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Cover illustration by Dion Owens.
Publisher's Remarks

Keyboarding Economy

The postal service reportedly poured millions of dollars down the tubes trying to invent the uninvetable: a machine for deciphering handwriting. Unquestionably there is a need for this. Most of the data input to computers consists primarily of names, addresses and orders for goods. There seems to be no practical approach to induce people to buy a typewriter with a special ball that can be read by optical character-reading (OCR) systems. The postal service might be able to implement some sort of OCR addressing if they set up a special class of mail with lower rates for letters addressed with a standard OCR.

The answer to speeding up (cutting the cost) of data input for computers lies in some sort of automatic reading of names, addresses and other simple data such as quantity and part number for orders. We already have equipment that reads pencil or pen marks on cards, so that gives us something to work with. Since there are too many ways of writing or printing for a computer to cope with, we are going to have to come up with some simplified coding which our computers can read, but which can be marked with a pen or pencil.

There are about 40 different characters that need to be deciphered (alphabet, numerals, punctuation marks). A system that required you to choose each individual character from a group of 40 boxes, each box representing one character, would be too cumbersome. Since a name and address would have to allow for up to 80 individual characters, a coded card would have to contain 3200 boxes just to cope with the name and address. Something simpler is necessary, and I think I have a solution.

Most of my flashes of intuition come while I am taking a shower. (I've read that this has something to do with the negative ions caused by the stream of water hitting the body. There may be something to this. I don't take long showers, either—though I suppose I should. I've worked my morning shower process into an efficient system: brushing my teeth (yes, in the shower, while the beard is softening), shaving (yes, also in the shower, while the beard is soft and very easy to shave), soaping and rinsing. The whole works takes under ten minutes, including toweling, applying after-shave and antiperspirant and combing what's left of my hair. If I save only ten minutes a day with this routine, it gives me 60 hours a year to do more productive things.)

This time the brainstorm had to do with utilizing the seven-segment LED or LCD character for an OCR system. With seven segments we should be able to represent two characters, or 128. That's plenty for the alphabet, numbers and punctuation.

Should we go to an ASCII-type coding or start over again? Since lookup tables for electronic circuits are so simple, the coding should be easy to read. If we start with the ten numbers, which are all handled easily with the seven-segment system, we are off and running (see Fig. 1). The alphabet is more difficult, but let's look at the letters that are easy to handle first: A, C, E, F, G, H, J, L and P (see Fig. 2).

Some letters, such as a lowercase b and d, can be handled without too much half-size i, o and u finish off the vowels, so they are all readable (see Fig. 3). I tackled the rest of the letters and punctuation, and I came up with Fig. 4.

To see if this was worth the trouble, I tried a few words in this new representational alphabet (see Fig. 5). It's a bit of a strain, but I think that a data-input person could become accustomed to reading this in a day or less.

The end result would be one seven-segment box for each character. A translation for the marks would not take up a lot of room on a coded order card, and the finished product could then be read by machine. This would cut the cost of data entry, and thus make it possible to sell products or subscriptions cheaper. Remember that many data-input systems call for each name and address to be keyboarded a second time for verification, so perhaps you can appreciate the savings.

If those savings are not apparent, then look at it this way. At one minute per order for data entry, plus a second minute for verification of the original data, we're looking at around 14¢ in data-entry costs just for labor. Add the cost of the equipment, worker benefits, heat, light, power, repairs, training and supervision, and you at least double your cost of labor, bringing the data input cost up to 28¢ per order. Wouldn't you like to save 28¢ on every subscription to a magazine you send in ... on every mail order you send in? An outfit that handled 1000 orders a day could save $280 per day by changing to GRC (Green Readable Character) data input. That's over $70,000 a year.

With this GRC system, a mail-order house or subscription agency would only need two data-input people. One person would take a quick look at each data input to make sure it was not screwed up; a second person would input those orders too badly confused for the system. I doubt if this system would put a lot of people out of work. Most data-input departments I've seen are chronically short of people—not many employees enjoy sitting at a tube all day long typing in orders or reader-service requests. This system should also be adaptable to post-office tasks. The first readers would be for
postcard-size cards with an optically readable symbology line for the system to use as a reference to start reading the name, address, city, state, zip and other order information. That machinery would adapt to read addresses on envelopes and automate letter mail.

Light green outlines for the characters could be printed on the envelopes or on the labels to stick on the envelopes. Characters would be marked by pencil or pen over the green guidelines. If the postal office used reader-sorters, they could drop the postage rate to maybe 10¢ for GRC mail, and soon every business in the country would use it, complete with GRC bars for typewriters.

Using the size and spacing of the IBM Selectric typewriter, a complete name and address could fit in an area 2½ inches long by 1 inch high, and that would provide three lines of 25 characters each. A four line address system would be 1½ inches high. That’s within the size requirements for presently used labels, so the system should not be particularly difficult to put into operation.

A character reading system such as this could be adapted to any computer, either by use of a chip with the lookup table in it or a simple lookup software program. An operator watching cards being read would see the characters translated into regular terminal characters rather than seven-segment readouts.

The character reader could either scan a row of characters, reading them sequentially, or have 875 sensing elements to read the four 25-character lines at one time. Another element or two could detect synch indicators. Order-reading systems would probably scan more like bar-code systems.

The standard I have set for the system is ten characters to the inch and a pitch of two points per line (1½ inch). The character blocks are ten point in size and can be approximated by using the IBM #10 Orator ball and typing an E overprinted with an H. This leaves a line beneath each character line for indicating what should be on that line.

**Hitachi and Tandy Coming?**

There are hints that Hitachi is releasing a new system that could sell well in this country. I understand that it has eight colors and a 640 x 200 resolution. It uses a 6809 processor.

We’re still waiting for the release of the Tandy color system, rumored to be called TRS-90 and use a Z-80. Although Tandy had plans for using the 6809, I suspect that the importance of being able to use the already developed program base had some effect on the decision. One of these days, we’ll see where rumor ends and facts begin.

The first evaluation units of the Hitachi system should arrive in this country by early fall. I think we’re in line to look at a system, so watch for more news.

**Winchester Technology**

This term is used a lot these days, and I’ll bet that few readers have any idea of its origin. It all started, according to a recent Pertec newsletter, with a 1973 IBM 3340 drive. This new disk development was supposed to be a dual 30 megabyte drive: 30-30. The drives eventually became 35 and then 70 megabytes each, but by then the "Winchester" name had stuck. So much for the history lesson for today.

(continued on page 218)
Program Search

Exidy's acquisition by Recordex should increase demand for program packages for this system. ISI is particularly interested in Exidy-oriented programs for possible publication. If you have both a TRS-80 and an Exidy, you might like to try translating programs from one system to the other—for a royalty on the sales.

North Star is doing well, and ISI has North Star-based program packages well along in development. And needs more. If you have written any good North Star programs, you can help both North Star and yourself by submitting them for possible publication.

It will be quite a while before we have a serious need for Apple II programs, but the ISI programs currently distributed for the Apple are faring well and are a nice source of income for the authors. Now that ISI has a good foundation of TRS-80 programs, more time is being invested in the support of the Apple and other systems, so turn your Apple programming work into royalty income.

We also need a machine-language word processor—particularly for the TRS-80. This would speed up the system and make such a use for the TRS-80 far more practical. How about it, all you machine-language fans?

Translators Needed

Pressure is being put on microcomputer manufacturers to provide software support for their systems: some of the majors are beginning to feel the heat. Dealers are complaining, and even the general-interest magazines are mentioning poor software support. Money magazine quoted Texas Instruments as having plans for only 100 programs by the end of 1981. This tiny number has to put a chill on the whole industry.

It seemed appropriate for Instant Software to help by putting some TI programs on the market. We consulted our associate-editor list to see who had volunteered to make the conversions from the TRS-80 to the TI-99/4. With over 1,000 editors from which to choose, we could find none available for this job!

Readers who want to tackle this should write and give me some idea of their equipment and experience. We have released hundreds of programs for the TRS-80; we want to translate as many as possible for use on the TI-99/4. We understand the problems with the system and the efforts Texas Instruments made to make translations difficult.

Several other firms have shown interest in getting substantial software support, so we may need translators for programs from TRS-80 to Heath, Atari, Apple and a few others. You do the work on your time, at your convenience. If you think you might go for this, drop me a line.

Electronic Design with Off-the-Shader Integrated Circuits

Z. H. Meiksin and Philip C. Thackray
Parker, West Nyack, NY, 1980
Hardbound, 383 pp., $19.95

This cookbook contains the design principles you'll need to exploit low-cost mass-produced integrated circuits and passive support components. An excellent one-stop reference for the computerist who designs his own hardware, the book is for both those who are adding to their systems and those who are full-blowm construction freaks.

The text focuses on practical approaches. It minimizes math and emphasizes a cut-to-fit method that must, in the end, be applied to the most thoroughly planned designs.

For example, the book supplies simplified equations for designing active filters with op amps. It covers first through fourth order, constant ripple, maximally flat and high-Q filters. Even with the simplified tables and equations provided, the authors say, values that result are "of much greater precision than can be obtained with commercial fixed value components." The text then outlines filter tuning procedures.

While most readers will use the sections on digital ICs primarily for reference, topics such as rise time and decay time are presented in an unusually lucid manner. The chapters on analog to digital conversion, linear applications, and nonlinear applications are also thought-provoking. These chapters cover photo sensor amplifiers, four-quadrant multipliers, peak detectors and sample and hold circuits.

The book, unlike any other text I've seen, covers passive components with the same depth it covers active components. These include resistors, capacitors, inductors and transformers.

This information will help you decide what type or composition of capacitor to use or what type of resistor you'll need. The characteristics of each type of part are explained in detail to let you make intelligent decisions.

The authors also discuss techniques for anticipating and eliminating noise problems. Computer buffs will be particularly interested in the chapter on grounding and shielding. A section on eliminating spurious signals in digital circuits includes ways to handle power supply noise, stray field effects, capacitive coupling and signal reflection. The chapter also suggests ways to overcome problems with analog and hybrid digital-analog systems.

The text ends with examples of system design and summarizes considerations that affect the overall performance of a system. The book provides guidelines for choosing the IC functional blocks that best satisfy an application's requirements with the greatest cost-efficiency.

"Pitfalls to Avoid," a feature of each section, has already earned the price of the book for me. It covers common errors in the design approach to applying the particular component. For example, the authors point out a common error in the design of light detector amplifiers and suggest an approach that eliminates the problem and reduces the circuit's part count.

While much of the book's information is
duplicated elsewhere in my library, nowhere is it so conveniently brought together. I think that if you have any experience with building or designing hardware, you’ll find this useful text that is neither too complicated nor too simple.

Gregg W. Squires
Sparkill, NY

Microcomputer Interfacing
Bruce A. Artwick
Prentice-Hall, Englewood Cliffs, NJ
Hardbound, 323 pp., $18.95

The title of this book led me to believe that it would discuss how to attach peripherals or signal conditioners to a functioning computer system. But it instead tackled such topics as construction of microprocessor chips, design rules for microprocessor controllers and construction techniques. Artwick is clearly talking about microprocessor interfacing.

If you’re a hobbyist ready to become an entrepreneur, your first decision will be which microprocessor to choose. Four, eight or 16 bits? Higher speed or lower power? One chooses a design that is directed toward data processing or industrial control? Artwick compares about a dozen different microprocessors. He is uneven, but does touch on the weaknesses and strengths of each. He also includes bitsliced chips and single-board controllers. Novice designers will find this helpful.

Because of its simple explanation of both static and dynamic RAM, the chapter on data storage is the best in the book. Imagine someone boiling down volumes of manufacturers’ literature and making the residue readable. Starting with the old 2102 memory chip and using many simplified block and timing diagrams, he works his way through to the recent dynamic and 16K RAMs. The text answers such questions as “Why do the new dynamic 16K RAMs have fewer address pins than 1K static RAMs?” and “What is the difference between an erasable PROM and an alterable ROM?” It even looks briefly at charge-coupled devices and magnetic bubble memory.

About one quarter of the chapter deals with magnetic recording methods for long-term storage on tape or floppy disks. Hard disk technology is ignored.

The chapter on interfacing components also deserves special mention for its completeness. Any possible way to get information into or out of a computer system is listed. Artwick covers the basics of TTL drivers and receivers and explains the importance of fan-out, what to do about unused gate inputs and how to mix MOS and TTL family chips in the same design. This is followed by the LSI interface circuits, such as programmable peripheral interface chips and CRT controllers.

A good section explains why a synchronous communication interface adapter is more complicated than an asynchronous communication interface adapter. The pages on analog and digital conversion, transducers and other devices contain many practical suggestions and criteria for selection.

Each topic, however, is limited in scope. A section on floppy disk controller chips mentions two that are designed to mate with specific microprocessors but neglects to mention the Western Digital 1790 series, which is manufactured for use with any microprocessor.

The rest of the text is more general. The chapter on input and output methods spends less than a page each on asynchronous serial communications, multiplexing and memory-mapped I/O and doesn’t even include examples. Artwick’s coverage of polling and interrupt-driven I/O is a bit more comprehensive, because he offers suggestions on how to assign interrupt priorities and handle interrupt processing.

Other chapters cover circuit board layout, construction techniques and interfacing to standard microcomputer buses.

