PRESSURE

COST FIGHTERS

RAMS		6800 SUPPORT	
211.02 (2 MHz)	..... \$1.25	6821P	..... \$5.95
211.02 (4 MHz)	..... \$1.50	6828P	..... \$11.95
211.4L (2 MHz)	..... \$5.75	6834P	..... \$12.95
211.4L (4 MHz)	..... \$5.95	6840P	..... \$18.75
4116 (250ns)	..... \$8.95	6850P	..... \$4.80
4116 (200ns)	..... \$9.50	6852P	..... \$5.79
4127 (70ns)	..... \$39.95	6875L	..... \$7.40
4164 (64K x 1)	..... \$175.00	68488P	..... \$25.00
5257 (2 MHz)	..... \$6.75		
5257 (4 MHz)	..... \$7.25		
BAUD RATE GENERATORS		PROMS	
MC14411	..... \$10.00	2708 (450ns)	..... \$8.95
CRYSTAL	..... \$4.95	2716 (450ns)	..... \$34.95
		2716 (5v)	..... \$34.95
		2732 (5v)	..... \$95.00
		2758 (5v)	..... \$34.95
SUPPORT DEVICES		MICROPROCESSORS	
8212	..... \$2.50	Z-80	..... \$10.95
8214	..... \$4.65	Z-80A	..... \$12.50
8216	..... \$2.95	6502	..... \$11.50
8224	..... \$3.25	6800	..... \$11.95
8226	..... \$3.85	6802	..... \$17.95
8228	..... \$4.95	6809	..... \$39.95
8238	..... \$4.95	8035	..... \$24.00
8243 \$8.00	8035-8 \$24.00
8250 \$14.95	8080A \$6.59
8251 \$6.50	8085 \$15.95
8253 \$13.95	TMS9900JL \$39.95
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8257 \$19.95	UARTS	
8259 \$17.95	AY5-1013A \$5.25
8275 \$49.95	AY3-1014A \$8.25
8279 \$8.95	TR1602B \$5.25
3881	..... \$12.95	TMS6011	..... \$5.95
3882	..... \$12.95	IM6403	..... \$9.00
3883	..... \$45.00		

Special Package Price ROCKWELL AIM-65 The Head-Start in Microcomputers

KIM-1 compatible
On-board printer
Full ACSII keyboard
AIM-65 w/1K RAM. \$395.00
AIM-65 w/4K RAM. \$439.95
8K BASIC ROM. \$100.00
POWER SUPPLY. \$59.95
CASE for AIM-65. \$49.95
4K Assembler/Editor. \$85.00



Special Package Price \$599.00
4K AIM-65, 8K BASIC ROM, Power Supply, and Case.

JADE Memory Expansion Kits FOR

TRS-80 APPLE EXIDY

Everything you need to add 16K of memory to your computer. Your kit comes neatly packaged with easy to follow instructions. In just minutes your computer is ready to tackle more advanced software.

\$59.95

Integral Data Systems THE PAPER TIGER 132 Column Dot Matrix Printer

Up to 198 CPS
1.75 to 9.5 inch adjustable tractor.
Parallel and serial interface.
98 character ASCII set.
80 to 132 columns.
6 or 8 lines per inch.
Eight software selectable character sizes.
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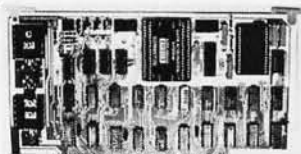
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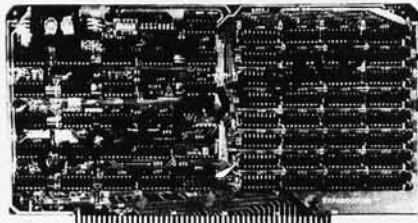
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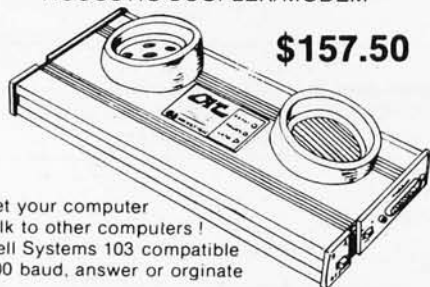
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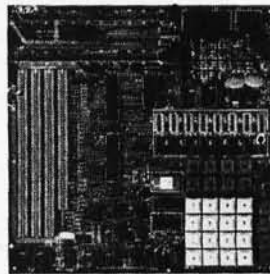
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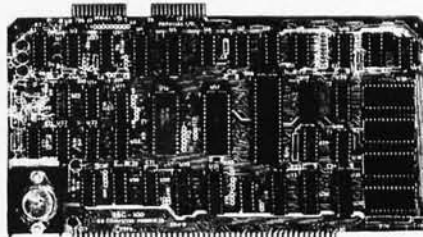
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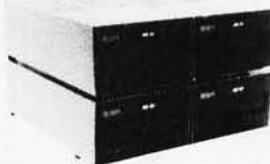
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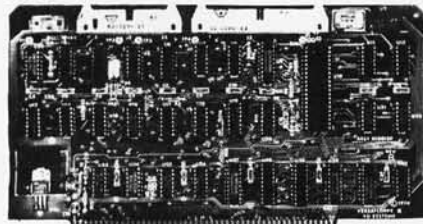
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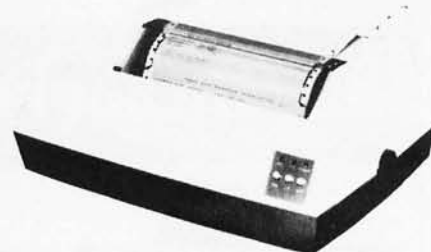
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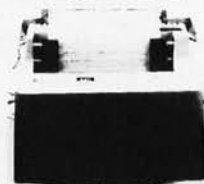
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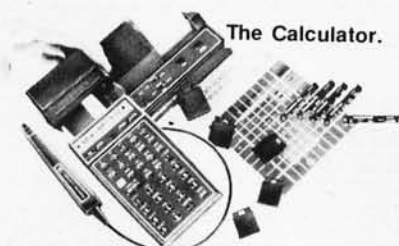
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SN7429N	.25	SN7439N	.45
SN7430N	.25	SN7440N	.45
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SN7432N	.25	SN7442N	.45
SN7433N	.25	SN7443N	.45
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SN7435N	.25	SN7445N	.45
SN7436N	.25	SN7446N	.45
SN7437N	.25	SN7447N	.45
SN7438N	.25	SN7448N	.45
SN7439N	.25	SN7449N	.45
SN7440N	.25	SN7450N	.45
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SN7442N	.25	SN7452N	.45
SN7443N	.25	SN7453N	.45
SN7444N	.25	SN7454N	.45
SN7445N	.25	SN7455N	.45
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SN7447N	.25	SN7457N	.45
SN7448N	.25	SN7458N	.45
SN7449N	.25	SN7459N	.45
SN7450N	.25	SN7460N	.45

Cromemco
Incorporated

Z80-4MHz Single Card Computer

Cromemco's Single Card Computer is a complete computer which brings the power of the Z80 and the flexibility of the S100 bus to the dedicated computer environment.

The card offers 4 Mhz operation, 3K bytes of on-board 2716 PROM, and 16 K bytes of static RAM memory. This stand-alone card provides an RS-232C (20mA current loop) serial interface with programmable baud rates up to 76,800, vectored interrupt capability, 16K of battery-backed I/O, and 5 programmable timers. Only a power supply and PROM memory are required for operation. The Single Card Computer is available in metal (Model SCC-M) or PCB (Model SCC-P) configurations and is available in two ROM's (Model SCC-216) for \$99.

SCC-W (Assembled) \$450.00

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialler	\$14.95
AY-5-9200	Rotary Telephone Dialler	14.95
AY-5-9300	C/MOS Keypad Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
HC722	Keyboard Encoder (8 keys)	7.95
HC723	Keyboard Encoder (20 keys)	6.25

ICM CHIPS

ICM7045	C/MOS Precision Timer	24.95
ICM7205	C/MOS LED Stowatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Digit Counter	19.95
ICM7209	Clock Generator	6.95

NMOS READ ONLY MEMORIES

MCME571	128 X 8 X 7 ASCII Shifted with Greek	13.50
MCME572	128 X 8 X 7 Math Symbol & Pictures	13.50
MCME575	128 X 8 X 7 Alpha Character Char Gen	13.50

DISCRETE LEADS

XC556R .200" red	5/51	MV50 .085" red	6/51	XC119L .190" red	5/51
XC556G .200" green	4/51	XC209R .125" red	5/51	XC119L .190" green	4/51
XC556Y .200" yellow	4/51	XC209Y .125" green	4/51	XC119L .190" yellow	4/51
XC556C .200" clear	4/51	XC229R .200" red	5/51	XC119L .190" clear	4/51
XC229R .200" red	5/51	XC556G .185" red	4/51		
XC229G .200" green	4/51	XC556Y .185" green	4/51		
XC229Y .200" yellow	4/51	XC556C .185" yellow	4/51		
MV10B .170" red	4/51	XC526C .185" clear	4/51		

INFRA-RED LED
1/4" x 1/8" x 1/16" flat 5/51

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C80	Divide 10/11 Prescaler	19.95
HS180	10-Spot Divider 10/11 Prescaler	19.95
4N33	Photo-Darlington Opto Isolator	1.25
MK50240	Top Octave Freq. Generator	3.95
DS02026H	5MHz 2-phase MOS clock driver	3.75
TL303B	.27-um. n.m. display w/ir/leg. logic chip	10.95
MM5320	TV Camera Sync Generator	14.95
MM5330	4 1/2 Digit DPM Logic Block (Special)	3.95
LD110/111	3 1/2 Digit A/D Converter Set	25.00/set
MC14433P	3 1/2 Digit A/D Converter	13.95

DISPLAY LEADS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	270	2.95	MAN 6730	Common Anode-red = 1	560	.99
MAN 2	5 x 7 Dot Matrix-red	300	4.95	MAN 6740	Common Cathode-red D.D.	560	.99
MAN 3	Common Cathode-red	125	2.50	MAN 6750	Common Cathode-red = 1	560	.99
MAN 4	Common Cathode-red	187	1.95	MAN 6760	Common Cathode-red	560	.99
MAN 7G	Common Anode-green	300	1.25	MAN 6780	Common Cathode-red	560	.99
MAN 7Y	Common Anode-yellow	300	1.25	DL701	Common Anode-red = 1	300	.99
MAN 7Z	Common Anode-red	300	1.25	DL704	Common Anode-red = 1	300	.99
MAN 82	Common Anode-yellow	300	1.25	DL707	Common Anode-red	300	.99
MAN 84	Common Cathode-yellow	300	.99	DL728	Common Cathode-red	500	1.49
MAN 3620	Common Anode-orange	300	.99	DL747	Common Anode-red = 1	630	1.49
MAN 3630	Common Cathode-orange = 1	300	.99	DL747	Common Anode-red = 1	630	1.49
MAN 3640	Common Cathode-orange = 2	300	.99	DL747	Common Anode-red = 1	630	1.49
MAN 4810	Common Anode-orange	300	.99	DL747	Common Anode-red = 1	630	1.49
MAN 4710	Common Cathode-orange	400	.99	FD170	Common Cathode-red	600	.49
MAN 4710	Common Cathode-orange	400	.99	FD170	Common Cathode-red	110	.35
MAN 4730	Common Anode-red = 1	400	.99	FD358	Common Cathode = 1	357	.99
MAN 4740	Common Cathode-red	400	.99	FD359	Common Cathode	357	.99
MAN 4810	Common Anode-orange	400	.99	FD503	Common Cathode(FD505)	500	.99
MAN 6610	Common Cathode-orange-D.D.	560	.99	FD507	Common Anode-red	500	.99
MAN 6620	Common Cathode-orange = 1	560	.99	HSDP-3403	Common Cathode	800	1.50
MAN 6630	Common Cathode-orange = 2	560	.99	HSDP-3403	Common Cathode	800	1.50
MAN 6640	Common Cathode-orange = 1	560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	600	3.95
MAN 6650	Common Cathode-orange = 2	560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	600	3.95
MAN 6660	Common Cathode-orange	560	.99	5082-7304	Overrange character (+/-)	600	15.00
MAN 6710	Common Anode-red-D.D.	560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	600	22.50

LITRONIX ISO-LIT 1

Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)

49¢ each

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
\$3.95 each

CMOS

CD4000	.39	CD4070	.55
CD4001	.39	CD4071	.49
CD4002	.39	CD4072	.49
CD4006	1.19	CD4073	1.39
CD4007	.25	CD4076	.39
CD4009	.49	CD4082	.39
CD4010	.49	CD4093	.39
CD4011	.39	CD4098	1.19
CD4012	.25	MC14409	14.95
CD4013	.49	MC14411	14.95
CD4014	1.39	MC14419	14.95
CD4015	1.19	MC14433	13.95
CD4016	.59	MC14436	13.95
CD4017	1.19	MC14498	.39
CD4018	.99	MC14562	11.95
CD4019	.49	MC14583	2.49
CD4020	1.19	CD4508	3.95
CD4021	.39	CD4510	3.95
CD4022	.39	CD4511	1.29
CD4023	.29	CD4515	2.95
CD4024	.79	CD4516	1.29
CD4025	.29	CD4518	1.29
CD4026	2.95	CD4520	.79
CD4027	.69	CD4562	2.25

RCA LINEAR

CA3013T	2.15	CA3082N	2.00	MMS725	\$2.95	MMS309	4.95	MC1408L7	4.95
CA3023T	3.25	CA3083N	1.60	MMS726	2.95	MMS311	4.95	MC1408L8	5.75
CA3027	2.48	CA3086N	3.75	MMS738	2.95	MMS312	4.95	MC1439L	2.95
CA3037N	1.35	CA3089N	3.75	DM8864	2.00	MMS314	4.95	MC3222P	2.95
CA3046N	1.30	CA3130T	1.39	DM8865	1.00	MMS316	6.95	MC3661	3.50
CA3059N	3.25	CA3140T	1.25	DM8867	.75	MMS318	9.95	MC4016(4445)	5.00
CA3066N	3.25	CA3165T	1.25	DM8888	.75	MMS369	2.95	MC4024P	3.95
CA3082T	1.25	CA3401N	.59	9374 7-seg.		MMS387/398A	4.95	MC4040P	6.95
CA3081N	2.00	CA3600N	1.50	LED driver	1.50	MMS387/398A	4.95	MC4044P	4.50
				MMS309	4.95	CCT 7001	6.95		

EXAR

XR205	\$8.40	XR224CP	1.50
XR210	4.40	XR2264	4.25
XR215	4.40	XR2556	3.20
XR220	1.55	XR2567	2.99
XR255	3.00	JZ220BK	19.95
XR355	3.00	XR1800	3.20
XR355	99	XR2206	4.40
XR567CP	99	XR2207	3.85
XR567	1.25	XR2208	5.20
XR1310P	1.95	XR4202	1.25
XR1468CN	3.85	XR2211	5.25
XR1489	1.95	XR2212	4.35
XR1489	1.95	XR2240	3.45
		XR4749	1.15
		XR4751	1.47

74C00

74C00	.39	74C163	2.49
74C02	.39	74C164	2.49
74C04	.45	74C173	2.60
74C08	.49	74C192	2.49
74C10	.75	74C193	2.49
74C14	1.95	74C195	2.49
74C20	.39	74C922	7.95
74C30	.39	74C923	6.25
74C42	1.95	74C925	6.25
74C48	2.49	74C926	4.95
74C73	.89	74C160	2.49
74C74	.89	74C161	2.49

LOW PROFILE (TIN) SOCKETS

1-24		25-49		50-100	
8 pin LP	.17	.16	.15	14 pin ST	.27
14 pin LP	.29	.19	.18	16 pin ST	.30
16 pin LP	.22	.21	.20	18 pin ST	.35
18 pin LP	.29	.28	.27	24 pin ST	.49
20 pin LP	.34	.32	.30	28 pin ST	.99
22 pin LP	.37	.36	.35	36 pin ST	1.39
24 pin LP	.42	.41	.40	40 pin ST	1.59
28 pin LP	.45	.44	.43		
36 pin LP	.60	.59	.58		
40 pin LP	.63	.62	.61		

DIODES

TYPE	VOLTS V	PRICE	TYPE	VOLTS V	PRICE
1N4746	3.3	400m	41/00	1N4004	500 PIV 1 AMP
1N4751	5.1	400m	41/00	1N4005	600 PIV 1 AMP
1N4752	6.6	400m	41/00	1N4006	800 PIV 1 AMP
1N4753	6.2	400m	41/00	1N4007	1000 PIV 1 AMP
1N4754	8.0	400m	41/00	1N4008	500m
1N4757	9.0	400m	41/00	1N4148	75 10m
1N4759	12.0	400m	41/00	1N4154	35 10m
1N4959	8.2	400m	41/00	1N4173	5.1 1w
1N4962	15	400m	41/00	1N4174	5.1 1w
1N5232	5.6	500m	28	1N4735	6.2 1w
1N5234	6.2	500m	28	1N4736	6.8 1w
1N5235	6.8	500m	28	1N4738	8.2 1w
1N5236	7.5	500m	28	1N4742	12 1w
1N5242	12	500m	28	1N4744	15 1w
1N5245	15	500m	28	1N1183	50 PIV 35 AMP
1N4556	25	40m	61/00	1N1184	100 PIV 35 AMP
1N4557	150	7m	61/00	1N1185	150 PIV 35 AMP
1N4558	180	10m	51/00	1N1186	200 PIV 35 AMP
1N4001	50 PIV 1 AMP	121/00	1N1188	400 PIV 35 AMP	

LINEAR

LM701N	.79	LM710N	.79
LM701N/H	.39	LM711N	.39
LM702N	.80	LM723N/H	.55
LM703CN/H	.75	LM733N	.110
LM704H	.60	LM740N/H	.35
LM705H	1.00	LM741-1AN	.39
LM707CN/H	.35	LM747N/H	.79
LM708CN/H	1.00	LM747N	.39
LM709H	1.10	LM7510N	.95
LM709K	1.25	LM754CN/H	.59
LM710CN	1.95	MC1488N	1.95
LM711N/H	.80	MC1489N	1.95
LM712N	1.95	MC1489N	1.95
LM713K	6.50		

MINIATURE SCREWDRIVER

RUGGED CONSTRUCTION
100% of USES - 1/8" TIP 2/\$1.00

MAGNETIC RETRIEVER TOOL

Picks up elusive metal parts or tools in hard-to-reach places.
EXTENDS TO 26" - ROTATES 360° STRONG, LIFETIME MAGNET
MRT-2281 \$3.95

CSC CONTINENTAL SPECIALTIES

LOGIC PROBE KIT

SPECIFICATIONS
Input Impedance: 300,000 Ohms.
Thresholds: "Lo" 30%Vcc - "Hi" 70%Vcc
Maximum Speed: 300 nsec., 1.5MHz
Input Protection: ±50VDC continuous 117VAC for 15 sec.
Power: 30mA @5V - 40mA @ 15V - 25V max. reverse voltage protected; 36" cable with color coded clips included.
Operating Temp.: 0-50°C.
Dimensions: 5.8L x 1.0W x 0.7D in. (147 x 25 x 18mm)
Weight: 30 oz. (85 gm)
LPK-1 \$21.95/Kit

Proto Clips

14-PIN CLIP	PC-14	\$ 4.50
16-PIN CLIP	PC-16	\$ 4.75
24-PIN CLIP	PC-24	\$10.00
40-PIN CLIP	PC-40	\$16.00

Proto Boards

PB-6	\$17.95
PB-100	19.95
PB-101	22.95
PB-102	26.95
PB-103	44.95
PB-104	55.95
PB-204	99.95
PB-203A	155.00
PB-203A-Kit	131.00

Jumbo 6-Digit Clock Kit

- Four .330"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Includes all components, case and wall transformer
- Size: 6 1/2 x 3 1/4 x 1 1/4

JE747 \$29.95

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6 1/2" x 3-1/8" x 1 1/4"

JE701

6-Digit Clock Kit \$19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to +5V, +9V and +12V with JE205 Adapter. Includes components, hardware and instructions.
Size: 3 1/2" x 5" x 2 1/4"
JE200 \$14.95

ADAPTER BOARD

Adapts to JE200 - ±5V, ±9V and ±12V
JE205 \$12.95

DC/DC converter with +5V input. Toroidal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3 1/2" x 2" x 9/16"

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		MICROPROCESSOR MANUALS	
8080A CPU	\$ 7.95	M-260 User Manual	\$7.50
8212 8-Bit Input/Output	3.25	M-COP1802 User Manual	7.50
8214 Priority Interrupt Control	5.95	M-650 User Manual	5.00
8216 Bi-Directional Bus Driver	3.49		
8224 Clock Generator/Driver	3.99		
8226 Bus Driver	3.49		
8228 System Controller/Bus Driver	4.95		
8238 System Controller	5.95		
8251 Prog. Contn. I/O (USART)	7.95		
8253 Prog. Interval Timer	14.95		
8255 Prog. Periph. I/O (PPI)	9.95		
8257 Prog. DMA Control	19.95		
8259 Prog. Interrupt Control	19.95		
6800/6800 SUPPORT DEVICES		ROM'S	
MC6800 MPU	\$14.95	25312(240) Character Generator(lower case)	\$9.95
MC6802CP MPU with Clock and Ram	24.95	25313(3021) Character Generator(upper case)	9.95
MC6810A(PI) 128Kb Static Ram	5.95	2515 Character Generator	10.95
MC6821 Periph. Inter Adapt (MC6820)	7.49	MM5230N 2048-Bit Read Only Memory	1.95
MC6828 Priority Interrupt Controller	12.95		
MC6830LB 1024X8 Bit ROM (MC68A30-8)	14.95		
MC6850 Asynchronous Comm. Adapter	7.95		
MC6852 Synchronous Serial Data Adapt.	9.95		
MC6860 0-800 bps Digital MODEM	12.95		
MC6862 2400 bps Modulator	14.95		
MC6880A Quad 3-State Bus Trans. (MC8T26)	2.25		
MICROPROCESSOR CHIPS - MISCELLANEOUS		RAM'S	
Z801780C CPU	\$13.95	1101 256X1 Static	\$1.49
Z80A(780-1) CPU	15.95	1103 1024X1 Dynamic	.99
CDP1802 CPU	19.95	2101(8101) 256X4 Static	3.95
2650 MPU	19.95	2102 1024X1 Static	1.75
6502 CPU	11.95	2112 256X4 Static MOS	4.95
8035 8-Bit MPU w/clock, RAM, I/O lines	19.95	2114 1024X4 Static 450ns low power	10.95
P8085 CPU	19.95	2114-L 1024X4 Static 300ns	10.95
TMS9900UL 16-Bit MPU w/hardware, multiply & shift	49.95	2114-L-3 1024X4 Static 300ns low power	11.95
		5101 256X4 Static	7.95
		5280/2107 4096X1 Dynamic	4.95
		7489 16X4 Static	1.75
		74S200 256X1 Static Tristate	4.95
		93421 256X1 Static	2.95
		UPD414 4K Dynamic 16 pin	4.95
		UPD416 16K Dynamic 16 pin 250ns	9.95
		(Mk4116) 4K Static	14.95
		TMS4044 4K Static	14.95
		TMS4045 1024X4 Static Dynamic 350ns	14.95
		2117 16,384X1 Dynamic	4/1.00
		MM5262 2KX1 Dynamic	
8-BIT REGISTER		PROM'S	
MM500H Dual 25 Bit Dynamic	5.50	1702A 2048 FAMOS	\$5.95
MM503H Dual 50 Bit Dynamic	.50	2718T16L 16K* EPROM	59.95
MM504H Dual 15 Bit Static	.50	TMS216L 16K* EPROM	39.95
MM506H Dual 190 Bit Static	5.00	(2715) *Requires single +5V power supply	
MM510H Dual 64 Bit Accumulator	.89	TMS2532 4KX8 EPROM	89.95
MM5016H 500/512 Bit Dynamic	.89	TMS256 8K EPROM	10.95
2504T 1024 Dynamic	3.95	2716 T.1 16K* EPROM	29.95
2518 Hex 32 Bit Static	4.95	5203 2048 FAMOS	14.95
2522 Dual 132 Bit Static	2.95	5303 (17811) 1024 Tristate Bipolar	3.49
512 Static	9.95	6335 (17802) 256 Open C. Bipolar	2.95
2525 1024 Dynamic	2.95	82S23 32X8 Open Collector	3.95
2527 Dual 256 Bit Static	2.95	82S115 4096 Bipolar	19.95
2528 Dual 250 Static	4.00	82S123 32X8 Tristate	3.95
2529 Dual 240 Bit Static	4.00	74186 512 TTL Open Collector	3.95
2532 Quad 80 Bit Static	2.95	74188 256 TTL Open Collector	3.95
3341 Filo	6.95	74S287 1024 Static	2.95
74LS670 4X4 Register File (TriState)	2.49		