Artwick does not include a bibliography. This is unfortunate, since I found many places where I needed more information. The figures are excellent and the majority of the text is very clear. The coverage of future trends in the industry will keep the book current long enough to avoid having to put out a new edition in loose-leaf form.

The overall usefulness of this book would depend on who you are. If you want to design something, Microcomputer Interfacing is just a starting point. It is not a circuit design reference book because not many specific circuits are included.

The book is good for hints, tips and rules. Here are two examples: “One-shot should never be used to drive Set, Clear or Clock inputs of logic devices,” and “Convert analog signals into digital signals as soon as possible.”

I doubt that an inexperienced designer would be able to complete an assignment with just this book, but it should shorten development time. The person who wants to know how microprocessor-based equipment works will be helped the most.

Mike Aronson
Oregon City, OR

Introduction to Computer Programming
Walter S. Brainerd
Charles H. Goldberg
Johnathan L. Gross
Harper and Row, New York, 1979
Hardcover, 534 pp., $16.95

The authors promise a textbook that will give the beginner a solid foundation of programming knowledge. And though the title is a little misleading—the novice will need to know something about programming if he does not have an instructor—the book is one of the best treatments of the art and science of programming I have used.

The authors take a unique approach. They have developed a Beginner’s Programming Language (BPL) that teaches the logic of programming without requiring the reader to master the conventions of a specialized language. The beginner can read and understand a BPL program without any knowledge of the

BPL rules; the language itself carries the structure of its own logic.

The beauty of this approach is the ease with which the student of BPL can transfer his learning to BASIC, FORTRAN, PL/I and COBOL programming. Once the reader adjusts to BPL, the 200 sample programs found in the text are completely understandable.

The book moves from the simple to the complex, using examples and applications every step of the way. For example, a continuing analysis of credit card sorting presents an excellent tutorial of various sorting routines. The authors go through finding the smallest element in a list, sorting by replacement, merging, the bubble sort and, finally, file sorting.

As they present this material, the authors lead the reader through formatting, looping and other standard tools of programming. The beginner learns in a building-block fashion, each bit of knowledge leading to the next.

The beginning programmer should follow the text sequentially. However, a reader with a solid foundation in programming will want to study selected chapters. The 500-plus exercises throughout the book provide a constant source of stimulation and challenge.

James P. Morgan
Scott AFB, IL

NEW RELEASES


Troubleshooting Microprocessors and Digital Logic—Robert L. Goodman. TAB Books, Blue Ridge Summit, PA. $12.95, hardbound ($7.95, paperback).


A Bit of BASIC—Thomas A. Dwyer and Margot Critchfield. Addison-Wesley, Reading, MA. $5.95.

“Percom Sells More Microcomputer Disk Systems Than Any Other Peripherals Manufacturer. I'd like to show you why.”

“Percom has been manufacturing mini-disk storage systems for microcomputers since 1977 when we introduced the 35-track, single-drive LFD-400™. Now we produce 1-, 2- and 3-drive systems in 40- and 77-track versions, a multi-density MEGABASE™ system and a host of accessories and software.

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“I know of no other microcomputer disk system manufacturer who even begins to offer the broad spectrum of disk equipment and programs available from Percom.”

“So before you buy a mini-disk system for your 6800, 6809 or TRS-80* computer, take a good look at what the people at Percom have to offer.”

Harold Mauch
President, Percom Data Company
"From an efficient 1K-byte control system DOS to high level languages such as FORTRAN and Pascal, no other microcomputer disk systems manufacturer provides the range and quality of development and application programs available from Percom."

"Connie is running a 'cats eye' test on a mini-disk drive to check radial track alignment. Drive motor-speed timing and sensor alignment tests have already been performed. Disk formatting and format verification tests are next. These measurements are part of the 100% testing every single unit receives."

"Whether you call about a shipping date or ask a tough technical question, you get a competent courteous answer. Outstanding customer service is a hallmark of Percom."

"Richard's making final changes to a disk controller which will allow Percom drives to be used with yet another computer. We're constantly developing and introducing new products that extend and enhance the value of Percom systems."

"Slipping a circuit board through the eye of a needle would be easier than slipping a cold solder joint past Beverly. These are four-drive LFD-400/800 disk system controllers she's inspecting."
NEW PRODUCTS

Apple III

Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014, has introduced its Apple III computer. Designed for use by professional/managerial personnel, the Apple III features a new Apple-designed central processor, up to 128K bytes of main memory, a built-in disk controller for handling up to four floppy disk drives, a new keyboard design with a 13-key numeric keyboard and an 80-character × 24-line upper/lowercase display. A number of items that were optional on the Apple II have been incorporated as standard equipment in the Apple III. In addition, a special emulation capability lets users convert an Apple III to an Apple II to permit the use of programs developed for the Apple II.

Two new application packages are offered for use on the Apple III: the Information Analyst software, for planning, forecasting, modeling, pricing and costing, scheduling and budgeting, and the Apple III Word Processor software, for preparing memos, letters and general typing, long documents, form letters and legal documents. Apple III prices range from $4340 to $7800. Reader Service number 481.

Dot-Matrix Printer

The Model 460, the newest addition to the Paper Tiger line of dot-matrix printers, features bidirectional print speeds of 160 characters per second and offers correspondence-quality, high-speed printing and high-resolution graphics. It offers a variety of programmable print control functions including proportional character spacing and automatic text justification.

The Model 460 can print in 80-, 96- and 132-column formats. Standard paper-handling features include adjustable pin-feed tractor drives that use a stepper motor to ensure fast, accurate movement of fanfold or roll paper and single- or multi-part forms ranging from 1.75 to 10 inches wide. A standard 2K byte buffer allows acceptance of the entire contents of a full 1920-character CRT screen. The unit has a standard RS-232C serial interface as well as a Centronics-compatible parallel interface. Serial transmission rates from 110 to 9600 baud are switch-selectable. Price is $1295. Integral Data Systems, Inc., 14 Tech Circle, Natick, MA 01760. Reader Service number 477.

TR-80-Compatible Computer

Personal Micro Computers, Inc., 475 Ellis St., Mt. View, CA 94043, has introduced a new computer that is hardware- and software-compatible with the TRS-80. The PMC-80 features a cassette tape recorder, 16K memory, Level II Microsoft BASIC interpreter in ROM, power supply and keyboard in one cabinet. It will display on either a TV monitor or on a standard TV set using a built-in VHF channel 3 modulator.

All software available for the TRS-80 will operate in the PMC-80. All peripherals designed for the Radio Shack parallel port will interface to the PMC-80 50-pin bus through a 40-pin interface adapter available from PMC. Disk-based programs can be run on the PMC-80 using the Radio Shack Expansion Interface, or equivalent, which makes peripherals designed for the TRS-80 (such as Winchester disks, speech recognition, printers or RS-232 adapters) compatible with the PMC-80. Price is about $200 less than a comparably equipped TRS-80. Reader Service number 476.

Hardware Debug Aid

New Technologies Co., PO Box 32, Streamwood, IL 60103, now offers an inexpensive al-
ternative to logic analyzers and logic probes in troubleshooting micros. The Hardware Debug Aid (HDA) is an S-100 board that provides sync pulses for oscilloscope use in troubleshooting specific instructions. Or, you can disconnect the address bus to sync any combination of up to 17 signals by using jumpers. The sync pulse is also used to latch and display the status of up to eight TTL-level signals. Price is $99.95 ($84.95, kit). Reader Service number 473.

RS-232 Storage Device

The Micro-Sponge is a mass storage device that is jumper selectable for 300, 1200, 9600 and 76.8K baud and stores a maximum of 80K bytes on a 75-foot Exatron Stringy Floppy wafer. The unit plugs into any computer system that has an RS-232 port. Wafers come in five-foot increments of tape length from a minimum of five feet to a maximum of 75 feet, and each five-foot length of tape stores 5.3K of RS-232 formatted data.

The Micro-Sponge features four basic commands: Read, Write, Go to Beginning of Tape and Space File Forward. The Sponge buffers up to 1000 bytes of data in internal RAM before writing out to the wafer and requires 4.5 seconds to transfer 5.3K bytes at 9600 baud—24 seconds maximum to find the beginning of tape in an average length wafer. Price is $349.50.

Exatron, 181 Commercial St., Sunnyvale, CA 94086. Reader Service number 471.

Variable Speed/Dot Density Printer

The Slimline SLG is a new graphics printer that provides a choice of two-speed/two-dot-density printing for alphanumerics. It will print routine reports at 400 lpm with a low-density pattern (7 x 5 and 7 x 6 matrices) and then switch to a high-density pattern (7 x 9 and 7 x 12 matrices) to print correspondence at 120 lpm.

In graphics mode, it provides a dot density of 100 x 100 dots per inch at a plotting speed of 12 inches per minute. It will reproduce anything that can be displayed on a CRT screen, including graphics, maps, bar charts and labels, as well as such foreign language characters as Arabic, Chinese and Farsi. It is available with Printronix-, Centronics- and Dataprod substitutable parallel interfaces and with a microprocessor-controlled RS-232 serial interface.

OkiData Corporation, 111 Gaither Dr., Mount Laurel, NJ 08054. Reader Service number 475.

H89 Disk Accessory

The H77 is a new floppy disk accessory for the H89 all-in-one computer. The H89 can accommodate up to three floppy disk drives with the H77. You can run operating system and program disks at the same time for fast and efficient access to programs and data.

Based on the H7 Floppy Disk System, the H77 uses standard 5.25-inch, hard-sectored 40-track diskettes, each of which is capable of storing 100K bytes of data. It uses the Siemens 82 disk drive system, which provides reliable high-speed access to data. Random sector access time is less than 250 milliseconds. The H77 ($395) includes one disk drive. A diskette storage accessory, which fits into the space reserved for the second drive, is also included. The H17-1 ($325) is available to provide two-drive capability for the H77, giving the H89 a total of three drives including the drive built into the computer itself.


Single Board Computer

The ZCB single board computer, designed to function as the center of a unique approach to system design, is aimed at system integrators as well as the industrial process control and scientific markets. It generates all standard S-100 bus signals, including emulation of an 8080 CPU, and contains a Z-80-A operating at 4 MHz, 1K of high-speed static RAM memory, three sockets for up to 12K of PROM, one serial port and three 8-bit programmable parallel ports. Circuitry is provided to support static or dynamic memories. Use of 2708, 2716 or 2732 PROMs is jumper selectable, and the addressing of the PROM and RAM is completely variable. Use of wait states on bus cycle and/or in-

H77 Floppy Disk System.
struction fetch cycle is also jumper selected. The serial port makes use of the Intel 8251 USART, which enables software to control the format of the transmitted data and to vary the mode of transmission. A DIP switch specifies the basic rate, between 110 and 9600 baud. The parallel ports use the Intel 8255, which allows the same lines to be used for input and output, under program control, and allows flexibility in assigning lines to I/O addresses, also under program control. Price is $395.

Microcomputer Down Loader

Wintek's new Down Loader allows you to automatically down-load programs developed on the Sprint 68 microcomputer to a target computer for final debugging in their true operating environment. The system consists of a switched RS-232 cable assembly and associated software on diskette. Price is $149.

Wintek Corp., 1801 South St., Lafayette, IN 47904. Reader Service number 470.

Wire-Wrapping Tools

OK Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475, announces several new tools and parts for prototype and hobby applications. The WK-4B wire-wrapping kit includes a universal PC board, an edge connector with wire-wrapping terminals, two industrial-quality 14-pin wire-wrapping DIP sockets, two 16-pin sockets, a DIP inserter/extractor, a wire dispenser with 50 ft. of wire and a cutting and stripping mechanism to prepare the wire for wire-wrapping or soldering and a new combination tool that wraps and unwraps 30 AWG wire on .025 square pins, plus strips 30 AWG wire using a convenient built-in stripper. Price is $25.99. Reader Service number 485.

Word Processor/Computer

Superstar is a word processor/small-business computer that consists of ITI’s Superbrain by Intertec, the NEC Spinwriter and MicroPro’s WordStar word-processing software. This combination features word wrapping, dynamic pagination, two double-density 5½-inch floppy disk drives, 64K bytes of user-programmable RAM and printing at 55 cps. Price is $7500. Software necessary to handle a company payroll of up to 75 people, general ledgers, accounts receivable and inventory is available for $2500. Information Technology, Inc., 56 Kearney Rd., Needham, MA 02194. Reader Service number 469.

Typewriter Interface

Now you can turn your electric typewriter into a hard-copy printer with the I/O Pak from Rochester Data, Inc., 3100 Monroe Ave., Rochester, NY 14618. This typewriter interface exploits the high quality and full upper and lowercase characters of electric typewriters, permitting users of small computer systems to expand those systems into applications demanding high-quality text, such as word processing.

The I/O Pak, consisting of an array of coils positioned in the same pattern as the typewriter’s keyboard, fits directly over the keyboard. These coils are wired into an electrical decoding matrix. The unit is designed to operate on voltages available from standard computers; no modification to the typewriter is required. All adjustments to compensate for different
key heights are incorporated in the I/O Pak. Interfaces and software are available for the TRS-80, Level I and II, and the Apple II. A 6-bit parallel interface for general operation with other computers is also available. Price is $499. Reader Service number 479.

TRS-80/H14 Interface

Now you can interface your TRS-80 and the Heath H14 Serial Printer without having to load a software driver into memory each time the computer is powered up. The PTS-3 interface plugs into the parallel printer port of the Radio Shack Expansion Interface, and the H14 connects to the DB-25S connector of the PTS-3. The H14 baud rate switches are set for operation at 4800 baud. All handshaking and printer status signals are supported with this interface.

Once the PTS-3 is installed, the TRS-80 "thinks" it is connected to a Centronics-parallel-type printer. Compatibility is extended to support all printer commands whether at the BASIC level or machine-language level.

The PTS-4 interface can be used with the PTS-3 in systems that do not include the Radio Shack Expansion Interface. The PTS-4 simply connects to the 40-pin card edge located on the rear of the TRS-80 keyboard. The PTS-3 can then be connected to the PTS-4 to obtain printer operation, just as if an Expansion Interface were being used. The PTS-3 and PTS-4 each cost $69.95, plus $3.50, shipping and handling.

Multi Media Systems, PO Box 41084, Indianapolis, IN 46241. Reader Service number 478.

Britain's S-100 Microcomputer

The Tuscan S-100 is a newly designed Z-80 single board computer that is based on the S-100 bus. Billed as the first British S-100-based microcomputer, it utilizes widely available S-100 extension cards and comes with five S-100 cards laid flat on one board. It features versatile I/O capability with immediate expansion possibilities, including a disk-based CP/M system, high-resolution graphics and speech synthesis. Packaged in a professional case with integral disk drives, the unit is available in all options as a kit or fully assembled and tested.

Transam, 12 Chapel St., London, England NW1 5DH. Reader Service number 484.

H8 Prototype Board

The HKB-I prototype board for the H8 bus, designed for ease of external cable connection, is a full-sized FR-4 board with heat sink/ mounting brackets, bus connectors and a polarizing key. It uses .042 inch diameter plated-through holes on .1 inch centers for use with wire-wrap pins or direct solder connections. It features a hole pattern with interlaced power and ground traces with built-in jumper locations available. Price is $46, kit.

Mullen Computer Products, Inc., Box 6214, Hayward, CA 94545. Reader Service number 482.

Power Control Console

Spike-Spiker is a computer power control console that makes it convenient to plug all your computer equipment into one unit and switch the equipment on and off in the required sequential order. It eliminates constant plugging and unplugging of power cords. It also protects your computer from power line transients with an absorber and provides rf hash filtering between the computer and motorized equipment. The console has eight individually switched 120 V ac outlets divided into two separate filtered circuits, main on/off switch, fuse and indicator light. Price is $44.95.

Kalglo Electronics Company, Inc., Colony Drive Industrial Park, Box 2062, Bethlehem, PA 1801. Reader Service number 472.

TRS-80 Power Control Interface

The Black Box Energizer plugs into any Level I TRS-80 to control up to 256 separate appliances and lamps. A built-in timer measures time from seconds to days, with 1/60 second accuracy. Lamps can be dimmed and brightened under full program control. An exclusive fast-control mode is provided for special applications such as lighting displays. It is also suitable for industrial applications such as automatic irrigation, solar energy, security systems and manufacturing control.

This power control interface works with any appliance or lamp control module manufactured by BSR and sold separately by Sears and Radio Shack. It broadcasts control signals directly over your home's electrical wiring. A complete system requires only the energizer and one or more power control modules (sold separately). Price is $49.95.


The Black Box Energizer from Oasis Systems.
Computer Bismarck

Computer Bismarck is a simulation game modeled after the confrontation between the British and the German naval units at the outset of World War II. It transforms the simple Battleship game into a game of advanced strategy and planning. The setup has been maximized, and skill, cunning and planning are the critical factors. I received two versions of the program for review: Apple disk and TRS-80 cassette.

The Apple disk is more entertaining because of its use of color graphics and the quick access to disk data that allows for faster play between the different program elements. The program consists of the setup, main program and combat program. The disk uses a single data file for all three parts and has auto load linking between the program elements.

The TRS-80 cassette version contains both 16K and 32K Level II. The 16K version is cumbersome to use. The setup program produces a data file on tape that has to be read by the main program for play to begin. Before engaging in battle, you must make a data file tape which is read by the combat program. Due to memory restrictions, each program section has to be loaded separately and run individually. The 32K version has the main and combat program elements combined, so it will play much easier and quicker than the 16K version. I would like to see a 48K disk version for the TRS-80. Apple disk version is $59.95; TRS-80 cassette version is $49.95.


Ed Umlor
Technical Dept., ISI

COBOL-80 Compiler

Microsoft, 10800 NE 8th, Suite 819, Bellevue, WA 98004, announces version 4.0 of its COBOL-80 compiler for 8080-, 8085- and Z-80-based microcomputers. New features include: full-screen interactive Accept/Display and Screen Section compatible with Data General Interactive COBOL, Chain with argument passing and Segmentation to ANSI standard Level I. This new version exceeds ANSI-74 requirements with full implementation of Level I, as well as many Level II features. COBOL-80's advanced features—full Copy facility, trace style debugging and ASCII, packed and binary data formats—maximize microcomputer utility. It supports all existing versions of CP/M, including 1.3, 1.4 and 2.X for files up to 8 megabytes. It runs under CP/M, ISIS-II, IMDOS, CDOS, TEI's TDOS and Model II TRSDOS operating systems; it can be easily adapted to other operating systems. Price is $750; documentation may be purchased separately for $20. Reader Service number 486.

TRS-80 Software

Simulation Software, PO Box 1368, Warren, MI 48090, announces the release of two programs for TRS-80S equipped with Level I BASIC and 16K RAM.

Dungeon Explorer 2.0 is a single-player game of combat and adventure in which a player tries to become a superhero by battling monsters within the Dungeon of Xanadu. This revised version features a streamlined game command input routine (using INKEY$), improved combat sequences, additional monsters and mapping graphics. No two trips into the dungeon are quite the same.

Cosmic Trader is a multiplayer game of interstellar trade. Up to four people try to amass a fortune by commanding their own star freighter in a quadrant consisting of nine star systems with nine categories of trade goods. Players must negotiate all transactions with alien merchants (the computer). Players must cope with sudden changes in the marketplace and in market prices. The user can adjust the game length.

Both programs are on cassette and come with complete instructions for $12.95, plus $1 per order for shipping. Reader Service number 487.

Nutritional Software

Nutri-Pack is a series of programs and a data base for the Apple II to help you evaluate the nutritional quality of your daily diet. The programs allow you to quickly retrieve information from, modify and add to a data base containing over 600 different foods. The data base contains information on the caloric, fat and protein content and the levels of eight vitamins and minerals in the listed foods. Price for the disk version is $39.95.

Micro-Comp, Inc., 1525 NW Circle Blvd., Corvallis, OR 97330. Reader Service number 490.

Adventure Game

Dungeons is a fantasy adventure for the OSI computer in which the player assumes the role of a fighter, dwarf, halfling, elf or magic-user in search of gold in the unexplored dungeons beneath the wizard's city or in the forest that surrounds the city. Evil monsters lurk in the forest and dungeons to guard the gold. It is based on the Dungeons and Dragons game. The adventure is graphically displayed for the C1, 2, 4 and 8P. Price is $12.95 for the cassette and $15.95 for 5¼ or 8 inch disk. Both versions require 8K.

Aurora Software Associates, 353 S. 100 E., #6, Springville, UT 84663. Reader Service number 486.

For Dentists Only

Graham-Dorian Software Systems, Inc., 211 N. Broadway, Wichita, KS 67202, introduces a computer software dental package written and tested by dental professionals. It handles patient records of charges, payments, insurance, delinquent accounts and daily and monthly transactions. It prints out patient statements and standard insurance forms for the American Dental Association (ADA).

The package can be ordered on standard 8 inch disk or various mini-floppy disks. Each package includes the software in INT and BAS file form plus a user's manual and hard-copy source listing for easy customizing. The package utilizes a two-disk storage system. Reader Service number 491.

Inventory Program

Micro Business World, 15818 Hawthorne Blvd., Lawndale, CA 90260, announces the Inventory Control System for the Apple II. The program will handle up to 8100 items and contains a transaction register, fast data retrieval and audit trails. It will generate inventory status reports, reorder reports and keep track of purchase orders automatically. It may be used in a retail or wholesale environment and will handle multiple departments or divisions. Minimum hardware requirements are an Apple II Plus with 48K, one disk drive and an 80-column printer. Price is $99. Reader Service number 492.

DBMS Business Program

Info/80 is a data base management system (DBMS) that runs under the CP/M operating system by Digital Research and utilizes Microsoft's Compiled (C-80) BASIC. This product features an effective and user-oriented method
of maintaining bookkeeping, recordkeeping and management information systems tailored for individual businesses. It is operational on various disk devices ranging from 8 inch diskette to multi-megabyte hard disk with the size of the data base the controlling parameter. Thus, it can manage both a small limited application and a complete multi-application for a full on-line integrated business system.

Data Train, Inc., 840 NW 6th St., Suite 3, Grants Pass, OR 97526. Reader Service number 493.

Business Software

L216 is a business software package for TRS-80 systems with 16k memory and Level II BASIC. It consists of the following programs: a cassette data base manager, a word processor, an inventory control system, a stock management program, a label printer, a deposit calculator and a statistics program. It also features a sort utility and a key access utility, which can be included as part of the user’s program. Price is $59.


OSI Compiler

XPLO is a block-structured, high-level compiler language for Ohio Scientific computers. This new programming language includes a self-contained editor and run-time interpreter. The editor allows easy source code creation and editing, and the interpreter makes XPLO programs transportable to any computer that has the interpreter written for it. Also, the block structure allows the creation of easy-to-understand, self-documenting code.

The diskette package ($79) comes complete with utility programs: DIRECTory, CREATE and DELETE, all written in XPLO. The diskette also has some sample programs in XPLO. The cassette version costs $75. The 34-page manual, which may be purchased separately for $9.95, has sample programs, tips and a section on using the editor.

Pegasus Software, PO Box 10014, Honolulu, HI 96816. Reader Service number 495.

AppleRoots

AppleRoots is a combination genealogy/animal breeding program that has 17 user-definable fields to specify the title and length of the field. The program will default to 17 titled fields. Functions include: configure system, enter records, change records, delete records, print index or records, print list of children, print family records and print four-generation pedigree chart. All printer functions can be displayed on the screen or sent to the printer. All functions are menu-oriented; no programming is required to custom-configure the system for your personal use. It is written in Applesoft and requires a single disk drive with 24K RAM. Price is $39.95.

CDS Corp., 695 East 10th North, Logan, UT 84321. Reader Service number 498.

BASIC-FORTRAN Translator

Now you can convert software written for DEC, IBM and any other ANSI standard FORTRAN system into microcomputer-compatible BASIC with Convert, a software package for translating programs in BASIC to FORTRAN and programs in FORTRAN to BASIC.

Convert allows special BASIC command definition and FORTRAN device number specification to ensure accurate translation between any microcomputer and FORTRAN system. This translator is available in either the version I source code written in BASIC or the version II source code in FORTRAN. Both versions will operate on all popular computers with either a BASIC or FORTRAN compiler, respectively, and a minimum of 8K. The program is supplied on cassette for Ohio Scientific and TRS-80 and on floppy disk for Alpha Micro. A tape is also available for DEC, Prime or IBM systems. Price is $115.

Cognitive Electronics Laboratory, PO Box 615, New Braunfels, TX 78130. Reader Service number 497.

Pinball Game

Pinball is an arcade game written in machine language for the Radio Shack Model I Level II TRS-80. The screen displays flippers, bumpers, rollovers, runs and bonus points. The space bar on the TRS-80 releases the ball at various speeds under player control. Ball speed and acceleration depend on the contact with various features on the board, including the mysterious "Bermuda Square." Price is $14.95 on cassette or $20.95 on disk.


MDBS Software

Micro Data Base Systems, Inc., PO Box 248, Lafayette, IN 47902, has recently released version 1.03 of its network data base management system (MDBS) designed to run on Z-80, 8080, 8086 and 6502 processors. The current version requires about 16K on Z-80 machines. MDBS furnishes a collection of different, relatively simple commands. The task performed by each command is identified in the command’s mnemonic. You are not restricted to getting, modifying and deleting data for the current record of the run-unit only. The design of MDBS allows you to write and execute application programs without having previously defined subroutines for them. The MDBS-Z-80 costs $750; prices for other processors are higher. Reader Service number 499.

NEW PUBLICATIONS

Challenger III Service Manual—handbook containing fold-out schematic diagrams, pictorial diagrams, block diagrams, parts lists, memory maps, board placement diagrams and component pin-outs for the 13 circuit boards used in OSI’s business computer systems.

Ohio Scientific, 1333 Chillicothe Rd., Aurora, OH 44202.


The Phoenix Group, 1425 West 12th Place, Tempe, AZ 85281.

Heathkit Spring Catalog—free 104-page catalog that contains descriptions of nearly 400 different electronic kits for home or business.


Micro Media Magazine—floperry-based bimonthly publication that features software, reviews, graphic art, advertisements and articles for the Heath H8, H88 and H89 and the Zenith Z89. Available in both Benton Harbor and Microsoft, as well as in either HDOS or CP/M disk format.

Micro Media Magazine, 1316 Elmhurst Dr., Garland, TX 75041.

Computers in Psychiatry/Psychology—bimonthly newsletter for professionals interested in the use of computers in psychiatry and clinical psychology.