JE600 HEXADECIMAL ENCODER KIT

FEATURES:
• Full 8 bit latched output for microprocessor use.
• 3 User Define keys with one being bi-stable operation.
• Debounce circuit provided for all 19 keys.
• LED readout to verify entries.
• Easy interfacing with standard 16 pin IC connector.
• Only ±5VDC required for operations.

FULL 8 BIT LATCHED OUTPUT - 19 KEYBOARD
The JE600 Hexadecimal Keyboard provides two separate hexadecimal digit displays produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bi-stable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 \$59.95
Hexadecimal Keypad only \$14.95

62-KEY ASCII ENCODED KEYBOARD KIT

FEATURES:
• 60 Keys generate the full 128 characters, upper and lower case ASCII set
• Fully buffered
• 2 user-define keys provided for custom applications
• Caps lock for upper case only alpha characters
• Utilizes a 2376 (40 pin) encoder read only memory chip
• Outputs directly compatible with TTL/DTL or MOS logic arrays
• Easy interfacing with a 16-pin dip or 18-pin edge connector

The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10mA for operation.

JE610 \$79.95
62-Key Keyboard only . . \$34.95

HICKOK LX303 Portable LCD Digital Multimeter

FEATURES:
• Big 3 1/2 inch High, 3 1/2 Digit Liquid Crystal Display
• Over 2000 Hours of operation with a 9V battery
• Automatic zero, polarity and average indication • 100mV DC F.S. sensitivity • 1% basic accuracy
• 99 ranges and functions • Rugged Cyclo-Comp case and removable covers, stores test lead set.
• Full one year warranty.

SPECIFICATIONS: DC vol (R range) 0.1mv to 1000v Accuracy 10.9% rms 10.5% f.s. Input imped 100KΩ
AC Volts (R range) 0.1V to 600V Accuracy 11.0% rms 10.5% f.s. 1-200 max. at 60Hz Max. input 600V
DC Current (R range) 0.1mA to 100mA Accuracy 10.9% rms 10.5% f.s. 10.5% max. at 200Hz Max. input 100mA
DC Current (I range) 0.1mA to 100mA Accuracy 11.0% rms 10.5% f.s.
Dimensions and Weight: 5 1/2" x 3 3/8" x 1 3/4" Wt. POWER 9V Battery (not included) at Hickok AC Adapter, No. H-8474-3 3oz.

PART NO.	DESCRIPTION	PRICE
CC-3	115V AC ADAPTER	7.50
CC-3	PADDED CARRYING CASE	7.50
VP-10	X 10 DC PROBE ADAPTER (Up to 10K)	14.95
VP-40	400X DC PROBE	35.00
CS-1	10 Amp DC Current Shunt	14.95

\$10.00 Min. Order - U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage - Add 5% plus \$1 Insurance (if desired)

Spec Sheets - 25¢
1980 Catalog Available - Send 41¢ stamp

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS - WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

5-80

The Incredible "Pennywhistle 103"

\$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method Frequency-Shift Keying, full-duplex (half-duplex selectable).

Maximum Data Rate 300 Baud.

Data Format Asynchronous Serial (return to mark level required between each character).

Receive Channel Frequencies 2025 Hz for space; 2225 Hz for mark.

Transmit Channel Frequencies Switch selectable: Low (normal) - 1070 space, 1270 mark; High - 025 space, 2225 mark.

Receive Sensitivity -46 dbm acoustically coupled.

Transmit Level 15 dbm nominal. Adjustable from -6 dbm to +20 dbm.

Receive Frequency Tolerance Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.

Digital Data Interface EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).

Power Requirements 120 VAC, single phase, 10 Watts.

Physical All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
• 8 each UPD4116-1 (16K Dynamic Rams) 250NS
• Documentation for conversion

TRS-16K \$75.00

JUST WRAP™

30 AWG wire • .025" square posts • Built-in cut off • Includes 50 ft. wire • No stripping or slitting required - just wrap

Part No.	Color	Price
JW-1-B	Blue	\$14.95
JW-1-W	White	14.95
JW-1-Y	Yellow	14.95
JW-1-R	Red	14.95

JUST WRAP™ Replacement Wire

Part No.	Color	50 ft. roll	Price
R-JW-B	Blue	50 ft. roll	\$2.98
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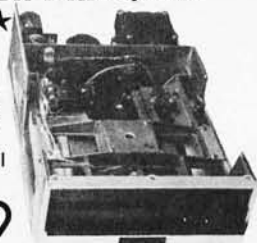
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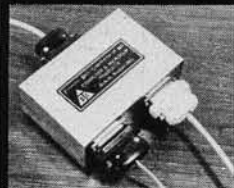
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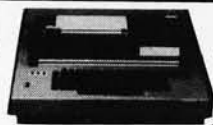
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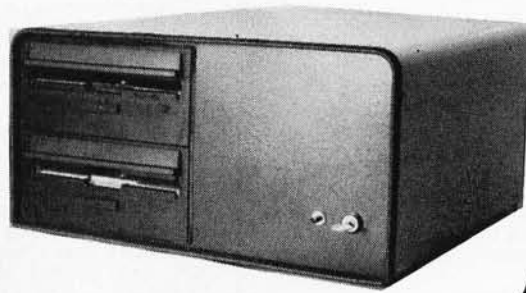
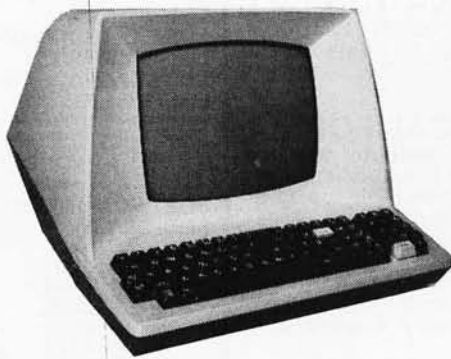
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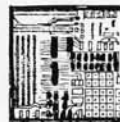
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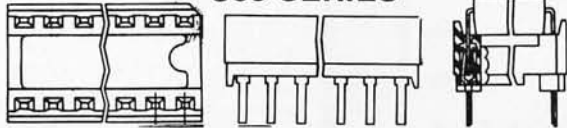
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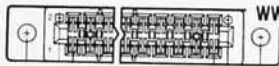
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TIC-4080-1 WWG	4.40	4.00	3.60	3.00
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TIC-4386-1 WWG	4.65	4.15	3.70	3.10
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TIC-2856-2 WWG	3.20	2.90	2.55	2.15
TIC-3060-2 STG	2.90	2.60	2.30	1.95
TIC-3060-2 WWG	3.40	3.05	2.70	2.25
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TIC-3162-2 WWG	3.50	3.15	2.80	2.35
TIC-3672-2 STG	3.45	3.10	2.75	2.30
TIC-3672-2 WWG	4.00	3.60	3.20	2.68
TIC-4080-2 STG	3.80	3.45	3.05	2.55
TIC-4080-2 WWG	4.45	4.00	3.55	2.95
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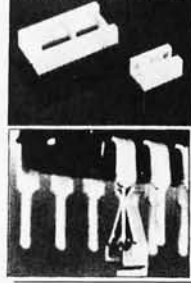
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CARD EXTENDER
CARD Extender has 100 contacts 50 per side on .125 centers. Attached connector is compatible with S-100 Bus Systems. \$27.69
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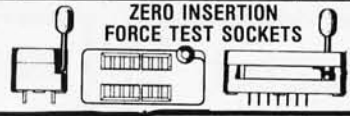
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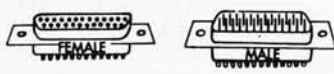
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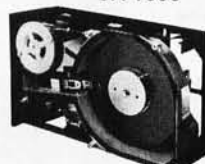
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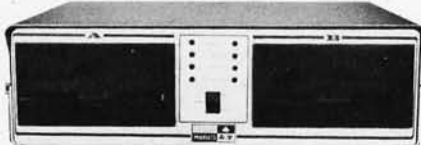
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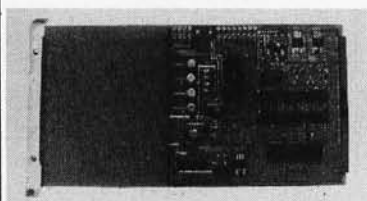
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NEW Series II Z-80, 4 MHz, List \$395	\$349
SSM CB1A 8080 CPU Board, List \$219	\$186
CB1A Kit, List \$159	135
SSM CB2 Z-80 CPU, List \$275	\$234
CB2 Kit, List \$210	179
DELTA Z-80, with I/O	\$239
SD SBC-100, List \$350	\$298
SBC-100 Kit, List \$295	250
SBC-200, List \$400	332
SBC-200 Kit, List \$320	272

MEMORY BOARDS

NORTH STAR 16K Dynamic RAM Board, A&T (RAM-16-A/A), List \$499	\$420
32K A&T (RAM-32/A), List \$739	620
CROMEMCO (16KZ-W), List \$595	\$495
64KZ-W, List \$1795	1485
MEASUREMENT SYSTEMS & CONTROLS	
<i>Guaranteed performance, incl. labor/parts 1 yr</i>	
DM6400 64K Board w/all 64K, \$795	\$659
DM4800 with 48K, List \$695	589
DM3200 with 32K, List \$595	509
DM1600 with 16K, List \$495	429
DM0000 with no RAM, \$395	349
THE DMB SERIES —	
DMB6400 64K Board w/all 64K	\$859
DMB4800 with 48K	789
DMB3200 with 32K	709
MORROW SuperRAM — all static, all A&T	
16K, 4 MHz or 2 MHz, List \$349	\$299
32K, 4 MHz, List \$699	629
16K Memory Master, List \$399	339
24K Memory Master, List \$549	465
INTERSYSTEMS (formerly Ithaca Audio)	
8K Static 2 MHz, A&T, List \$165	\$149
8K Static 4 MHz, A&T, List \$195	176
16K Static 2 MHz, A&T, List \$475	427
16K Static 4 MHz, A&T, List \$495	445
64K Dynamic, List \$995	895
CALIFORNIA COMPUTER	
16K Static, A&T, List \$349.95	\$259

FLOPPY DISK CONTROLLER BOARDS

MORROW Disk Jockey 1, A&T (\$213)	\$189
Disk Jockey 2D, A&T, List \$479	429
SD Versafloppy 1, Kit, List \$250	\$212
Versafloppy II, DD Kit, List \$430	360
Versafloppy II, DD, A&T, List \$350	278
DELTA double density A&T (\$385)	\$345
CONDUCTOR, double density A&T	\$269
INTERSYSTEMS (formerly Ithaca Audio)	
FDC-2, A&T, List \$495	\$439
MICROMATION Doubler, DD, A&T	\$399
TARBELL Floppy Disk Interface, Kit	\$199
double density, Kit, List \$325	295
double density, A&T, List \$425	380

SHIPPING & INSURANCE — Add \$2 for boards, \$5 for Selectric converter, \$7.50 for Floppy Disk Systems, \$15 for Horizons. Shipped freight collect: Cromemco Systems, Centronics, DEC, NEC, and T.I. printers. Contact us for shipping information on other terminals and printers. All prices subject to change and all offers subject to withdrawal without notice. Prices in this ad are for prepaid orders. Slightly higher prices prevail for other-than-prepaid orders, i.e., C.O.D., credit card, etc.