Computers in Psychiatry/Psychology, 26 Trumbull Street, New Haven, CT 06511.

Data Bits—monthly newsletter that coordinates worldwide the data and automation efforts of health planners within the 205 health systems agencies and 51 state health planning and development agencies.

Hapenny Associates, PO Box 1076, Columbia, MD 21044.

Software Vendor Directory—listing of over 700 vendors within 35 categories of hardware and operating systems.

Micro-Serve, Inc., PO Box 482, Nyack, NY 10960.

Archer Engineer’s Notebook—handbook of 415 electronic circuits for electronics hobbyists, experimenters, technicians and engineers.

Radio Shack, 1300 One Tandy Center, Fort Worth, TX 76102.

Nibble—magazine published eight times a year that focuses on the Apple II and Apple II Plus computers.

Micro-Spare, Inc., PO Box 325, Lincoln, MA 01773.

All About Personal Computers—report that traces the development of the personal computer, discusses applications and future trends and outlines how to buy a computer.

Datapro Research Corporation, 1805 Underwood Blvd., Delran, NJ 08075.
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*TRS-80 is a trademark of the Radio Shack Division of Tandy Corporation.
Carl Moser of Winston-Salem, NC, was the first to provide a comprehensive machine language assembler for the PET and other 6502-based systems. The assembler program itself was written entirely in machine language and ran much faster than other assemblers written in BASIC.

The program was not very well publicized or advertised, so it was required at least 16K of memory and was not practical on an 8K PET. But Moser has teamed up with J. R. Hall and formed Eastern House Software (EHS) of 3237 Linda Drive, Winston-Salem, NC 27106. They are now advertising several products for the 6502 microcomputer market, primarily for the PET.

Their most interesting product is the EHS macro assembler/text editor package for the 32K PET with a 2040 disk drive. This package is similar to the older assembler, but is now greatly enhanced with the exclusive use of disk files. EHS appears to be the most powerful 6502 assembler and text editor package on the market.

The EHS assembler (EHS ASSEMBLER) and text editor (EHS ENDER), which reside simultaneously in 10K bytes of memory (5000-77FF hex). In addition to the 10K for EHS, sufficient memory must be allocated for label and text files, which normally take up locations 1800-2FFC and 3000-4FFC hex respectively. These boundaries leave memory for an extended monitor at 1000-17FF hex, for DOS support (segment) in upper memory, and for BASIC and machine language programs at 0400-1000 hex.

The label and text files are position-independent and may be located almost anywhere in RAM memory. In addition, records within these files are variable in length and directly dependent on the number of characters to be stored. This results in more efficient memory use.

The TED occupies about one-half the memory space. It sets up and maintains the source file by interacting with the user via 27 commands (Table 1). When inputting to the TED, you have the full capabilities of the built-in cursor-oriented screen editor, and can automatically repeat any key held for a half-second or more. Source files are created and edited much like BASIC programs are normally handled by the PET operating system, so it is very easy to get used to.

The assembler scans the source program in the text file and creates a label file (or symbol table) on the first pass. An optional listing is generated during the second pass, and a relocatable object file can be generated by a third pass. The relocatable object file is recorded on disk and, with a separate relocating loader program, can be relocated almost anywhere in memory.

The loader can relocate your program in three segments: page zero variables, absolute variables and program body. When not generating relocatable object, the assembler can store the executable object code directly into memory. The code can even be stored at a different address from its execution address. This can be useful if you want to execute in memory space occupied by EHS or any of its work files.

The assembler source statements consist of a required line number, along with standard label, mnemonic, operand and comment fields, in a free format. That is, each field need not start in a specific column or character position. Labels can be up to 31 characters long while standard 6502 mnemonics and addressing mode formats are used. Symbolic, decimal, hex, binary and ASCII values can be entered and expressions can contain addition or subtraction operators. There is even a way to obtain just the high or low part of an address.

The conditional assembly features direct the assembler to conditionally assemble certain portions of your program and skip other portions. The macro facilities are extensive, with non-repeating labels, nested macros and conditional assembly within macros. Table 2 lists the standard assembler pseudo ops.

Source for a large program can be divided into several modules, each entered into the text file one at a time and recorded on disk. These modules can then be linked during assembly via a control file, which specifies the order the modules are assembled in. At assembly, the assembler will load and assemble each module until the entire program is done.

The EHS assembler also provides a unique interactive assembly mode. The assembler can print messages and/or accept keyboard input during the first pass of the assembly. This provides many possibilities, such as specifying the actual assembly start address when the assembly begins.

For program debug, an extended monitor is included in the EHS package. This program is a 2K extension of the PET monitor that occupies locations 1000-17FFF hex. A BASIC program on the EHS diskette provides an interactive review of the extended monitor commands and instructions on how it can be relocated to another area of memory. The extended monitor provides commands for dis-
assembly, enable/undo stop key, fill memory, hunt memory, interrogate memory, quick trace, memory transfer, walk code and others.

In four weeks of testing, I found the MAE package to be well documented, and I had no problems learning to use the text editor and assembler. The assembler was fast and program debugging went quickly. The ability to assemble and debug a program with everything resident in memory greatly reduced normal program debugging time.

This package should be indispensable if you are doing any amount of machine language programming, but the price ($169.95) may be a little steep for a home system. The package includes an excellent 44-page manual, which has clear instructions and many examples. It even includes a sample program to help clear up several areas.

The programs are distributed on a 2040 compatible floppy diskette with the following files:

- DOS support (wedge),
- Extended monitor object code,
- Extended monitor instructions,
- MAE object code,
- Relocating loader object code,
- Relocating loader relocatable object code,
- Library of PET RAM locations for the 32K PET in a MAE source file,
- Notes pertaining to MAE and

- Example program (UART driver).

By the way, another interesting product advertised by EHS is their PET RABBIT program. This is a 2K machine language program that allows loading an 8K program from tape in just 38 seconds. It also provides a RAM memory test, a keyboard auto repeat feature and several other commands. It costs $29.95.

A number of versions are available for each machine, depending on the desired code location. Contact EHS for more information on this and other products.

---

**COMPUTER CLINIC**

I am the proud owner of an 8K PET with upgraded ROMs and a Betsy waiting to be brought on-line. I am an analyst-programmer for the Australian government, so my background is in programming. I am interested in corresponding via programs or letters with any interested persons.

David Jones
34 De Graaf St.
Holder Australian Capital Territory 2611
Australia

Does anyone out there recognize any of the following computer circuit cards? These are all hamfest specials bought to build a cheap computer. Any photocopies of condensed manuals or schematics would be appreciated. Will pay for the favor. I've included all identification I could find.

1. Data media 8080A CPU card. 2DAA005, 9.36 MHz, xtal, dated April 21, 1978, 21201. Two empty 2101 slots, about 50 TTL, two Z8 pin sockets, all chips TI, 100 pin edge connector (not S-100). (Got two for $5 each.) Maybe goes to a Datamedia smart terminal.

2. Small unknown 6503 card. TC1-1 logo. 6503, 6530, 6532 chips, 3.579 xtal, 36 pin connector on one side, 38 pin connector on other side, paper tag says P/A model up7-1, Rev. C C11-80139 on card. (Paid $25.) Maybe a video processor?

3. Big Univac memory card. ID numbers 7318-2-73 (1973), 38-75, BE-3, Assy. 4161700-05. Seventy-two Intel 4915636 MOS, 7720A chips (18 pin, 256x4 RAMs?), two 100-pin connectors on one side.

3534009.01 Rev. G 127 stamped on other edge connector (Paid $5.)

4. Small RAM cards. Told they go to "Accukeyser," memory board 1769-25" stamp. Twenty-four Intel C1101A 256x1 RAMs, 2Kx3, 44-pin connector. (Got four for $2.50 each.)

Charles Gerbino
1831 Stanley Place
Falls Church, VA 22043

The Psychology Department at the University of North Carolina at Chapel Hill is currently in the planning stages of a computer based "lab" system for undergraduates. We chose the Apple microcomputer and decided upon Pascal as the programming language. We would appreciate hearing of any applicable software that is available.

R. F. Genovese
Dept. of Psychology
The University of North Carolina at Chapel Hill
Davie Hall 013 A
Chapel Hill, NC 27514

I am willing, even anxious, to open my Tektronix 4051 computer. Can anyone supply references and product names on how to modify this system and/or adapt other 6800 products to it?

Dr. George E. Sinclair
1985 Devonshire Drive
Sierra Vista, AZ 85635
Two comments on W. A. Harrison’s article, “Programming Optimization Techniques” (May 1980)

For shame! The very first rule in optimizing the performance of a program is to fully understand the environment in which the program is to execute. This means a rather detailed understanding of object code produced by your compiler, or the functional characteristics of your interpreter, and a detailed understanding of the instruction set and instruction timings of your processor.

Mr. Harrison’s remarks may have held true on the system with which he is working, but to take them as his own is sheer presumptuous abuse of his readers. I imagine that Mr. Harrison was working with a compiler, if he tested his examples at all.

I suspect that most of his remarks would be appropriate in that environment, but I am sure that 99 percent of your readers are using an interpreted BASIC, rather than a compiled BASIC.

Getting down to brass tacks, in Example 8, three ways of skinning a cat are shown, marked “inefficient,” “more efficient” and “most efficient.” I have implemented these three approaches in Listings 1, 2 and 3, respectively.

The execution times (on a TRS-80 model II) were 65 seconds, 68 seconds and 72 seconds, respectively, exactly the opposite of what Mr. Harrison would lead you to believe.

Generally, with an interpreter, it is preferable to reference an initialized variable rather than a constant. This process of fetching the value of a known variable is quicker than evaluating the literal. The failure of the “most efficient” example is simply based on the fact that the overhead of interpreting an extra statement for the temporary variable costs far more than the referenced references.

I have seen many instances where a young programmer will go to great pains to optimize the efficiency of a program he is coding, only to be shot down because he doesn’t really understand what is happening at the next level down.

I welcome technical articles on programming techniques, but please try to improve the level of applicability to the real world as opposed to painting towers an ivory color.

Robert Snapp
President
Snapp, Inc.
Cincinnati, OH

“Programming Optimization Techniques” was well-written and accurate with one glaring exception. Harrison noted that “access speed” can be increased by using a constant as a subscript rather than a variable (i.e., V(7) instead of V(K)).

On any computer with BASIC language, at least those which utilize interpreters rather than compilers, the opposite is true. A variable subscript results in significantly faster operation time than a constant. This is because it takes the computer longer to convert a constant into its binary floating-point equivalent than it takes to look up and retrieve a variable value.

Examples of the time difference are displayed on the printout from our Commodore PET computer running routines using variable subscripts versus constants (Listing 4). I verified the same time savings with a similar routine on a Data General minicomputer with time-sharing BASIC. I’ve found one of the keys to swift program operation to be the liberal use of variables in any application where the value is referenced repeatedly.

Steven G. Spearman
Hastings, NE

Harrison replies to criticisms

I enjoyed reading Mr. Snapp’s letter immensely. As to his first remark, he is correct! When attempting to facilitate machine dependent optimizations upon programs, you should be familiar both with your machine and your translator, be it a compiler, an interpreter or an undergraduate research assistant toggling 0’s and 1’s into the front panel of your machine. My purpose in writing “Programming Optimization Techniques” was to present a number of commonly used machine independent optimization techniques.

Mr. Snapp’s remarks about compilers vs interpreters were noted, and I agree with him on
that point. As he has shown, the use of a constant as a subscript is not more efficient than using a variable. However, when using a compiler (there's a rumor afoot here at the "tower" that there actually is a compiler or two available for the micron), the use of a constant as a subscript can result in a substantial improvement in performance. This is because the address of the array element can be computed and inserted at compile time. Because of this, a reference to the array element at execution time would be similar to a reference to a scalar.

On the other hand, if you use a variable as a subscript, the machine must constantly (or perhaps un-constantly?) compute the location of the element at execution time. I realize that this is dependent upon the use of a compiler, yet if Mr. Snapp's arguments were to be touted as "universal truths" the readers with compilers would be misled in a similar manner.

As for Mr. Snapp's Listing 3, it is rather obvious why it ran slower than either of the others. The very first point that I attempted to make in "Programming Optimization Techniques" was that invariant calculations should be put outside the loop (see Example 1). Therefore, if Mr. Snapp were to move line 1075, I'm quite sure that he would notice a substantial improvement in performance. After all, 9,999 needless evaluations of $T = C(75)$ can be time-consuming.

As for "ivory-tower" thought, I'm afraid that it would be a bit presumptuous of me to consider "Programming Optimization Techniques" an example of "ivory-tower-think" (to borrow from Orwell). Please do not confuse theory with uselessness. Almost everything which has anything to do with computers was no more than a theoretical concept five, ten, 20 or 30 years ago.

For a survey of "ivory-tower" optimization, I suggest you see:


```
TEST:
PROCEDURE OPTIONS (MAIN);
DCL X(100) FIXED BIN (15) INIT((100)10);
DCL N FIXED BIN (15);
DCL I FIXED BIN (15);
DO I=1 TO 25000;
   N=10+X(75);
END;
END TEST;
LISTING PL/I - 1

CPU Time: 11 Seconds
```

```
TEST:
PROCEDURE OPTIONS (MAIN);
DCL X(100) FIXED BIN (15) INIT((100)10);
DCL N FIXED BIN (15);
DCL I FIXED BIN (15);
DCL K FIXED BIN (15);
K=75;
DO I=1 TO 25000;
N=10+X(K);
END;
END TEST;
LISTING PL/I - 2

CPU Time: 12 Seconds
```

```
TEST:
PROCEDURE OPTIONS (MAIN);
DCL X(100) FIXED BIN (15) INIT((100)10);
DCL N FIXED BIN (15);
DCL I FIXED BIN (15);
DCL ITEMP FIXED BIN (15);
ITEMP=I(75);
DO I=1 TO 25000;
N=10+ITEMP;
END;
END TEST;

CPU Time: 11 Seconds
```

---

**Example 1.**

```
INTEGER I(100) /100*10/
DO 100 J=1,25000
   N=10+I(75)
100 CONTINUE
STOP
END

LISTING WATFIV-1

CPU Time: 6 Seconds
```

```
INTEGER I(100) /100*10/
K=75
DO 100 J=1,25000
   N=10+I(K)
100 CONTINUE
STOP
END

LISTING WATFIV-2

CPU Time: 6 Seconds
```

```
INTEGER I(100) /100*10/
ITEMP=I(75)
DO 100 J=1,25000
   N=10+ITEMP
100 CONTINUE
STOP
END

LISTING WATFIV-3
```

Listing 5.
This month we are presenting a slightly different view of the Stringy Floppy. For months we have expounded the virtues of the "Stringy" and our Program Chairmen and users group organization. This month we are presenting a letter written by one of the program chairmen in response to a written inquiry by a potential "Stringy" owner. We present the letter in its entirety and without editing.

Richard Harrison
Rt. 2 Drysdale
Warrenton, Virginia 22186
6 May 1980

Mr. David L. Johnson
4106 Montreal Avenue
Prince George, VA 23875

Dear Mr. Johnson,

First of all please excuse the long delay in responding to your letter. The demands of my regular job keep me on the go for long periods of time.

I will key my response to the items as listed in your letter:

1. The STRINGY will give you excellent results with the TRS-80 Mod I (with or without the expansion interface.) STRINGY models are available for use with S-100 configurations: again results will be excellent.

2. Sorry, but cannot comment on machine language text editors for the Poly-88 system. Highly recommend the Electric Pencil for the TRS-80 (definitely over the R/S Script). Yes the Electric Pencil can be used with the STRINGY: and the files are stored on wafer.

3. I have several systems in use for general computing and specific applications, but the STRINGY is used on the TRS-80 Mod I 48K system. The STRINGY has been in use for one year now and other than two MECHANICALLY faulty tapes there has NEVER been a bad load or save with the unit. There is no 'Foolery' associated with the STRINGY, and as such it is a real work-horse which is elegant in its operational simplicity yet ultra-reliable.

4. My main application for STRINGY is in support of my Communications Repair business, i.e., inventory, billing, work processing etc. But that is not the ACID test for the unit...my kids are. The kids use it daily for games, education and general computer exploration. None of the sensitivities normally associated with floppy disc apply to the STRINGY. Sir, I have dealt with many computer companies over the past five years and there are only two which I have not found fault with either their product or the company officials, they are: EXATRON and APPARAT. What this means to you is that you will receive courteous responses over the telephone and prompt written replies, when requested (your chances of being ripped-off are slim with EXATRON).

Mr. Johnson, I am taking the liberty of sending a copy of this to EXATRON so that they may answer your questions regarding Poly-88 application in more detail and also get you on their literature mailing list.

Best Regards and Happy Computing.

Sincerely,

Richard J. Harrison

P.S. This letter is prepared using the STRINGY and Electric Pencil. If you are a HAM, will discuss this further over the radio sometime. My call is N2JR.

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The 16-Bit
Super Processors
Are Here

This report zeroes in on the Intel 8086, the Zilog Z8000 and the Motorola MC68000.

Martin Moore
2735 S.W. 229
Beaverton, OR 97006

The gurus of the microprocessor business have been predicting a takeover by the 16-bit microprocessor for some time now. They told us about three years ago that the 16-bit microprocessor was just around the corner, and that the 8-bit machines had better heed the warning. And, as if to prove it, Texas Instruments came out with the TMS9900 microprocessor, the first, low-cost 16-bit microprocessor to hit the streets.

People didn't take to it immediately. The noise about 16-bit machines turned into a deafening silence. But it seems those gurus were right after all. They were just a little ahead of their time. The 16-bit revolution has come.

At this writing, at least four 16-bit microprocessors are available: Intel's 8086, Zilog's Z80000 (second-sourced by Advanced Micro Computers, Inc.), Motorola's MC68000 and Fairchild's 9440 Microflame.

The 16-bit microprocessors discussed here (I'm purposely leaving out the Fairchild 9440 because of its close resemblance to the Data General microNova) refer to memory as bytes, and for a very good reason. Few memory boards are set up to handle a 16-bit data bus. Almost everything available is for the 8-bit microprocessor. The manufacturers took this into consideration when designing their processors. Designing a microprocessor that can't access 8-bit memories is pointless. For this reason, all the manufacturers have built their devices to work with byte-oriented memory.

The 8086 Architecture

By using a silicon-gate NMOS process, Intel has managed to cram 29,000 transistors onto a very small die about 225 mm square (less than the area of Lincoln's head on the penny). That many transistors allow the 8086 to be divided into what are basically two processors. Fig. 1 shows a functional block diagram of the 8086.

Notice that the 8086 is divided into two halves called the bus interface unit (BIU) and the execution unit (EU). The 8086 performs a neat little trick by letting the BIU collect and send program information while the EU executes it. The BIU fetches instructions before they are required by the EU; it then loads the instructions in a stack, or queue, that will hold up to six bytes of instruction. The EU takes the instructions as it needs them, without having to wait for bus cycles, and without having to control such things as operand fetch and store, address location and bus control.

The process of parallel and simultaneous operation is called pipeline processing. It speeds instruction execution by never forcing the processor to wait while an instruction is being fetched.

Registers

The register structure of the 8086 is shown in Fig. 2. The 8086 contains 12 16-bit registers and a set of nine 1-bit flags. The asterisks in Fig. 2 represent the 8080A registers as a subset of the 8086 registers. This allows the 8086 to execute the 8080A instruction set without too much trouble.

The registers are grouped together within the 8086. Each group has a specific set of functions. The AX, BX, CX and DX registers are called the general register group, which are used in the arithmetic and logic operations of the 8086. Both halves of each register are separately addressable. Thus, you can think of this group as being two sets of four 8-bit registers.

The next four registers (SP, BP, SI and DI) are called the pointer and index register
group. They usually contain addressing offset values.

The instruction pointer (IP) register works in the same way as the 8080A program counter register.

The flag register contains nine 1-bit operation flags. The flags record 8086 status and are used to control the 8086 operation. Five of the flags are 8080A flags; four new flags have been added for the 8086.

Finally, the CS, DS, SS and ES registers, called the segment register file, are used in all memory address computations. For example, all instruction fetches are taken relative to the CS register, using the instruction pointer register (IP) as an offset.

These are not particularly general-purpose registers, and here is where the 8086 falls down in comparison to the Zilog Z8000 microprocessor.

Memory

The Intel 8086 boasts a remarkable 20 address lines, which allow the 8086 to address over one megabyte (1,048,576 bytes) of address space. (That equals about 62.5 16K-byte memory boards.) Of the 20 address lines, 16 are time-multiplexed to act as the data bus.

For best performance, the memory would be arranged with the least significant byte of a 16-bit data word located at an even address, and the most significant byte at an odd address. That's the way the 8086 expects it. Instructions are fetched from memory as words; the bus interface unit (BIU in Fig. 1) loads the instructions into the queue as bytes for consumption by the EU.

In addition to the massive one megabyte of address space, the 8086 can be configured to address 64K 8-bit I/O ports.

The requirements for using this memory and I/O are very specific, and are best found in the Intel MCS-86 user's manual. Suffice it to say that memory space is not a problem with the 8086.

Instruction Set

The instruction set for the 8086 is divided into six functional groups: data transfer, arithmetic, logic, string manipulation, control transfer and processor control. Each of the first three functional groups is divided further into subgroups of instructions.

Data Transfer. Data transfer instructions are divided into four classes: general purpose, accumulator specific, address-object and flag. These instructions are used to move data to and from the 8086.

Arithmetic. The 8086 arithmetic instructions provide five basic mathematical operations: flag register settings, addition, subtraction, multiplication and division. These instructions have a number of varieties, including both 8- and 16-bit operations and signed and unsigned operations.

Logic. The 8086 provides basic logic operations for both 8-bit and 16-bit operands. In addition, it has three single-operand operations and four double-operand operations.

String Manipulation. The 8086 can manipulate byte or word strings with relative ease. The 8086's ability to repeat string operations within hardware is one convenient feature. Primitive one-byte instructions can be prefixed with a repeat number. Then, that instruction (or series of instructions) can be repeated n times, with no extra coding required. This feature can prove important when performing such jobs as code translation.

Control Transfer. The 8086 has four classes of transfer operations: calls, jumps and returns; conditional transfers; iteration control; and interrupts.

Processor Control. A variety of 8086 instructions control the processor. The 8086 can be halted, single-stepped and told to wait. Also, a one-byte prefix can precede any instruction to "lock out" any request to use the bus (as might occur in multiprocessor systems). During the time the 8086 is in this locked-out mode, all interrupts are masked. Interrupt requests are latched, but not acted upon until the lock prefix goes away.

Summary

The Intel 8086 was the first of the new generation of 16-bit microprocessors, and as such is probably better than the 8080A (if, indeed, you can compare the two).

Intel literature says that the 8086 can increase program execution speeds from seven to 12 times over the 8080A, while using 10 percent to 25 percent less code.

Also, the 8086's I/O capability should prove irresistible in any situation requiring an intelligent controller.

Z8000

Zilog's entry in the 16-bit microprocessor race is the Z8000. When I first looked over the Z8000 specifications, I was instantly reminded of that old workhorse of the minis, the LSI 11, from Digital Equipment Corporation.

The Z8000 (also produced by Advanced Micro Devices as the AmZ8000) is newer than the 8086 and shows it. The Z8000 has eight times the direct memory addressing capability (eight megabytes) of the 8086.

Architecture

The Z8000 is register-oriented. It has sixteen 16-bit registers, 15 of which are general-purpose, and an instruction set that supports over 400 combinations of instruction types, data elements and addressing modes. The Z8000 is simpler than the 8086 and resembles a minicomputer more than a micro.

Memory

Two versions of the Z8000 are available: a 40-pin version (called unsegmented) and a 48-pin version (segmented). The 48-pin de-
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Fig. 3. Z8000 pin-out.

Fig. 4. Z8000 register set.
vice's extra eight pins increase its memory capabilities. I'll talk mostly about the 48-pin version. Remember that software written for the 40-pin version will run fine on the 48-pin version, but not vice versa.

The 48-pin Z8000 has the standard 16 address/data lines, much like the 8086 (see Fig. 3). In addition, the segmented version has an additional seven output pins (SN0-SN6 and SEG1) that extend the normal 16 address lines to 25 (SEG2 is a control line). AD15 can address 64K addresses. If you use the segment lines SN0-SN6, you can point to 128 segments of 64K each. Using all 23 address lines, total memory is eight megabytes of address space (8,388,608 addresses, to be exact).

The basic data unit for the Z8000 is thought of as an 8-bit byte. It will as easily operate with 16- or 32-bit data words.

Back to the eight megabytes of address space. If, along with the Z8000, you purchase a memory management device, the memory capabilities of the Z8000 are multiplied sixfold. The memory management device (MMD) couples to the high-order address lines (AD8-AD15), the seven segment lines and the status lines. You end up with a chip set capable of directly accessing 48 million addresses. For all practical purposes, this is virtual memory. This all adds up in the following manner:

\[ \text{ADO-AD15} = 64K \]
\[ \text{SN0-SN6} = 64K \times 128 = 8 \text{ megabytes} \]
\[ \text{Status lines} = 8 \times 128 \times 64K = 48 \text{ megabytes} \]

The status lines serve to divide memory into system code space, normal code space, system data space, normal data space, system stack space and normal stack space. Each space can be addressed by a 23-bit address.

Aside from producing a huge address space, the MMD provides some other advantages. Consider the effort required to keep track of 48 million addresses. It is a monumental task at best, impossible at worst. Fortunately, the MMD, along with the Z8000 instruction set, does most of the work for you.

System/Normal. Recall that the status lines divide memory into system and normal code, data and stack space. The Z8000 can differentiate between your operating system code (system) and the code you're working on (normal). This allows the Z8000 to protect your system code from accidental alteration.

Addressing Structure. Addressing with the segmented version of the Z8000 is easy to do. The segment lines (SN0-SN6) establish a base address, pointing to one of 128 segments. The 16 ADO-AD15 lines point to a specific location within the addressed segment. The Z8000 registers are, therefore, designed to handle addresses in the same fashion.
Registers

The register structure of the Z8000 is one of its strong points. Fig. 4 shows the Z8000 register set. The 40-pin version has two stack pointers: a system stack pointer and a normal stack pointer. The 48-pin version has four stack pointers: 32 bits for normal operation and 32 bits for system operation. In the 48-pin version, 16 bits of the 32-bit stack contain the segment number, while the offset value is contained in the remaining 16 bits.