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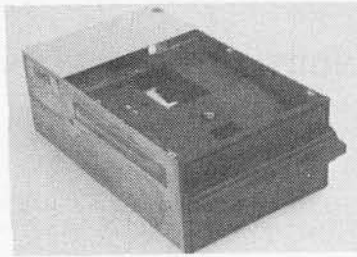
1618 James Street, Syracuse NY 13203 (315) 422-4467 TWX 710-541-0431 Circle 305 on inquiry card.

FLOPPY DISK DRIVES SYSTEMS

Qume Datatrak

Double sided floppy with NO HEADACHES. Although many think this an impossibility, seeing is believing, and this drive is really something! Shugart compatible, fully optioned, reliable, and rapidly becoming the standard in double-sided diskdom.

\$599. 2/\$549.



Siemens FDD100-8D

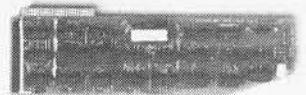
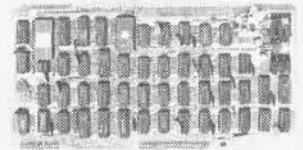
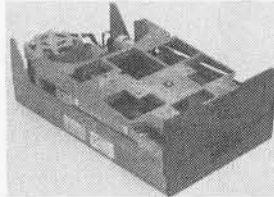
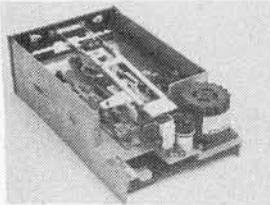
All Siemens options included in this drive, which can be configured hard/soft sector, is Shugart compatible, and not prone to some overheating problems (that other drives are). A highly reliable machine, with write protect, file busy indicator, and more.

\$499.

Cal Disk 142M 8"

Built like the proverbial tank. Single/double density, write protect, much more. With Electrolabs' special cabling, it magically becomes Shugart compatible.

Please ask about Cal Dis, enclosure \$389. 2/\$379. and power supply package bargain.



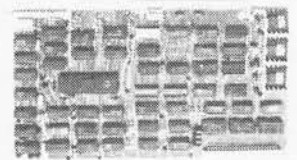
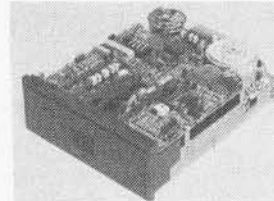
The following 5 1/4" mini-floppies share most features with their 8" cousins, so without further ado. . .

Siemens FDD 100-5D	\$279		
Cal Disk Mini	\$279		
Qume Datatrak 5		BASF Mini mini	\$279
(double sided)	\$399	SA 400	\$299

All the above mini-floppies are fully SA400 compatible.

Manuals for all drives are \$10, refundable against future purchase of drives. Also, all 8" drives can be ordered with 220 v/50 hz for worldwide use.

Moving on to the realm of floppy disk controllers . . . although we still feel that single density is more reliable, there are many excellent double density disk controllers available, so choose your weapons carefully.

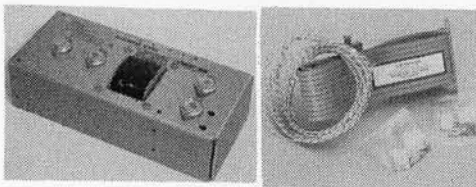


Tarbell floppy disk controller, A & T \$325
 Tarbell floppy disk controller, A & T \$225
 Tarbell double density, DMA A & T \$425
 Tarbell double density, DMA, kit \$325

Delta Products double density disk controller
 Operate at 2 or 4MHZ, with 8 or 5" drives \$399
 Micromation doubler w/programmable UART
 RS-232 port \$495
 Sorrento Valley single density for Apple \$399
 Again, purchase price of manuals (\$5) is applicable towards future purchase price.

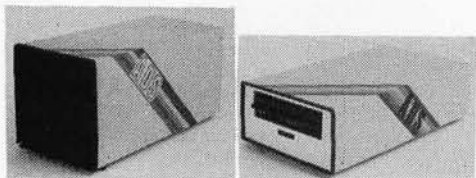
Subtract 15% OFF any Controller
 with Purchase of 2 Drives.

Disk Accessories



Cable kits for 8" drives with 10'50 cond. flat cable, power cable, & all connectors. Assembled if desired. One drive 27.50, two 33.95, three 38.95 for mini floppies (34 cond): one 24.95, two, 29.95

CP-206 Power-one power supply. Powers two drives more than adequately, top quality. 2.8A/24V, 2.5A/5V, .5A/-5V. \$99.



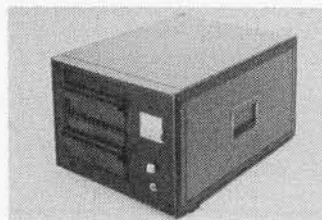
Double disk drive enclosure.
 Enclosure alone \$139.
 Including power supply & fan \$199.

Single disk drive enclosure. Fits all 8" disk drives, please specify make & model No. of drive to assure proper mounting hole positions. Nonmar paint available in blue, beige, silver, & off-white.
 Enclosure alone \$60
 Including power supply & fan \$109.

Electrolabs

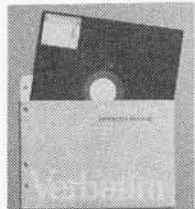
POB 6721, Stanford, CA 94305
 415-321-5601 800-227-8266
 Telex: 345567 (Electrolab Pla)
 Visa MC Am. Exp.

ENCLOSURES, SLEEVES

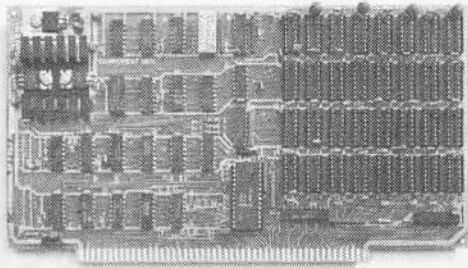


Rackmount Mainframe MT-200. This gorgeous beast is so appealing that it can easily function also as stand-alone mainframe. Very modern styling with fully actively terminated S-100 bus.
 Enclosure alone \$399.
 With power supply & fan \$499.
 With 15 slot S-100 bus \$699.
 With two 8" single-sided disk drives \$1,699.
 With two 8" double sided disk drives in place of single-sided variety \$2,299.

Media



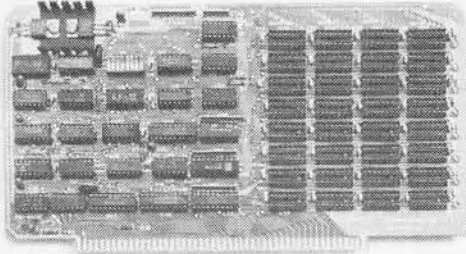
8" . . \$39.95/10 single-sided/single density
 8" . . \$55.00 single sided/double density
 8" . . \$55.00 double sided/single density
 8" . . \$60.00 double sided
 8" . . specify hard or soft
 5 1/4" . . \$34.95 single sided
 5 1/4" . . \$60.00 double sided
 Verbatim, Memorex, Scotch, or equivalent name brand
 Diskette head cleaning kid for 5 1/4" or 8" — \$28.75 includes everything for 1 drive for 1 year
 Alignment Diskette \$39
 For Floppy Drives



SD Systems Expandoram II Dynamic RAM

Operates at 4 Mhz, expandable memory from 16K to 256 K, allows up to 8 boards on the same bus, Z-80 based, and invisible refresh, among other things.

- 16K kit \$295.
- 16K A & T \$349.
- 32 K kit \$369.
- 32 K A & T \$419.
- 48K Kit \$440.
- 48K A & T \$490.
- 64K kit \$510.
- 64K A & T \$560.



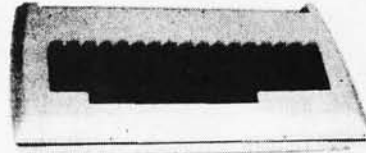
EXTRA SPECIAL !!

Imsai 65K dynamic RAM III

We made a special purchase of this now unavailable board, which were always noted for their fine performance & quality. We have a limited quantity on hand, get your orders in rapidly. These come assembled and tested, with burned-in 200 Ns RAM. Kit 299

A & T \$399.

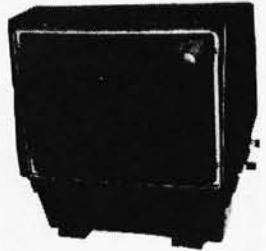
Keyboard Special



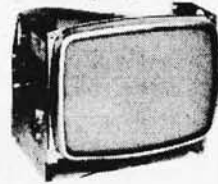
CHERRY "PRO" Keyboard \$119.00
Streamlined Custom Enclosure \$34.95
BOTH ONLY \$134.95!!!

Data Display Monitors

Used 12" Sylvania monitors. Composite Video, 15 MHz, 120VAC. Re-built with NEW P39 anti-glare tube \$89.00
New P4, \$89.00, used P4 \$69.00
U-fix model, 10/\$300.00



"OEM STYLE" as above, will fit any case, (Both versions serviced by qualified tech). Identical to above but subtract \$12.00



Televideo 912c

\$760.

Upper/lower case

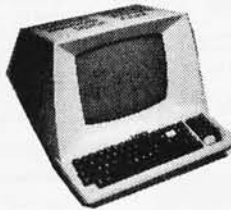
Adjustable baud rate - 80 X 24

Editing capabilities - Printer port

Second page memory option

This is a VERY limited extravaganza, so please act quickly

New!



Televideo 920c

\$860.

Same specs as above, save for special function keys, ideal for text editing and word processing

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(415) 321-5601 (800) 227-8266
Telex: 345567 (Electrolab Pla)

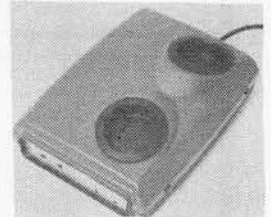
Paper Tiger

IDS MODEL 440

- 8 Software Selectable Character Sizes
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- Tractor Feed \$899.
- Graphics option with 2K CRT screen buffer add \$199.00

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- Acoustically coupled modem assembly set
- Asynchronous 0-300 Baud
- Switchable originate or answer modes
- Operates full or half duplex mode
- 15 minute assembly \$129.
- Novation Cat \$179.
- Digicom Coupler \$189.