**General-purpose registers.** The Z8000 has 16 general-purpose registers, labeled R0 through R15. Each register can contain 16 bits of information. In addition, R0-R7 can each be divided into two 8-bit registers (RH0, RL0, RH1, RL1, etc.).

Word registers 32 bits long can be constructed from pairs of general-purpose registers (e.g., R0-R1, R2-R3). And 64-bit registers can be constructed from register quads (e.g., R0-R1-R2-R3, R4-R5-R6-R7). The 64-bit register quads are required by instructions such as Multiply and Divide.

**Stack pointers.** In the 40-pin non-segmented Z8000, R15 is doubled to act as the stack pointer (normal stack, system stack). In the 48-pin segmented Z8000, R14 and R15 are doubled to act as stack pointers (R14 contains the segment number, R15 the offset value).

**Flag control word.** The flag portion of the flag control word is the same for both versions of the Z8000. The flags used include carry, zero, sign, parity or overflow, decimal adjust and half-carry.

The control portion of the flag control word differs between the segmented and non-segmented versions. Control bits include vectored interrupt enable, non-vectored interrupt enable, stop mode, segmentation enable (48-pin version only) and system/normal mode.

**Program counter register(s).** The non-segmented version of the Z8000 has one 16-bit program counter register. The segmented version has two 16-bit program counter registers: the first holds the segment number, the second holds the 64K offset value.

**New program status area pointer.** This register contains the memory location of new program status words for the Z8000. In the non-segmented version, this register points to an address using only the upper eight bits of the 16-bit address bus. In the segmented version, two registers are used. One points to the segment number; the other points to the upper eight bits of the address.

When an interrupt or program trap occurs, the old program status words are pushed onto the system stack (identified by the system stack pointer register). New status words are fetched from the new program status area pointed to by the new program status area pointer register(s).

**Refresh register.** Refresh is a little less of a headache with the Z8000 than with the older microprocessors. A counter within the Z8000 automatically refreshes the dynamic memory. You can set a special memory refresh access at programmable intervals.

A programmable prescaler (a 6-bit modulo-n counter) is driven at one-fourth the system clock rate. The refresh register is nine bits wide and is automatically incremented by two each time the prescaler times out. This allows up to 256 rows of memory to be refreshed. The refresh feature can be disabled if necessary.

**Instructions.**

While developing the Z8000, Zilog determined which instructions were used most often. Zilog then took these statically frequent instructions (the instructions most often found in a listing) and reduced the number of words required to execute them. Less code density was the result.

Some 110 distinct instruction types are used by the Z8000. Each instruction is divided into four (more in certain operations) basic fields. Those fields include mode field, indicating the addressing mode; the opcode field, indicating the instruction; the data element type, the byte or word designation; and register designation field, designating the register used in the instruction. An instruction can require from one to five words, depending upon its type and addressing mode.

**Data types.** The Z8000 can operate on five data types: BCD digits (four bits), bytes (eight bits), words (16 bits), long words (32 bits) and byte and word strings.

The byte is the basic data element. The number of bytes in any instruction is implied in the instruction, or in some cases is explicitly detailed by the programmer.

Bits, bytes and words (both 16 bit and 32 bit) are manipulated within the Z8000 registers. Byte and word strings, however, are stored in memory. String manipulation is eased by the use of the Z8000’s auto increment/decrement addressing feature.

**Instruction addressing modes.** The Z8000 uses five main user-selectable addressing modes: register (R), indirect register (IR), direct address (DA), indexed (X) and immediate (IM).

In addition, several other modes are used for certain instructions: base address (BA), base indexed (BX), relative address (RA), auto increment and decrement.

**Multi-processor capability.** The Z8000, like the 8086 and MC68000, is specifically designed to work in a multi-microprocessor environment. The Z8000 has two pins included to ease multi-processor functions (see Fig. 3). The µ input disables the Z8000, while another processor is using a shared resource. The µ0 output lets the Z8000 prevent another processor from taking the bus if the Z8000 is using a critical shared resource.

Multi-processing is becoming more and more an economical prospect. The price drop in microprocessors versus their increasing power means that there is no reason to load one processor with all the work, when several can do the job better.

**Summary.**

The Z8000 is, above all, a general-purpose machine. With its large addressing capabilities, its most common use will probably be in mainframe minicomputers, competing with DEC. The Z8000 is an advanced machine, but don’t let that overwhelm you. The Z8000, like the other 16-bit processors, isn’t any more difficult to understand than your 8080 or 6800. It’s just a little bigger.

If you are interested in getting the complete story on the Z8000, get in touch with your local Zilog or Advanced Micro Devices representative.

**MC68000.**

Now we come to the mystery machine. During its development, Motorola kept a tight lid on the MC68000. Now they’re ready to send out small quantities for evaluation, though you still can’t order more than ten. Motorola is rationing the MC68000 for fear that a few big buyers will snatch up 90 percent of their stock for the next year.

**Architecture.**

The MC68000 appears to have been worth the wait. By using a HMOS fabrication method, Motorola has managed to put over 68,000 active devices on their wafer, as opposed to the 8086’s 29,000.

The MC68000 comes in a 64-pin package like the T.I. TM59900. Unlike either the 8086 or 28000, the MC68000 has separate address and data pins. But like the 8086, the MC68000 is a pipeline processor. Recall that the 8086 fetches instructions before it actually needs them. The same thing happens in the MC68000. One half of the device performs instruction fetches, while the other half executes the instructions. Here again is an example of pipeline processing, something you’ll be seeing a lot more of.

**Registers.**

You will find sixteen 32-bit registers in the MC68000 (Fig. 5). They are divided into two groups: eight registers for data and eight for address.

The data registers can be used for byte, word or long-word data operations. The address registers are typically used for stack pointers and base address registers. In certain situations, the address registers can
The trouble with video terminals today is that most of the low-cost models just don't have the performance to handle your tough applications. And the few that do are usually not compatible with your existing system. But now, Intertec has resolved this age old dilemma with the introduction of its new Emulator™ Video Terminal.

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also serve as word and long-word data registers.

As a side note, some believe that the MC68000, with its 32-bit registers, will act as Motorola's bridging processor into the 32-bit mini field. We'll have to wait and see. Notice in Fig. 5 that the eighth address register is actually doubled. The A7 register acts as the stack pointer for the MC68000. And the stack pointer is doubled, as in the Z8000, into a user (normal in the Z8000) and supervisory (system in the Z8000) register.

The program counter register is 24 bits wide, allowing the MC68000 a memory addressing range of 16 megabytes (16,777,216 addressable locations).

The status register has some interesting features, too. This 16-bit-wide register is divided in half. The user byte contains the normal status information you would expect to see. The system byte contains three bits for the interrupt mask, one bit to indicate a user or supervisory operating mode and one bit to indicate a trace mode.

Trace. The trace feature is unique to the MC68000. When the trace mode bit is set, the MC68000 traps to a tracing routine (that you write) after each instruction is executed. This valuable tool is like a built-in debugging feature. You can use trace whether you're operating in the user or supervisory mode, but you can only enter trace mode from the supervisory.

According to Motorola, the unused bits in the status register are for future expansion. Maybe they'll convert the MC68000 into a 32-bit machine.

Memory

The MC68000 has 23 address lines, labeled A1-A23 in Fig. 6. Notice that the MC68000 doesn't have an address line A0; the data bus is controlled in a byte-oriented fashion. That is, there are two control lines on the MC68000 called upper data strobe (UDS) and lower data strobe (LDS). These two lines remove the need to ever use the least significant bit of the address bus.

Motorola plans on making available a memory management controller that will handle memory segmentation and protection, much like the Z8000's memory management device.

Instructions

Motorola has taken a number of steps to enhance the MC68000 instruction set.

First, the MC68000 instruction set is a super-set of the old MC6800 instruction set. This was done to ease translation of 68000 code to MC6800 code. A translator will be available to perform this upgrading task.

Second, Motorola performed the same research and coded to look at statically frequent instructions (those instructions that occur most often in a program listing). But Motorola went a step further and looked for dynamically frequent instructions (those instructions that are most often executed). Keeping the numbers in mind, Motorola tried to create instructions that were as short as possible.

Third, Motorola prepared for the emergence of modularized high-level languages, such as Pascal. Several specific instructions in the MC68000 instruction set are geared directly for structured languages such as Pascal. Instructions such as LINK and UNLINK allow linked data lists to be manipulated within the stack areas. There are other examples, but the point is that the MC68000 is a hardware set to use structured languages efficiently.

There are 59 distinct instruction types in the MC68000 instruction set. Each instruction, with a few exceptions, will operate on data bytes, words and long words. And most instructions use any of 15 main addressing modes. If you combine the instruction types, possible addressing modes and data types, you end up with about 1000 distinct instructions.

And yet, with all those possible instruction combinations, the basic instruction list is easy to remember. If you can program a 6800 without having to look at the book all the time, you can probably program an MC68000 without looking.

As with the other 16-bit microprocessors we've discussed, the MC68000 will perform signed and unsigned multiply and divide operations in hardware, thus speeding arithmetic program execution. The microprocessor can deal with BCD arithmetic, as well as standard binary integers. The new MOVE data instruction will allow you to transfer bytes, words and long words in all data addressing modes.

Speaking of addressing modes, the MC68000 has five basic types: register direct, register indirect, absolute, immediate and program counter relative.

---

**Fig. 5. MC68000 register set.**

**Fig. 6. MC68000 pin-out.**
In the register indirect addressing mode, the MC68000 has two sub-modes called post-increment and pre-decrement. Here again, as in the Z8000, the MC68000 has enhanced data string manipulation capabilities. Overall, there are 15 addressing modes of operation.

Three pieces of information are required in an MC68000 instruction: the location of the operand(s), the size of the operand (byte, word, long word) and the function to be performed.

The MC68000 will operate with dual operands. The location of the operand in memory is either explicitly specified in the instruction or implied by the instruction as addressing modes.

This short explanation of the MC68000 instruction set does not do justice to the wide range of instruction possibilities, and I suggest that you seek out more information from Motorola if you're interested in the MC68000.

Support

The 8080, Z-80, and 6800 have a lot of support devices. Rather than design totally new devices for the MC68000, Motorola decided to implement the existing chips. Almost all of the 6800 family of peripheral devices can be used (in pairs, usually) with the MC68000. The VMA, E, RW and RESET lines on the MC68000 are used exactly as they are on the 8-bit 6800. This means that you don't have to learn new peripherals as well as a new microprocessor when you use the MC68000. As far as I'm concerned, this is a big plus for Motorola.

Summary

I'm short-changing you in this brief outline of the MC68000. It is a remarkable device, and Motorola has apparently put a lot of forethought into its design. Literature describing this microprocessor in more detail will be available soon.

At this writing, Motorola is experiencing difficulty with the design of a buffer register within the MC68000. It doesn't want to pass data accurately. This will undoubtedly be cleaned up before the device gets into mass production.

What Does All This Mean to You?

First, does this mean 16-bit microprocessors will replace our reliable 8-bit processors? No. The 8-bit machines are too well entrenched to be dislodged by an increase in data length. After all, some 4-bit microprocessors are still around, used in simple control applications.

A plan is now before IEEE to adopt the S-100 bus, with provisions for a 16-bit-wide data bus. If this goes through (as it probably will), then S-100 will become standardized and will be capable of handling the new 16-bit processors.

The current outlook is that these microprocessors will be used in mini-type applications. They require massive memories to take advantage of their architecture. The part-time hobbyist may not want to become involved with the 16-bit processors. After all, purchasing 48 megabytes of memory is costly.

But if you're interested in plain old number crunching, with the maximum possible throughput, then you should definitely investigate this new breed of microprocessor. Speed is increased merely by doubling the data size for each instruction used. Other enhancements are included in the 16-bit machines, too. Long-word multiplication and division in hardware certainly won't hurt anyone's feelings.

Should you look into the 16-bit microprocessor? You bet! But if you decide to start implementing 16 bits, don't treat them any differently than your 6800. Use the expertise you've developed with 8-bit machines, and don't let the whiz-bang numbers fool you.

We're entering a new era in microprocessors (we seem to do this about once every three years). This will probably be a short era too. Next? 32 bits. In the meantime, let's sit back and watch the 16-bit revolution.
The marriage between the law offices of Piel and Lynn in Montgomery, Ala., and their Sol 20 computer system is one that has worked.

For less than $12,000, the firm has an electronic helpmate that does collection letters, divorce papers, incorporation papers and bylaws. It processes real estate closings in half the time it used to, and has reduced the time needed to prepare a will with a trust from two or three hours to 25 minutes.

And, says attorney Richard Piel, the system paid for itself in the first few months of operation.

Use of the Sol 20 revolves around the Word Wizard, a word-processing program from Processor Technology. Since paper is the major physical output of a law office, the computer was put right on the production line.

The disk files are loaded with documents and standard forms. The correct form is called from the file, the CRT fills in the blanks, and a Diablo printer produces the document. The result: a customized document that looks like an original.

Entering each document the first time takes a lot of work, and system operator Glenda Senn uses numerous control codes. She has taken one data processing course, and the rest of her training is on the job.

Buying the microcomputer was a family effort involving much research, says Piel. The firm spent two years looking for a system that would meet its needs economically. Many systems were available, but most dedicated word processors were expensive and rigid. They often controlled, rather than helped, office procedures because of a feeling that maximum use should be made of the expensive equipment.