Daisy Wheel Printers



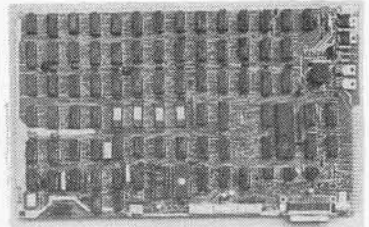
Qume Sprint 3/45

- PRINTER (factory warr.) \$1499.
- POWER SUPPLY (Borschert) 349.
- (Shown mounted on rear of printer)
- COMBINATION SPECIAL 1699.
- Cases available 200.
- S-100 interface card 149.
- SPRINT 5/45 RO, RS-232
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6502	\$ 6.25	UNPRECEDENTED!!!	
6809	49.00	* 16K Dynamic RAM	
6845	39.00	Set of 8 For: TRS-80,	
8085	13.00	Apple, Exidy, Heath,	
1771	26.95	etc.	
1791	37.95	* Includes all parts &	
AY5-1013A	3.95	instructions	
		* 200 NS \$59.	

Please call for dealer or quantity pricing. Minimum order \$20.00
We do custom prom programming.



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COMMUNICATING
TERMINAL

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Beckman TECH310 **\$130.**

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FREE 8 pc. Tool Set (value \$14.95) with \$200.00 purchase from this ad.

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9 ranges from 1999 pF to 199.9 µF • 0.1% of reading accuracy **\$170**

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Fully assembled breadboard contains four OT-59S sockets, seven OT-59B bus strips and four 5-way binding posts

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9 ranges from 1999 pF to 199.9 µF • 0.1% of reading accuracy **\$170**

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40W stereo **\$249.95**

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36 resistors (15 1Ω to 10 MΩ) • 18 capacitors (100 pF to 0.22 µF) Reg. \$49.95 **\$42.**

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4007	-27	4027	-45	4072	-25	74C151	-1.75
4009	-45	4028	-80	4073	-22	74C157	-1.75
4010	-45	4029	-80	4093	-56	74C190	-1.20
4011	-22	4030	-35	4516	-1.00	74C161	-1.15
4012	-22	4034	-2.25	4518	-1.20	74C163	-1.10
4013	-40	4035	-97	4520	-1.00	74C165	-1.25
4014	-1.20	4040	-1.00	74C00	-27	74C173	-1.30
4015	-1.00	4042	-35	74C02	-27	74C174	-1.20
4016	-45	4043	-45	74C08	-20	74C175	-1.40
4017	-1.05	4046	-1.95	74C10	-27	74C192	-1.30
4018	-30	4048	-75	74C14	-20	74C193	-1.40
4019	-45	4050	-45	74C20	-27	74C001	-50
4020	-1.10	4051	-1.10	74C24	-90	74C002	-50
4021	-1.10	4052	-1.10	74C27	-75	74C014	-1.90
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25 watt Infra Red Pulse (SG 2006 equiv.) Laser Diode (Spec sheet included) **\$24.95**

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74LS01	-39	74LS156	-1.19
74LS02	-28	74LS157	-1.19
74LS03	-28	74LS158	-1.19
74LS04	-35	74LS160	-1.10
74LS05	-35	74LS162	-1.10
74LS06	-35	74LS163	-1.20
74LS07	-35	74LS164	-1.20
74LS10	-30	74LS168	-1.25
74LS11	-30	74LS169	-1.10
74LS12	-35	74LS170	-1.30
74LS13	-35	74LS171	-1.30
74LS14	-1.95	74LS174	-1.30
74LS15	-35	74LS175	-1.00
74LS16	-35	74LS176	-1.10
74LS17	-35	74LS177	-1.10
74LS18	-35	74LS178	-1.10
74LS19	-35	74LS179	-1.10
74LS20	-35	74LS180	-1.25
74LS21	-35	74LS181	-1.25
74LS22	-35	74LS182	-1.25
74LS23	-35	74LS183	-1.25
74LS24	-35	74LS184	-1.25
74LS25	-35	74LS185	-1.25
74LS26	-35	74LS186	-1.25
74LS27	-35	74LS187	-1.25
74LS28	-35	74LS188	-1.25
74LS29	-35	74LS189	-1.25
74LS30	-35	74LS190	-1.25
74LS31	-35	74LS191	-1.25
74LS32	-35	74LS192	-1.25
74LS33	-35	74LS193	-1.25
74LS34	-35	74LS194	-1.25
74LS35	-35	74LS195	-1.25
74LS36	-35	74LS196	-1.25
74LS37	-35	74LS197	-1.25
74LS38	-35	74LS198	-1.25
74LS39	-35	74LS199	-1.25
74LS40	-35	74LS200	-1.25
74LS41	-35	74LS201	-1.25
74LS42	-35	74LS202	-1.25
74LS43	-35	74LS203	-1.25
74LS44	-35	74LS204	-1.25
74LS45	-35	74LS205	-1.25
74LS46	-35	74LS206	-1.25
74LS47	-35	74LS207	-1.25
74LS48	-35	74LS208	-1.25
74LS49	-35	74LS209	-1.25
74LS50	-35	74LS210	-1.25
74LS51	-35	74LS211	-1.25
74LS52	-35	74LS212	-1.25
74LS53	-35	74LS213	-1.25
74LS54	-35	74LS214	-1.25
74LS55	-35	74LS215	-1.25
74LS56	-35	74LS216	-1.25
74LS57	-35	74LS217	-1.25
74LS58	-35	74LS218	-1.25
74LS59	-35	74LS219	-1.25
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74LS69	-35	74LS229	-1.25
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74LS79	-35	74LS239	-1.25
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74LS81	-35	74LS241	-1.25
74LS82	-35	74LS242	-1.25
74LS83	-35	74LS243	-1.25
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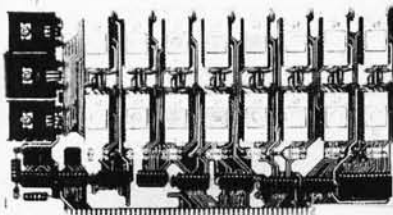
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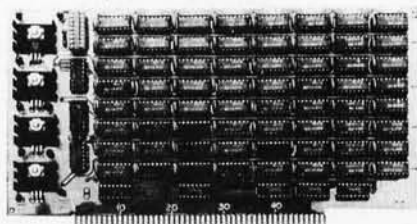
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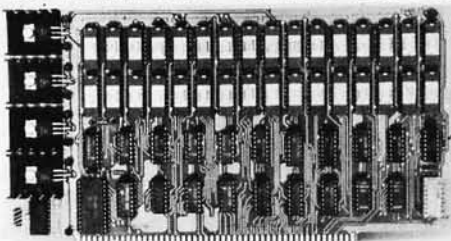
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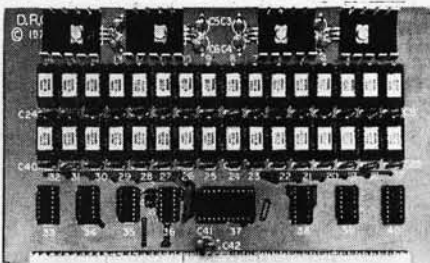
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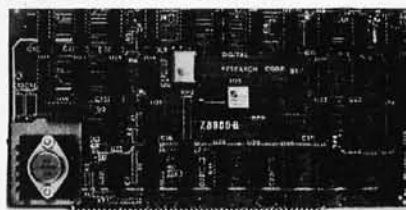
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100% 90 DAY MONEY BACK GUARANTEE ON ALL ITEMS SOLD
SEND \$2.00 for 1980 CATALOG

DAL - COMP MAIL ORDER DIV.

TERMS OF SALE: Cash, checks, money orders, VISA, Master Charge. Minimum order \$10.00. Texas residents add 5% sales tax. Minimum shipping and handling charge \$2.50. COD orders add \$1.15 COD fee. U.S. funds only. D&B rated firms call for open account.

DAL-COMP M/O DIV. 2560 ELECTRONIC LANE, SUITE 108, DALLAS, TEX. 75220 • (214) 350-6895

DEAL #1

Hobby Wire Wrap Starter Package



BW2630 WW Tool	\$19.95
BT30 #30 Bit	3.95
BC1 Batteries & Charger	14.95
*Kit #1 Wire Kit	9.95

Regular Price \$48.80

\$39⁹⁵

*Kit #1 Contains 900 pcs. of precut wire in asst. sizes.

Choose from Red, Blue, White, Black, Green, Orange, Violet, Yellow, or assortment.

DEAL #2

Industrial Wire Wrap Starter Package



BW928BF WW Tool	\$52.95
BT30I #30 Bit & Sleeve ..	29.50
BC1 Batteries & Charger	14.95
*Kit #3 Wire Kit	32.95

Regular Price ... \$130.35

\$119⁹⁵

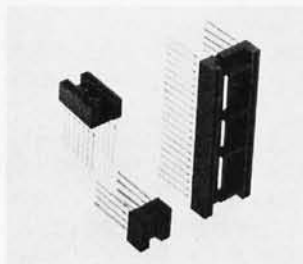
*Kit #2 Contains 4000 pcs. of precut wire in asst. sizes.

Choose from Red, Blue, White, Black, Green, Orange, Violet, Yellow or assortment.

★ ★ BIG DEAL ★ ★

RN IC Sockets by the Tube

RN HIGH RELIABILITY eliminates trouble. "Sidewipe" contacts make 100% greater surface contact with the wide, flat sides of your IC leads for positive electrical connection.



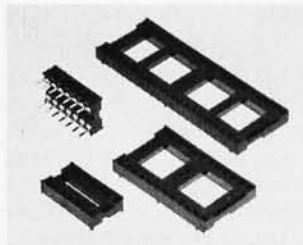
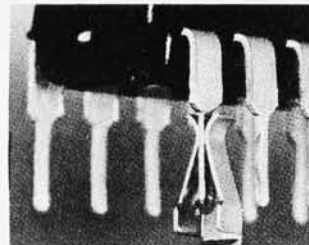
WIRE WRAP

SOCKETS

Size	Quantity/Tube	Price ea.*	Price/Tube
08 pin	52	.39	\$20.28
14	30	.46	\$13.80
3-level Gold	16	.50	\$13.00
Closed Entry	18	.68	\$15.64
Design	20	.85	\$17.85
	22	.42	\$16.56
	24	.94	\$15.95
	28	1.23	\$18.45
	40	1.60	\$16.00

*Sockets sold at these prices by the tube only.

Above prices include gold up to \$800/oz.



SOLDER TAIL

Low Profile Tin
Closed Entry
Design

1¢/pin
(over 5 tubes)

3/4¢/pin
(over 100 tubes)

*Sockets sold at these prices by the tube only.

See tube quantities above.

ORDERING INFORMATION

- Orders under \$25 include \$2 handling
- All prepaid orders shipped UPS Ppd.
- Visa, MC & COD's charged shipping
- All prices good through cover date
- Most orders shipped next day.

Limited to products Page Digital stocks. All discounts are off of list price. Call or write for list prices.

- 10% off on all OK hobby products!**
- 10% off on all Bishop Graphics products!**
- 5% off on all Vector products!**

California Digital

Post Office Box 3097 B • Torrance, California 90503

FREE



software selectable character size to allow print densities upto 132 characters per line. Full forms handling capabilities and tractor feed mechanism adjustable to 9.5". The Paper Tiger is engineered to accept either parallel or RS232 serial ASCII, 110/220V.50/60Hz.

With Purchase of The INTEGRAL DATA 440

Paper Tiger

Your Choice, \$200 Value

- 1) Graphics Option Package
 - 2) Interface for APPLE II
 - 3) TRS-80 Printer Interface
- California Digital has recently researched the complete low cost printer market. It is our opinion that the IDS440 Paper Tiger is, without doubt, the most versatile and offers the best value of any printer costing under \$1,000.

This quality dot matrix printer incorporates such features as

CONNECTORS

RS-232

DB25P male plug & hood \$395

DB25S female \$395

Edge Connectors

GOLD 100 PIN IMSAI/ALTAIR

Imesai solder .125x.250 \$2.95 3/4 7.50
Imesai w/w .125Centers \$4.95 3/4 13.00
Altair solder tail .140 row \$5.95 3/4 15.00

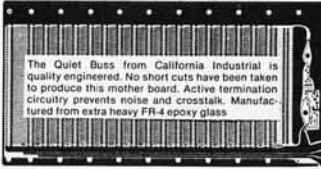
SPECIALS

22/44 Kim eyelet .156" \$1.95 3/4 5.00
25/50 solder tab .156" \$1.09 3/4 2.00
36/72 wide post w/w .156" \$1.95 3/4 5.00

S-100 Mother Board

Quiet Buss

\$2995
8803-18
18 slot
IMSAI



The Quiet Buss from California Industrial is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. Manufactured from extra heavy FR-4 epoxy glass

New factory surplus, M3000/3211 Motorola CRT monitors.

20 MHz bandwidth Electronics terminate into single ten pin (.156") edge connector. Requires DC power supply

\$149



MOTOROLA

TELETYPE MODEL 43

4320 KEYBOARD
TTL AAA \$1050
RS232.... AAK 1150
Friction... AAE 1100 plus shipping
103 Modem AAB 1575



FREE PLASTIC LIBRARY CASE with purchase of each box of Memorex mini-diskettes. \$5 value.

\$2.95 BOX OF 10 DISKETTES

Authorized Distributor

Scott's Data Products

740-0	IBM soft format.	\$39.00	50+	\$3.50
740/2	Double side soft	65.00	6.00	
741-0	Double density	53.00	4.90	
743-0	Double/D double	70.00	6.60	
740-32	8" Hard sector	39.00	3.50	
744-(0)(10)(16) 5 1/4" mini		39.00	3.50	

Library case for any above; Add \$3.00

B34 A	Data Cassette	5.50
DC100	Mini Cartridge	16.00
DC300	Data Cartridge	20.00
920()	Disk Cartridge	89.70

Shugart Associates

SA800-R Floppy Disk Drive

The most cost effective way to store data processing information, when random recall is a prime factor. The SA800 is fully compatible with the IBM 3740 format. Write protect circuitry, low maintenance & Shugart quality.

\$449.50

XEROX 800 WORD PROCESSING KEYBOARD

ASCII ENCODED

This 77 key word processing keyboard was manufactured by Microswitch for use in the Xerox 800 word processing system. The keyboard outputs a seven bit ASCII code along with an eighth bit that allows most keys to shift and double function as special characters. Extra large "Tab & Return" keys are designed into the layout of the keyboard to emulate the IBM Selectric. 17 Illuminated keys serve for special word processing codes. The keyboard is equipped with two thumbwheel switches for defining line width.

Original Xerox acquisition over \$400.00. California Digital USED price only \$49.00. Excellent cond. Documentation included.

MEMORY

TRS-80 \$59 APPLE II 16k memory (8) 4116's

Installation is simple. Anyone who has ever changed a spark plug should be able to up-grade his microcomputer. How can California Digital offer these memory up-grade sets at 25% below our competition? Simple, we buy in volume, wholesale to dealers and sell the balance directly to owners of personal micro-systems. These 16K dynamic memory circuits are factory prime and unconditionally guaranteed for one full year. NOW, before you change your mind, pick up the telephone and order your up-grade memory from California Digital. Add \$3 for TRS80 jumpers.

STATIC

	1-31	32-99	100-5C	-999	1K+
211L02 450nS.	1.19	.99	.95	.90	.85
211L02 250nS.	1.49	1.39	1.25	*	*
2114 1Kx4 450	5.95	5.50	5.25	4.75	4.50
2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.25	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	5.95	5.50	5.00	4.80	4.60

SPECIAL CIRCUITS

Z80A 4 MHz.	24.95	AYS-1013A UART	4.95
8080A CPU	9.95	Floppy Disc Controllers	
8085	22.50	WD 1771 single D.	39.95
8086 Intel 16bits	85.00	WD 1781 Double D	65.00
TMS9900 16bits	49.95	WD 1791 D/D 3740	*

E PROMS

1702A 2K	4.95	4.50	4.00
2708 8K	9.95	9.50	9.00
2716 5v 16K	29.95	27.50	*
2716 T1	24.88	20.00	*
2532	85.00	*	*

SYSTEM X-10

It's not often that California Digital ventures into the distribution of consumer products, but we have recently come across a product that appears so unique that we just had to add it to our product line. This is the System X-10 manufactured by the IBM Trustable company. This space age system will remotely control any light or appliance in your home or office. Command signals are transmitted from the command console over your existing wiring. From your bed or easy chair you can control up to 16 different electrical devices inside and outside your home. Use the System X-10 to control your stereo, television or any light fixture on the premises.

The modular system is available in the following components:

- Ultrasonic Master Control Console..... \$34.95
- Battery Operated Ultrasonic Controller..... \$19.95
- Application Module, Lamp Module or Wall Switch..... \$3.95

ACOUSTIC MODEM

The Omnitac model 701 Modem connects the RS-232 serial port of your computer or peripheral device acoustically to your telephone line. This is the System X-10 manufactured by the IBM Trustable company. This space age system will remotely control any light or appliance in your home or office. Command signals are transmitted from the command console over your existing wiring. From your bed or easy chair you can control up to 16 different electrical devices inside and outside your home. Use the System X-10 to control your stereo, television or any light fixture on the premises.

The modular system is available in the following components:

- Ultrasonic Master Control Console..... \$34.95
- Battery Operated Ultrasonic Controller..... \$19.95
- Application Module, Lamp Module or Wall Switch..... \$3.95

\$89 USED

PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for chain store inventory control and order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered into the recorder, the main warehouse is telephoned, the handset is placed in the acoustic coupler and all the recorded information is transmitted back to the master computer. With a little imagination and one of these portable entry systems, you should be able to exchange programs and computer information with associates across the country. All units were removed from service in working condition. Original cost \$2,500. Each system comes complete with:

- Portable Cassette Drive Unit
- Removable Entry Keyboard with LED Display
- Five Gold "D" NiCads
- Acoustical Coupler
- Battery Charger
- DB25 Cable
- Shoulder strap
- Full Documentation

\$139.50

Regent 25

Through years of research the ADES Corporation has evolved a low maintenance, extremely durable CRT terminal capable of withstanding an abusive 24 hour duty cycle. The Regent 25 features Intel 8085 microprocessor controlled circuitry along with the Cherry Switch long-life capacitance keyboard.

18 key cursor and numeric pad doubles to allow for user-definable special functions. True descending lower case characters along with a fully addressable cursor makes the Regent 25 the ideal word processing terminal.

High-resolution screen is capable of displaying 96 upper and lower case ASCII characters and 20 control codes. This terminal is switch selectable to display six European languages.

At \$850 (plus shipping) the Regent 25 offers the best value in today's CRT terminal market. Additional data upon request.

\$850

MINIATURE SWITCHES

your choice

10	50	100	1k
\$.98	\$ 8.81	\$ 73.66	

SPDT Miniature Toggles

7101 C&K ON-NONE-ON	
7107 C&K ON-OFF (incl. ON)	
7108 C&K ON-(moment. ON)	
7103 CK ON/OFF ON	

Rotary 3P-4-Pos. 3P-6-Pos. Push B (N.O.) \$39ea./\$1

DIP Switch

10	25	100	1k
\$1.29 ea.	\$1.19	\$1.09	\$1.73

specify 4 for 8 pos.

SPST

DISCOUNT Wire Wrap Center

IC SOCKETS

pin	wire wrap ea. 25 50	low profile ea. 25 50
8	17	16 15
14	37	36 35 18 17 16
16	38	37 36 19 18 17
24	99	93 85 36 35 34
40	169	155 139 63 60 58

50ft. **\$98**

KYNAR WIRE WRAP

500	1,000	11,000
\$9.515	\$105.	

\$545

OK HOBBY WRAP-10 wire wrap & strip tool

7400

SN7400N	19	SN74123N	59
SN7401N	19	SN74124N	39
SN7402N	22	SN74126N	44
SN7403N	22	SN74128N	59
SN7404N	22	SN74132N	69
SN7405N	23	SN74136N	95
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	69
SN7408N	26	SN74142N	295
SN7409N	23	SN74143N	295
SN7410N	22	SN74144N	295
SN7411N	29	SN74145N	69
SN7412N	29	SN74147N	195
SN7413N	39	SN74148N	120
SN7414N	59	SN74150N	99
SN7416N	29	SN74151N	67
SN7417N	29	SN74152N	67
SN7420N	22	SN74153N	67
SN7421N	35	SN74154N	119
SN7422N	29	SN74156N	82
SN7423N	29	SN74157N	69
SN7425N	29	SN74158N	165
SN7426N	29	SN74160N	95
SN7427N	29	SN74162N	89
SN7429N	45	SN74161N	95
SN7430N	23	SN74162N	89
SN7432N	29	SN74163N	97
SN7433N	29	SN74164N	97
SN7434N	29	SN74165N	97
SN7435N	29	SN74166N	120
SN7440N	24	SN74167N	196
SN7441N	79	SN74170N	169
SN7442N	79	SN74172N	595
SN7443N	79	SN74173N	79
SN7444N	79	SN74174N	89
SN7445N	79	SN74175N	89
SN7446N	79	SN74176N	85
SN7447N	79	SN74177N	85
SN7448N	79	SN74179N	180
SN7450N	23	SN74180N	75
SN7451N	23	SN74181N	175
SN7453N	23	SN74182N	75
SN7454N	23	SN74184N	195
SN7455N	23	SN74185N	195
SN7460N	23	SN74186N	995
SN7470N	39	SN74188N	390
SN7472N	38	SN74190N	115
SN7473N	38	SN74191N	115
SN7474N	38	SN74192N	85
SN7475N	38	SN74193N	85
SN7476N	38	SN74194N	85
SN7479N	460	SN74195N	85
SN7480N	39	SN74196N	85
SN7481N	110	SN74197N	85
SN7482N	110	SN74198N	139
SN7483N	55	SN74199N	139
SN7485N	65	SN74211N	139
SN7486N	39	SN74212N	195
SN7489N	175	SN74273N	105
SN7490N	39	SN74279N	89
SN7491N	65	SN74283N	215
SN7492N	52	SN74284N	390
SN7493N	49	SN74285N	390
SN7494N	72	SN74291N	195
SN7495N	65	SN74298N	95
SN7496N	72	SN74365N	68
SN7497N	310	SN74366N	68
SN74100N	99	SN74367N	79
SN74107N	119	SN74369N	95
SN74109N	63	SN74390N	190
SN74163N	195	SN74393N	190
SN74121N	29	SN74490N	190
SN74122N	39		