Piel and Lynn do not do the actual number crunching of figuring accounts on the Sol. The system is used to address envelopes and print the bills. Piel is convinced that timely billing is the key to prompt payment, a viewpoint many businesses can appreciate.

The firm does not do accounts receivable or office typing on the system; much work is still done on standard office machines.

The key to the firm's success, says Piel, is that the company knew what it wanted. While local free-lance software people are looking at more uses for the system, anything the firm buys will have a fixed price and a specific purpose. The firm, says Piel, bought the computer system with realistic expectations, and was not driven by a need to get a return on a large investment.

Piel and Lynn's successful use of a relatively low-cost microcomputer system has several lessons for other small businesses thinking about a similar move.

- First, determine exactly what you want the system to do.
- Then, shop around. Do not be lured by pretty hardware.
- Buy general programs for a predetermined price.
- Put in some time setting up the proper forms.
- Do not let the system dictate the way you do things.
- Finally, be happy if you meet your original goals.

As in all marriages, realistic expectations and formal understandings of roles and responsibilities are necessary. It probably will not always be a bed of roses, but a warm relationship with a microcomputer can lead to unexpected delights.
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I'm Irwin Taranto, and times have changed. In the first twelve months, almost a thousand businesses put me to the test. You can buy my TRS-80 systems all over the country — dozens of companies sell them. Some are my dealers, some aren't. And this creates a new set of problems.

You see, learning to use a computer — any computer — is like learning anything else. It takes some getting used to. If you sit down with a computer program and the manual and try to figure it out all by yourself, you'll probably just give up and feel you've been had. You have to hang in there for a month, make a few phone calls, and have somebody who really understands the system help you work it out.

That's why I still answer the phone. And why, I guess, people say all those nice things.

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Microcomputing, August 1980 35
Winning the Micro Game

Don Lancaster
Synergetics

Hands on is everything. The only way to ever learn anything about computers is to jump in with both hands and feet, get on line and do some computing. Until you actually do and see what the micro world is about, you’ve accomplished nothing. You must do things yourself, on your own terms, in front of a working, real computer, alone.

It’s both funny and sort of sad to hear a student say he just took a DP course but couldn’t get any CPU time. He got taken, not the course.

You become computer literate by using computers, not by having someone tell you about them or by reading about them.

Understand a timing loop by writing one and watching it work. Do an interface by taking a triac, an optocoupler and a 100-Watt light bulb and shining light on the real world. Find out what an interrupt is by interrupting a computer. Do it—yourself.

You have to make mistakes. If you are learning micros or developing any new product, half your experiments should fail. A canned set of exercises on a micro trainer is next to worthless if everything falls into place and works perfectly the first time.

In the micro world, you make mistakes to learn and to progress. You should expect mistakes. Prepare for them. Welcome them. Aggressively seek them out.

Of course, it makes sense to never make the same mistake twice. Build on what you have. To expand your microcomputer universe, try new things that may fail. Find out why they fail, and use this as a newer and bigger base to work from.

Usually, you are never anywhere near where you think you are in solving any hardware or software problem. Unexpected surprises and plain old stupidity are always between you and reality. If you think you have something working perfectly, you probably don’t even understand the problem.

You must mix hardware and software. Some heads-in-the-clouds pure software people out there still believe that hardware is a mundane inconvenience standing between them and pure “computing.” And there are technician types who do everything with bushel baskets full of integrated circuits.

Neither approach is good. Sometimes a simple and inexpensive hardware circuit can replace bunches of software. Other times and other places, a few lines of elegant software can eliminate the need for custom circuits or a special device.

Winning computer products will combine both hardware and software, using the best features of each to give you the simplest system and the lowest possible cost.

This means that if you are a hardware person, you should learn programming and learn it fast. If you have a software background, start soldering and wire-wrapping with a vengeance.

Synergy says that $1 + 1 = 4$. This is definitely the case when you get an optimum mix of hardware and software interacting with each other.

Neither can stand alone—not any longer. The real world is fuzzy. Some textbooks and lab experiments work every time. Everything is nice and clean, neatly tied up. You do exactly what you need to do the job, no more, no less. Unfortunately, reality doesn’t work that way.

First, you must deal with people, and that will always mess things up. Key items will be missing or late. The magic chip may be a figment of an ad writer’s dreams. Or a problem may have a simple and inexpensive technical fix that is politically or socially unacceptable. Goals conflict. So do egos.

Expect and accept fuzziness. As you get into a new computer area, things will start out completely confusing. Then they will become fuzzy. Then they will become, for a glorious instant, crystal clear. Then, of course, they get fuzzy again as you become more involved.

As you go to the bigger picture, expect more fuzziness. Also recognize that there really isn’t much in the way of real-world beginnings and endings. Rather, things sort of dribble off into the great whatever.

Micros might — just might — be the missing link between people and intelligent life in the universe.

Hit the basics hard. Any 6502 micro freak can sit down and immediately “prove” that the 6502 is ten times better than any other micro in the world. The trouble is that you can do the same with any other micro family, as well.

For most micro uses, it makes no difference which micro from which family you use. Even if there temporarily was a “best” micro, other factors such as your own skills and attitude, the available software, the elegance of your competitors’ programs and so on will reduce any advantage of the “best” micro to zilch.
If you don't happen to like the "best" micro, just wait a month or two, and it will get shot out of the saddle by something much more promising.

This all means that the micro you learn is not the micro you will use. Later on, there will be much better ones to work with, and they are sure to have completely different tech details.

To beat this, hit the basics hard. All known micros have address space and addressing modes. All have interrupts, subroutines, clocks, ports, memory and I/O. Use any micro you like to add tech details to the fundamentals. But get the essentials down solidly.

Reach out and put the touch on someone. The nickels in the micro world are now to be made in places where people are not yet using micros. Find these places and get involved with these areas and people on their own terms.

Put micros to work feeding cattle, treating sewage, gambling on Wall Street, designing looms, mixing cement, baking calzones, milking goats, hauling pecans, questing tinajas, animating video, co-oping groceries, hybridizing sinsemilla, improving wood stoves, redesigning bicycles, restoring steam calliopes, monitoring steam gauges, selling paper clips, cutting dress patterns and teaching trumpets.

When you do reach out, always work in the other person's terms and language, bending the micro info to fit as you can. If they are smart enough to learn micros, they won't need you for anything.

Find places where they don't yet know that micros can help. Then jump in.

Don't reinvent the wheel—steal the plans instead. Much of the needed and obvious micro-related information has already been done and is readily available for your use. For instance, if you want to drive a Teletype or another printer, use someone else's driver routine. Don't stop what you are doing and invent your own—unless you truly want to know how a driver program works.

Scads of Morse code trainer programs are out there. Why write another? The same goes for sorts and word justification subroutines. And there are more versions of Lunar Lander than there are moons in the solar system. How many Hangman, Hexapawn or Nim games have you seen?

Now, if you want to learn these programs, that's fine. But if your goal is using something, rather than creating something, find out what has already been done and go with it, or improve it and then go with it. Refer to monitor listings, user software exchanges, micro magazines, application notes, club newsletters, program books and micro information exchanges for programs to use.

Better wrong now than right later. In anything you do in the micro world, your first attempt will be wrong and will have to be reworked. So, immediately kludge up your first attempt and let your mistakes show you the way to go. Often you don't even understand what the real problem is until you are inside a program or a wire-wrap board looking at it.

Try a simple, quick and dirty tactic that at least sends you in roughly the direction you want to go. Make some guesses. Take a stab at it.

In your early attempts, if it works, use it. Start your project flying more or less right side up. Later on, you can go back and add structure to your programs, elegance to your methods, convenience to your user and simplicity to your hardware.

Add the final spit-and-polish on the way out the door, and not early in the game. Write it down. And not on the back of an old envelope, either. Documentation is the aren't supposed to smile while you are playing their games.

Simon says don't smile. It's still a game. Have fun.

You will never get enough. No matter how far you have gone in microcomputing and no matter how much of what kind of hardware and software you have on hand, you will always "need" more of something.

More memory? Start with a 1K trainer, then 4K, then a 16K micro. Then overflow the 16 megawords of an extended micro space. Need hard copy? Start with Excedrin headache number ASR-33, then on to thermal, a Selectric and finally a daisywheel.

Now, if only daisy was intelligent and had its internal word processing.

From plain-jane video, go on to graphics, color graphics, hi-res and then super-resolution color with gray scale. From cassettes, it's on to floppy, dual floppies, quad density and then a Winchester.

You can learn far more about micros watching fourth graders zap Klingons than you ever will in a university COBOL course.

There never is, nor will there be, a time when you have "enough" of anything. What looks like a light at the end of the tunnel is a train speeding towards you.

You will find only one way out of the "more" syndrome. Always go with what you have. Make it work. Live with it as long as you can. Force it to pay its own way.

Make it do. Use it up. Wear it out.

If it's old line, stomp on it. Some pre-micro people and institutions are still kicking around the lunatic fringe of the new micro world. They persist with large, bureaucratic, centralized, insanely priced and unavailable megacomputers run by an elite priesthood singing the incantations of an arcane language. They completely fail to recognize the power of the micro as a highly personal, one-to-one, decentralized, inexpensive, interactive and individual congenial tool.

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tried it their way and it didn’t work.

Old line not only fails to see the problem; they are the problem.

Always ask, “Why are you telling me this?” The useful products and ideas in the micro world are not heavily advertised. In fact, anything genuinely useful takes a lot of time and trouble to nail down.

If a micro is widely or heavily advertised, it more than likely means that something much better is available elsewhere. If someone is radically trying to convert you to his microprocessor or his way of doing things, the chances are he has drifted into right field and become snookered into a bad scene. He is looking for converts to ease the pain when he is shot out of the saddle.

When anyone tries to tell you about micros, always ask, “What is the real reason you are telling me this?” Find out the motives involved. Then get a second opinion, check out another choice or find a different viewpoint before you plunge ahead.

Nail down all resources. It is easy to assume that formal courses and expensive, hardbound textbooks are the only way to “learn” microcomputers. In fact, these are two of the worst possible ways to become computer literate. Most of these learning aids are stillborn, hopelessly obsolete and misdirected.

Anything you can relate to that involves micros is a resource. Your first, and foremost, resource is yourself, through hands-on experience.

Other resources include micro magazines, clubs, game playing, Dungeons and Dragons sessions, micro trainers, computer stores, used wire-wrap boards, tech journals, funky books, reader-service cards, bookmarks, student teachers, trade shows, surplus stores, computer fairs, rap sessions and swap meets.

And most important of all, go on your own vibes. There is no right or wrong direction in the micro world. In fact, 99.9 percent of the micro world remains unknown, unexplored and uncharted. So, if “they” insist on something, most often “they” don’t know what they are talking about.

If you are interested in something and want to go in that direction, fine. Do it!

Your surest bet for long-term winning is to roll with your own vibes. Explore what you want to. Ignore the herd thundering the other way. Get off the beaten path.

Make yourself your own best customer. Satisfy your own needs and your own curiosity. Put as much psychic energy and personal value as you can in the routes that you pick, and you are certain to win the micro game.

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Don’t ever forget it. ■
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OSI's C2 is a general-purpose system incorporating several unique features. In addition to the advertised features, there are other hardware features and prototype areas on many of the circuit boards that you can use to implement some specialized circuits.

While the documentation is sparse for the C2-4P, a thorough study of the 500 manual and the schematics for the various boards will reveal several features such as: dual system clock operation, a serial interface with multiple baud rate operation and modern control leads, two selectable video screen sizes, reverse video display and a parallel interface option.

This article describes the hardware features of the various boards and the modifications I made to these boards to implement the additional features. I used an older C2-4P system, which contained two power supplies (+5 V, 3.5 Amps and -9 V, 1.5 Amps), a four slot bus backplane, a model 500 CPU board, a model 540 video board and a model 542 polled keyboard in a typewriter-style case. In the newer systems the 500 CPU board has been replaced by a 502 CPU board, and there is only one power supply (+5 V, 4.5 Amps).

Model 500 CPU Board

This CPU board includes the following hardware features:  
- A 6502A microprocessor operating at 1 MHz.  
- A 6850 ACIA (asynchronous communications interface adapter)-based serial interface configured for both RS-232C and 20 mA loop current.  
- 4K static RAM for user programs.  
- Microsoft BASIC in 8K ROM.  
- System monitor and I/O controllers in three 1702 EPROMs.  
- Provisions for a user-provided 6820 PIA (peripheral interface adapter) parallel I/O port.

System Clock

The 6502 clock (see Fig. 1) is provided by a dual one-shot operating as a multivibrator. The clock circuit is populated as an adjustable two-speed clock that is normally set for a high speed of 1 MHz, but with the optional WAIT diodes, it will revert to a low-speed operation of approximately 500 kHz whenever the WAIT line is brought low.

With the components supplied by OSI, you can adjust the clock via R50 (see Fig. 2) for a high speed of 1.6 MHz without creating any problems. Since the frequency will have a tendency to change with temperature, all frequency adjustments should be made only after a long warm-up and with the case closed.

If the clock speed has been set too high or has drifted high, then the following problems, which are usually caused by the slow access time of the EPROMs and the ROMs, may occur:  
- Screen does not display C/W/M? after reset.  
- Monitor or I/O not operating correctly.  
- Keyboard operation not recognized by computer in machine or BASIC mode.  
- Programs stop running or will not run.  
To correct the problem, lower the clock speed or install any of the WAIT diodes (D5, D6, D8, D10 or D11). See Fig. 3.