74LS00

74LS00N	35	74LS164N	119
74LS01N	28	74LS165N	89
74LS02N	28	74LS166N	248
74LS03N	28	74LS169N	189
74LS04N	39	74LS169N	189
74LS05N	28	74LS170N	199
74LS06N	39	74LS173N	89
74LS09N	39	74LS174N	99
74LS10N	28	74LS175N	99
74LS11N	39	74LS181N	220
74LS12N	39	74LS190N	115
74LS13N	47	74LS191N	115
74LS14N	125	74LS192N	98
74LS15N	39	74LS193N	98
74LS20N	26	74LS194N	115
74LS21N	38	74LS195N	95
74LS22N	38	74LS196N	89
74LS26N	39	74LS197N	89
74LS27N	39	74LS211N	149
74LS28N	39	74LS220N	299
74LS30N	26	74LS241N	249
74LS32N	38	74LS242N	229
74LS37N	79	74LS243N	229
74LS38N	39	74LS244N	295
74LS40N	26	74LS245N	895
74LS42N	79	74LS247N	110
74LS47N	79	74LS248N	110
74LS48N	79	74LS249N	110
74LS51N	26	74LS251N	179
74LS54N	35	74LS253N	98
74LS55N	35	74LS257N	98
74LS73N	45	74LS259N	98
74LS74N	59	74LS259N	295
74LS75N	68	74LS260N	69
74LS76N	45	74LS261N	249
74LS78N	65	74LS266N	59
74LS83AN	99	74LS273N	175
74LS85N	119	74LS274N	440
74LS86N	45	74LS279N	59
74LS90N	75	74LS283N	110
74LS92N	75	74LS290N	129
74LS93N	75	74LS293N	195
74LS95N	75	74LS295N	110
74LS96N	98	74LS298N	129
74LS107N	45	74LS324N	175
74LS109N	45	74LS347N	195
74LS112N	49	74LS348N	195
74LS113N	49	74LS352N	185
74LS114N	59	74LS354N	165
74LS122N	55	74LS363N	149
74LS123N	119	74LS365N	99
74LS124N	135	74LS366N	99
74LS125N	89	74LS367N	99
74LS126N	89	74LS368N	99
74LS132N	79	74LS373N	275
74LS136N	59	74LS374N	275
74LS138N	89	74LS375N	69
74LS139N	89	74LS377N	195
74LS141N	125	74LS380N	195
74LS148N	149	74LS386N	65
74LS151N	79	74LS390N	195
74LS153N	79	74LS393N	195
74LS154N	249	74LS395N	170
74LS157N	119	74LS397N	195
74LS158N	99	74LS424N	295
74LS157N	99	74LS668N	175
74LS158N	75	74LS670N	229
74LS160N	98	81LS96N	199
74LS161N	115	81LS98N	199
74LS162N	98	81LS97N	199
74LS163N	98	81LS98N	199



FLOPPY DISK DRIVES

MPI BS1-5 1/4" 40 Tracks	279.00
Shugart SA400-5 1/4" 35 Tracks	295.00
Shugart 800/801R B	475.00
Siemens Shugart Compatible Model FDD-100-80	429.00
PERSCI Model 277 Dual	1195.00
WANG/SIEMENS 5 1/4" Drive	290.00
MPI BS2 5 1/4" Dual	395.00
WANG/SIEMENS 282 Dual 5 1/4"	395.00
WANG/SIEMENS 82	290.00



HICKOK LX303 \$69.95

5% 3 1/2 digit 19 Range DVM, 1 1/2" LCD displays runs 200 hrs on 1 battery, 10 Meg Ohm Input, 1 yr. guarantee, made in U.S.A., test leads included.

Available Accessories	\$7.50
CC-3 Decoder Adapter	\$7.50
VP-10 X10 Probe Adapter	\$14.00
VP-40 40 W DC Probe	\$35.00
CS-10 Amp Current Stimul	\$14.95

TEXAS INSTRUMENTS INCORPORATED

Calculator Discount Prices

Ti 30 SP	17.95
Ti 50	39.95
Ti 55	35.95
Ti 87	54.95
Ti 58C	97.95
Ti 59	219.95
Ti PC 100C	146.95
Ti 1035	15.95
Ti 1750	19.95
Ti 5025	69.95
Ti 5040	79.95
Ti Data Card	26.95
Ti Data Chron	37.95
Ti Business Analyst II	42.95
Ti Programmer	48.95
Ti MBA	57.95
Ti Business Card	34.95
Ti Speak & Spell	64.95
Ti Dataman	19.95
Ti Spelling B	27.95
Ti Lf Professor	12.95
Ti Vowel Power	12.95
Ti Super Stumpers 4, 5, 6	12.95
Ti Super Stumpers 7, 8	12.95

MONITORS

Sanyo 9"	\$169.95
Sanyo 15"	279.00
Lexidea 12" High Resolution, 22 MHz, OEM Model #M300C-340	219.00
Zenith 13" Color Monitor	499.00
MGA 13" Color TV	349.00
VAMP 19" Color Monitor	575.00
VAMP 15" Color Monitor	449.00

TRS-80/APPLE MEMORY EXPANSION KITS

4116's
16K (200/250 ns.)
8 pcs. for \$62.95 w/instructions & jumpers.
Call For Volume Pricing

HAZELTINE TERMINALS

Model 1400	\$749.00	Model 1500	\$1085.00
Model 1410	\$825.00	Model 1510	\$1245.00
Model 1420	\$945.00	Model 1520	\$1495.00

Continental Specialties

Model 3001 Digital Capacitance Meter	275.00
Model 333 Tri-Mode Comparator	295.00
Model 400 40-channel Logic Monitor	585.00
Model LM-1 Logic Monitor	60.00
Model LM-2 Logic Monitor	147.00
Model 2001 Sweeplex Function Generator	186.00
Model 5001 Universal Counter-Timer	360.00
Model 6001 650 MHz Frequency Counter	395.00
MAX-100 100 MHz Portable Frequency Counter	149.00
PS-500 500 MHz Decade Prescaler	70.00
MAX-50 50 MHz Handheld Frequency Counter	71.00
MAX-550 550 MHz Handheld Frequency Counter	165.00
Model 4001 Pulse Generator	835.00
Model OP-1 Digital Probe	83.00
Model LP-1 Digital Logic Probe	50.00
Model LP-2 Economy Logic Probe	28.00
Model LP-3 High Speed Logic Probe	77.00
Model LPK-1 Logic Probe Kit	21.95
Model LPK-2 Logic Probes	395.00
Model LTC-1, LTC-2 Logic Analysis Kits	220/250

ADVANCED COMPUTER PRODUCTS

Apple II. 16K or Apple II. Plus \$990

Hi-Speed Serial I/O	\$174.95	DS65 Digi-Sector	\$349.00	Integer ROM Card	\$175.00
Centronics Printer I/O	199.95	Apple Graphics Tablet	795.00	Proto Card	21.95
AppleSoft II Firmware	174.95	D.C. Hayes Modem II	349.95	M & R Modulator	29.95
Apple Clock	189.95	Disk II w/Controller	475.00	Sanyo Cassette	54.95
Introl X-10 System	269.95	Disk II	575.00	16K Upgrade Kit	62.95
Introl X-10 Controller	179.95	Pascal Lang. System	475.00	Apple Radio Car	155.00
AI Music Synthesizer	289.95	Parallel Printer Card	165.00	F floppy Controller	350.00
16 Ch. Analog Input	249.95	Communications Card	210.00	Heuristics Speechbar	179.00
2 Ch. Analog Output	164.95	Business Software Pkg	625.00	Romplus +	169.00
13-Key Keypad	119.95	Corvus 10 Megabyte Drive	4625.00	SuperTalker	279.00
Visi-Calc	149.95			Casheer	250.00

ATARI 800 & 400 Personal Computer System

ATARI 800 \$899.00
ATARI 400 \$499.00

ATARI 800 Includes: Computer Console, BASIC Lang. Cartridge, Education System Master Cartridge, BASIC Language Programming Manual, 800 Operator's Manual w/Notebook, Atari 410 Program Recorder, BK RAM Module, Power Supply, TV Switch Box.

Peripherals	599.00	Education System Course Programs	35.00	Soiling	35.00
Disk Drive	499.00	U.S. History	35.00	Basic Electricity	35.00
Printer	69.00	U.S. Government	35.00	Basic Algebra	35.00
Program Recorder	69.00	Supervisory Skills	35.00	Basic Game and Program Casettes	35.00
Education System Master Cartridge	289.00	World History (Western)	35.00	BASIC Game Programs	18.00
Atari BASIC	55.00	Counting Procedures	35.00	48K Memory	19.00
Assembler Debug	55.00	Principles of Accounting	35.00	16K RAM Memory Module	119.00
Bookshelf	42.00	Physics	35.00	16K RAM Memory Module	225.00
Life	42.00	Great Classics (English)	35.00	Drummers	35.00
Super Baseball™	42.00	Business Communications	35.00	Bank Dictates	3.00
Music Composer	55.00	Basic Psychology	35.00	Disk File Manager	3.00
Super Bug™	42.00	Effective Writing	35.00	Accessory Controllers	18.00
Computer Chess	55.00	Auto Mechanics	35.00	Drum Controller Pak	18.00
Home Finance	55.00	Principles of Economics	35.00	Joystick Controller Pak	18.00

TEXAS INSTRUMENTS INCORPORATED 99/4 PERSONAL COMPUTER

Superior Color, Music, Sound and Graphics - and a Powerful Extended Basic - All Built In.
\$1099.00

Commodore PET AS LOW AS \$775.00

DISCOUNT PRICES

2001-861	775.00	2023 80-Cal Print Paper	685.00
2001-168K	975.00	2940 Dual Min Disk Drive	1250.00
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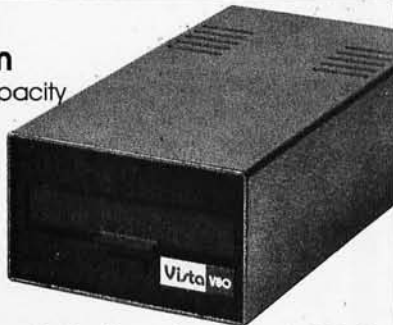
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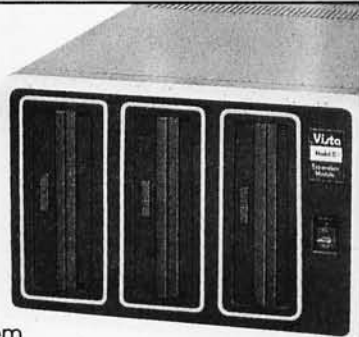
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WANTED: Heathkit Microprocessor Trainer ET-3400 and Memory I/O Accessory ETA-3400 for use with Heathkit Microprocessor Course. Will trade for Teletype printer parts, and/or cash. Please write and give details (ie: assembled/unassembled and if the unit(s) are operational). George Keim, POB 160, Yap Island GU 96943. First class mail for fastest reply, US Domestic Post Office rates.

February BOMB Results Graph Theory

Readers of BYTE expressed a burning interest in "A Computer-Controlled Wood Stove" by Steve Ciarcia (page 32). Steve won first place in the voting, his fourth first-place finish in as many months. Second place in the tally went to John A Lehman for "A Financial Analysis Program" (page 192). Judging from comments written on the BOMB cards, many readers were fascinated by an example of the balance sheet for MITS, Inc. Third place was taken by Ted Carter for "Implementing Dynamic Data Structures with BASIC Files" (page 92). Fourth place was taken by Robert A Morris for "Comparison of Some High-Level Languages" (page 128).

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Inquiry No.	Page No.	291	292	24
320 AB Computers 329		Farnsworth Computer 320	OSM Computer 320	Smoke Signal Broadcasting 45
117 ABW Corp 195		174 FMG Corp 249	Owens Associates 198	25 Smoke Signal (Dealers only) 45
191 Ackerman Digital 259		103 Folio Books 174, 175	262 Pacific Exchanges 308	48 Softagon Inc 84
50 (ADD5) Applied Digital Data Sys 87		307 Fordham Radio Supply 326	289 Pacific Exchanges 320	112 Softech 190
323 Adv Computer Prod 332, 333		268 Frederick Computer Prod 308	328 Page Digital 330	138 Softside 225
200 AL Industries 265		226 Futureworld 278	176 PAIA 251	131 The Software Exchange 239
267 ALL Electronics 308		107 GW Computers Ltd 182	250 Pan American Elect 300	234 Software Factory 284
83 Altos 142, 143		Game Design (Taito America) 294	(A Radio Shack Auth Sales Ctr)	264 The Software Farm 308
44 Anadex Inc 179		318 GEM Business Sys 328	127 PCD Systems Inc 210	310 The Software Review 328
257 Ancrona 304		6 General Business Comp 16	290 PEEK (65) 320	217 Software Works 275
109 Anderson Jacobson 184		9 Gimix 58	5 Per Com Data 15	308 Solid State Sales 326
28 APF Electronics 51		204 Global Parameters 268	37 Per Com Data 67 & 77	154 Sorrento Valley Assoc 241
202 Apparat 266		103 Godbc Electronics 177	43 Per Com Data 76 & 77	35 Southern Computer Sys Inc 64
4 Apple Computer 13		209 GR Electronics Ltd 271	97 Personal Computers 161	325 Southwest Tech Prod Corp C II
76 Applied Computer Sys 132		75 H & E Computronics 156	99 Personal Software 167	210 Spectrum Software 271
240 Aristo Polks 294		95 H & E Computronics 157	Phase One Systems 227	3 SSM 11
10 Artec Electronics 24		304 Hampshire Design 322	168 Pickles & Trout 247	166 The Stackworks 246
253 ASAP 302		128 Harbide 211	184 Potomac Micro Magic 255	282 Starburst Computer Group Inc 316
316 A-T Enterprises 328		62 D C Hayes Associates Inc 106	55 Power One 95	130 Strategic Simulations 213
244 ATV Research 294		141 D C Hayes Associates Inc 228	285 Priority One 318, 319	93 Structured Sys Group 154
133 Automata Simulations 219		39 Houston Instruments 71	92 Prodigy 153	31 SubLOGIC 60
218 Awonic Enterprises (A.E.I.) 275		40 Houston Instruments 71	119 Program Design Inc (PDI) 199	73 Summagraphics 125
63 Balcode Software Inc 107		148 IBC 236	81 The Program Store 139	298 Sunflex 322
70 BASF 121		170 Int'l Data Science 248	84 QC Microsystems 145	254 Sunny International 302
271 Becklan 309		82 Int'l Data Sys (IDS) 141	21 QT Computer Sys Inc 39	3 SuperSoft 92
195 John Bell Engineering 263		41 Intertec 73	272 QT Computer Sys Inc 310, 311	78 Supersoft 135
Beta Computer Devices 253		5 Independent Business Sys 55	301 Quadrus Associates 322	94 Supersoft 155
Bits Inc 285		34 Industrial Micro Sys 63	47 Quasar Data Products Inc 83	206 Support Tech & Prod Inc 269
150 Bizcomp 238		330 Infosoft Systems Inc 50	59 Quay Corp 101	11 Symtec 25
The Business & Home Computer Shows 207		189 INMAC 259	42 Quiet Designs Inc 75	60 Sydex 103
BYTE Back Issues 285		15 Integral Data Systems, Inc 31	252 Quest 301	61 Synchro Sound 105
51 BYTE Books 89, 129		190 Integrand 259	91 R & K Enterprises 152	222 Synergetic Comp Prod 277
BYTE Books 279		426 Intel insert (between pp 16 & 17)	66 RACAL - Milgo 113	108 Tarbell 183
BYTE Conference 185-188		17 Intelligent Systems Corp 33	258 Racet Computers 265	69 Tech Sys Consultants (TSC) 119
C & S Electronics Corp 246		287 Interactive Microwave 320	36 Raygam 62	13 TeleVideo Inc 27
California Computer Sys 20, 21		170 Int'l Data Science 248	93 RCA 159	278 Terminal Data 316
California Data Corp 308		82 Int'l Data Sys (IDS) 141	77 RCA Solid State 134	57 Texas Electronics Instruments (T.E.I.) 98
California Digital 331		41 Intertec 73	172 Reliable Comp Resources 248	26 Texas Instruments 47
Cambridge Develop Labs 273		7 Ithaca Intersystems 9	275 Renaissance Sys Inc 316	3-G Co 243
CBS Records 10		71 Ithaca Intersystems 122	2 RITAM International 8	23 3/M Computer 42, 43
COM Inc 322		311 J & B Computer Products 328	239 RLK Software 294	Robert Tinney Graphics 17
Central Data 197		259 Jade 306, 307	129 RNB Enterprises 212	TL Industries 328
Chatsworth Data 34		274 Jameco Electronics 314, 315	182 Robotics Age 255	297 Torrey Pines Business Sys 322
Chrislin Industries 206		314 Jini Microsystems 328	225 S-100 277	199 TransNet 265
Chrislin Industries 240		67 Kemco Ltd 115	S & A Data Sys 308	United Software 245
Circle Computer Sales 282		185 Konan Corp 256	149 Howard W Sams Co Inc 237	241 Univair Inc 294
Cleveland Consumer Computers & Components 303		185 Lifeboat 116, 117	177 Sara-Tech 251	36 Universal Data Sys 65
Compas Microsystems 263		303 Logicon 322	223 SC Digital 277	207 US Robotics 269
Complete Business Systems 235		169 Lomas Data Products 247	227 SCDP 278	216 Vector Electronics 274
CompuMart 312, 313		312 M-Software 328	65 SCION CORP 5	20 Verbatim Corp 37
72 CompuMax 123		145 Macrotronics 232	205 Selanar 269	302 Videx 322
CompuServe (microNET) 97		286 Macrotronics 320	212 Michael Shrayer Software 273	324 Vista Computer 334
CompuSystems 49		224 McClintock Corp 277	Shugart 6, 7	270 VR Data 309
Computer Data Systems 205		Meas Sys & Controls 57	158 Sigma International 243	251 Wameco 300
Computer Factory 133		293 Med-Ford Software 320	183 Sigma International 255	Wang Labs 217
Computer Furniture & Access 32		173 MICAH 249	178 Sirius Systems 251	197 Western I/O 263
Computer Hardware 254		32 Micro Age Computer Stores 61	134 Small Business	Whitesmith's Ltd 127
Computer Marketing Corp 253		87 Micro America 150	Applications Inc 221	313 Wintek Corp 328
Computer Prof Books Club 231		89 Micro America 151	Small Business Sys Group 158	281 Worldwide Electronics 316
Computer Services Center 316		101 Micro America 171	161 Ed Smith's Software Works 245	181 ZS Systems 253
Computer Services 316		113 Micro America 191		
Computer Shop Inc 320		164 Micro Applications Group (MAG) 246		
Computer Shopper 308		237 Micro Architect 294		
86 Computer Specialties 149		249 Micro Business World 299		
Computers Wholesale 246		329 Microcomputer Tech Inc 266		
12 Computex 26		277 Microcomputer Tech Inc. 316		
203 CompuView 267		38 MICRO DATA BASE SYSTEMS 69		
256 Concord Computer Components 304		136 Micromail 223		
Coosol Inc 244		261 Micro Mart 308		
22 Corvus Systems 41		80 Micro Mike's Inc 137		
220 Cover Craft 275		156 Micro Management Sys 242		
179 CPU Shop 102		Micro Pro Intl 131		
299 Cranial Labs 322		238 Microsette 294		
1 Cromemco 1, 2		52 Microsoft 91		
192 CT MicroCOMPUTER, Inc 261		100 Microsoft (Cons Prod Div) 169		
Cybernetics Inc 248		45 Micro Source 81		
236 DAR Sales 294		30 Microtek 59		
321 Dal-Comp 329		229 Microwave 278		
Data Access 233		7 The Micro Works 18		
213 Data Discount Center 273		49 Micro World 85		
228 Datadisk Systems 278		171 Midwest Computer Periph 248		
58 Data Management Labs 99		247 Mikos 298		
131 Data-Safe Products Inc 214		187 Mini Computer Suppliers 257		
153 The Data Corp 241		98 Mini Micro Mart 164, 165		
295 Delta Products 321		105 Mini Micro Mart 179		
175 DG Electronics 249		142 Mini Micro Mart 229		
137 Dennison Kybe Corp 224		305 Mini Micro Mart 323		
265 Des-Mar Electronics 308		326 Morrow/Thinker Toys CV III		
106 Diablo (Div of Xerox) 181		8 Mountain Hardware 19		
124 Digi Byte 30		79 Mountain Hardware 136		
194 Digital Graphic Systems 261		19 MT MICROSYSTEMS 35		
221 Digital Marketing 276		296 Multi Business Comp Sys 322		
120 Digital Pathways 201		139 National Multiplex 225		
309 Digital Research: Comp 327		National Small Comp Show 230		
111 Digital Research Corp 189		NCC (Personal Computing) 281		
160 Discount Software Group 245		167 NEBS (New England Business Service Inc) 247		
198 Dr Dobb's Journal 264		88 NEECO 150		
155 Dynacomp 241		90 NEECO 151		
288 Dynasoft Systems 320		102 NEECO 171		
Ecosoft 261		114 NEECO 191		
Electrawave Industrial 294		115 Netronics 193		
284 Electrolabs 317		116 Netronics 193		
306 Electrolabs 324, 325		121 Netronics 203		
54 Electronic Control Tech 93		14 North Star 29		
126 Electronics Book Club 209		283 Northwest Computer Serv 316		
245 Electronic Systems 295		327 Ohio Scientific Instrument CV IV		
246 Electronic Systems 296, 297		45 OK Machine & Tool Corp 82		
215 Escan 273		85 OK Machine & Tool Corp 147		
135 Essex Publishing 222		188 OK Machine & Tool 257		
186 Excel 257		219 The Old Association 275		
211 EXCOM 271		OnComputing 289		
Factory Direct Sales 252		68 Orange Micro 118		
315 Faircom 328		74 Oregon Software 128		
		132 Osborne/McGraw-Hill 215		

BOMB

BYTE's Ongoing Monitor Box

Article #	Page	Article	Author
1	12	The Cassette Lives On, An Alternative to Floppy-Disk Mass Storage	Cook
2	20	A DC-to-DC Converter	Picco
3	22	I/O Expansion for the Radio Shack TRS-80, Part 1: Principles of Parallel Ports	Ciarcia
4	44	KIMDOS, Using Your KIM-1 with a Percom Floppy-Disk Drive	Swank
5	72	Interface a Floppy-Disk Drive to an 8080A-Based Computer	Hoepfner
6	104	A Graphics Text Editor for Music, Part 2: Algorithms	Nelson
7	120	Using the Computer as a Musician's Amanuensis, Part 2: Going from Keyboard to Printed Score	Raskin
8	130	Comparing Floppy-Disk Drives by Software Simulation	Nendza
9	196	Give Your Computer an Ear for Names	Munnecke
10	202	The Club Computer Network	Kasser
11	214	The COSMAC Doodler	Duntemann
12	250	Error Checking and Correcting for Your Computer	Walker

Bomb results on previous page

There are two sides to our story.

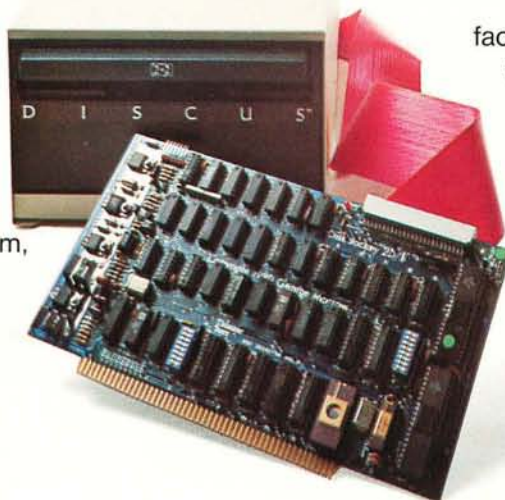
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