I have been operating the system at 1.58 MHz without any WAIT diodes and have not had a problem. However, I have noticed that programs execute faster and the cassette operation is flawless even when operated at 1200 baud.

ACIA Clock

The ACIA-based serial interface (Fig. 4) uses a 555
A stable multivibrator to provide the baud rate clock. The clock circuit has provisions for five capacitors, which are jumper selected to provide a wide range of baud rates. Potentiometer R51 allows the frequency to be fine-tuned to 16 x the baud rate. However, this hard-wired method limits the interface to operation at only one baud rate.

There are two methods you can use to switch the frequency of the 555 multivibrator: change the C5 capacitor or change resistors R22 and/or R23. Of the two methods, I chose the former. Changing resistor values involves changing multiple combinations of R22 and R23 or using large values for R22. Additionally, the duty cycle of the square wave, which is directly affected by the ratio of the resistor values, becomes a spike whenever the R22-R23 ratio is too large.

I made the following modifications to provide switch-selectable baud rates:

1. Calculate the capacitors required for the desired baud rates. Table 1 gives the formula to calculate the capacitor values. Table 1, column A, gives six capacitors for six possible baud rates.
2. Install the six capacitors on a two-pole, six-position rotary switch (Radio Shack #275-1386). The capacitors in column A are not available as standard values. Therefore, I used standard values wired in series to obtain the required values (see Table 1, column B).
3. Connect the first capacitor, 0.068 μF, between the first switch position and one terminal on the other half of the switch (see Fig. 5). The five remaining capacitors are wired in series from terminal to terminal starting at the first terminal.
4. Remove the jumper between the J5 donut and the capacitor on the board (see Fig. 6).
5. Install a shielded wire from the J5 donut to the rotary switch pole. The shield should be grounded at the board end with the other end soldered to the ground terminal on the rotary switch (see Fig. 5). I used a shielded wire to prevent stray signals from affecting the 555 circuit and frequency.
6. After the wiring has been completed and checked, turn on the computer and allow it to warm up.
7. To check and adjust the frequency, connect a frequency counter to L1 connector pin 7 (see Fig. 6), then reset the computer.
8. Select the first switch position, 110 baud, and adjust the potentiometer, R51 (see Figs. 5 and 6), for a frequency of 1760 Hz.
9. Select the other baud rates and check that they are within 0.1 percent of the required frequency (see Table 1, column C). Do not readjust R51.

**Frequency Adjustment**

If the frequency is higher than the required value, a low-value trimming capacitor can be added in parallel with the capacitor being tested to lower the frequency. If the frequency is lower than required, replace the capacitor with a capacitor of lower value and add trimming capacitors in parallel to obtain the required frequency.

With the capacitors wired in series, any change made to one capacitor will affect all others after it in the chain. When trimming capacitors to obtain the required frequency, always work on the lower frequency before adjusting the next higher frequency.

Using the above capacitor trimming procedure, it is possible to get the frequencies within ±.05 percent (see Table 1, column D). Generally, I use only three baud rates — 110 for a Teletype and 300 and 1200 for the audio cassette and modem.
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**Fig. 6. ACIA clock component location.**

**Fig. 7. Serial interface circuit.**

For 300/1200 baud operation only, install a .0068 uF capacitor on the board and adjust R51 for a frequency of 19,200 Hz. Under software control, set the bits in the 6850 control register (see serial interface section) to select the + 16 (1200 baud) or + 64 (300 baud) clock rate.

**Serial Interface**

The 500 board (see Fig. 7) is provided with a 6850 ACIA chip and the components for both a 20 mA current loop and an RS-232C interface output circuit, simultaneously connected, and a 20 mA or RS-232C input circuit. Only one input circuit can be connected at a time.

The 6850 is a 24-pin DIP that interfaces the CPU to outside devices by converting parallel I/O to serial I/O. Either a byte of parallel data or a control code is transmitted by the CPU to
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the 6850, while data or status is received by the CPU. In addition to the data bus and the transmit and receive clock and data leads, the 6850 has other control leads: the modern control leads CTS, RTS and DCD; the RS (register select) lead, which determines which of two addressable locations will be accessed; and the RW lead, which determines whether a read or write operation is in progress. (The two addressable locations are the control/status address (F000 hex) and the data address (FC01 hex)).

The control register is used to control the operation of the 6850. A code, which establishes the parameters for the 6850's operation (see Table 2), is written into the control register by the CPU. When the computer is reset, the CPU first loads the register with 03 hex (reset) and then B1 hex (+16 clock rate, eight bits, no parity, two stop bits). If this operation does not meet your needs, reset the control register and load in a new code (see Table 2).

The status register uses status flags to monitor the serial data transfer logic (see Table 3). The status register is read into the CPU's accumulator, then bit 0 or 1 is shifted right into the carry register. The carry register is then checked for the status of the receive data register or the transmit data register. If the register is set, the CPU will proceed to read or write data to the 6850 (see Table 3).

A program to read or write data to the 6850 is listed in Table 4. The other bits in the status register are used by the 6850 to determine the status of external devices, bits 2 and 3; to detect receiving errors, bits 4, 5 and 6; and to determine the source of an unacknowledged interrupt request, bit 7. The computer does not check the status of bits 2 through 7, and, in most cases, we do not need to check them for status during normal operation.

The serial I/O ports of the 6850 are wired to the components that comprise the 20 mA and RS-232C circuits. (The 20 mA current loops interface is specifically for use with the ASR-33 Teletype. It has no common ground and cannot be used with terminals requiring a common ground on output.) The 500 board has a serial interface auxiliary connector mounted near the 6850 chip (see Fig. 8), which uses pins 5 through 12 for the RS-232 and 20 mA data leads and a CTS (clear to send) control lead.

The 6850 uses a low CTS to set the status register and report a TDRE (transmit data register empty) condition. The computer determines when to transmit a byte of data to the 6850 by testing the register for the TDRE condition. A high
Table 4a. Serial data operation. Receive data from the serial port. This program will continue until all data is received. It should check for end of data character, and the index register must be incremented to access the next memory address.

<table>
<thead>
<tr>
<th>Code</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDA</td>
<td>load status register</td>
</tr>
<tr>
<td>LSR</td>
<td>shift bit '0' to carry</td>
</tr>
<tr>
<td>BCC</td>
<td>not ready, check again</td>
</tr>
<tr>
<td>STA</td>
<td>store data in memory</td>
</tr>
</tbody>
</table>

Table 4b. Transmit data from memory to serial port. This program will continue until all data has been transmitted. It must increment the index register to access the next memory address. It must also check for the last data address.

<table>
<thead>
<tr>
<th>Code</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDA</td>
<td>load status register</td>
</tr>
<tr>
<td>LSR</td>
<td>shift bit '1' to carry</td>
</tr>
<tr>
<td>BCC</td>
<td>not ready, check again</td>
</tr>
<tr>
<td>STA</td>
<td>store data in ACIA</td>
</tr>
</tbody>
</table>

CTS signal will prevent the register from reporting a TDRE condition.

The CTS is normally strapped to ground; however, the lead can be used as an interrupt signal for loss of transmission facilities, low paper alarm, printer or cassette not on line, etc., to prevent the needless transmission of data into an open line.

To modify the CTS lead, remove the strap between pin 24 and ground and install a 1k resistor from pin 5, auxiliary connector to +5 V. The CTS lead, which will be high, can now be used to determine the status of the receiving device. Do not make this modification unless you can control the CTS lead, since the computer will go in a loop on SAVE, where it will remain until CTS is brought low.

The 6850 also has an RTS (request to send) control lead used to inform a data set that it is ready to transmit data. The data set will return the RTS signal as a CTS signal when it establishes a data link. The 6850 outputs a low RTS; therefore, CTS will be low and the computer will proceed to output the data. The RTS terminal, pin 5 of the 6850, is not used; however, it can be wired to the spare pin 4 of the auxiliary connector.

The only remaining work is to install an EIA connector (DB255) in the cutout at the rear of the case and wire it to a Molex plug (KK-156 cut to provide one 3-pin and one 9-pin plug) following the pin-out in Table 5. Now you can use the EIA connector to connect to a printer or data set. The 20 mA leads are wired to the connector only for convenience and

![Serial interface connector.](image)

Fig. 8. Serial interface connector.

**Master Accountant**

**Accounts Receivable**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/R wimanual</td>
<td>$100.00</td>
</tr>
<tr>
<td>Manual</td>
<td>$25.00</td>
</tr>
<tr>
<td>Demo system wimanual</td>
<td>$50.00</td>
</tr>
</tbody>
</table>

**Accounts Payable**

Keeps track of current and aged accounts payable. Maintains a complete record for each vendor, helps determine which vouchers to pay by due date or discount date or within certain cash requirements. Designed to interface with the general ledger (if present) to provide automatic monthly journal entries.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/R wimanual</td>
<td>$100.00</td>
</tr>
<tr>
<td>Manual</td>
<td>$25.00</td>
</tr>
<tr>
<td>Demo system wimanual</td>
<td>$50.00</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payroll wimanual</td>
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</tr>
<tr>
<td>Manual</td>
<td>$25.00</td>
</tr>
<tr>
<td>Demo system wimanual</td>
<td>$50.00</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Ledger wimanual</td>
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</tr>
<tr>
<td>Manual</td>
<td>$25.00</td>
</tr>
<tr>
<td>Demo system wimanual</td>
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</tr>
</tbody>
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RAM Addressing

The 2102 RAM on the 500 board is decoded for a 4K block starting at hex 0000 (page zero) (see Fig. 9). Additional memory boards, model 420 or model 527, can be added to a spare slot on the motherboard. The addition of a 420 board will not cause a problem, since the board can be decoded to occupy the next unused 4K block of memory. The addition of the 527 board, however, will create a problem, since it can only be changed to occupy an 8K block. Therefore, when installing a 527 board, you should decode it for page zero and decode the 2102 RAM for some other location. The foil trace from the Ax donut to the right-most donut (see Fig. 10) must be cut and a new jumper installed to the Ax donut.

I installed a 527 board with 16K of memory and moved the 2102 memory to location C000 hex. This memory is now used for machine-language programs. BASIC, which normally uses all consecutive memory, cannot normally access this memory; therefore, there is little danger of destroying any programs stored at that location.

ROMs and EPROMs

No changes were made to these areas, but other ROMs, PROMs or EPROMs containing a more versatile language or monitor can be substituted for the ROMs and EPROMs presently on the board. The 500 CPU manual lists other ROMs that can be used with only minor strapping changes.

Peripheral Interface

The 6820 PIA interfaces with the CPU to provide two parallel I/O ports. Although I have not implemented the parallel port fully, I have added the following components to the board (see Fig. 11):

- A 40-pin IC socket at location A1.
- J1 and J2 jumper located at the bottom and right side of socket.
- Two Molex connectors along left edge of board.

All that remains is to install the 6820 chip in the socket and then develop devices that will work with the parallel port, joystick, X-Y plotter or AC control. The newer 6522 VIA (versatile interface adapter) may be a better chip than the 6820; however, I have not investigated the modifications required.

We will continue with our discussion of hardware modifications to OSI's circuit boards next time.

Fig. 9. 2102 RAM address decoding.

Fig. 10. Address jumpers for 2102 RAM.

are not part of the RS-232C standard.

Table 5. EIA connections.

<table>
<thead>
<tr>
<th>EIA</th>
<th>Pin-out</th>
<th>Auxiliary</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Input to CPU</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Output to CPU</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Request to send</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Clear to send</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Signal ground</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>20 mA output (+)</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>13</td>
<td>20 mA output (-)</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>24</td>
<td>20 mA input (+)</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>25</td>
<td>20 mA input (-)</td>
<td>25</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: Auxiliary connector pins 1, 2 and 3 are wired to the 6502 CPU control pins, RDY and RES.
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Reader Service index—page 241
Back-Space Mod for CP/M and Microsoft BASIC

An annoying characteristic of the system prompted this article.

Rod Hallen
State Dept. Accra
Washington, DC 20520

I have used Digital Research's CP/M disk operating system and Microsoft disk BASIC for about two years, and I still think the combination is great. However, one feature of both of them annoys me: the way character deletions are handled.

If you type a CP/M command line and inadvertently hit the wrong key, you can delete that character from the command line buffer by pressing the Delete key. If you continue to press the Delete key you will delete another character from the buffer for each depression. That's fine. What bothers me is the screen presentation. Instead of the cursor backing up and erasing the undesired characters, they are repeated on the screen. You type DIX by mistake, delete to get rid of the X and you have DIXX. CP/M understands that this means DIR, but there has to be a better way. This is especially confusing when you have to make multiple corrections within a line.

A worse situation exists in Microsoft disk BASIC. The first time you hit Delete, a backslash is printed, then the undesired character. If you continue to hit Delete, the previous characters are printed one by one. When you hit anything other than Delete, another backslash is printed, and then you can go on with the line. I assume the reason for both methods is that they were originally designed for a hard-copy terminal, which can't back up and erase.

The Better Way

I finally decided to rewrite CP/M so that the cursor would back up and erase, instead of echo, anything I wanted to eliminate. Unfortunately, all this echoing and backslashing takes place deep within CP/M and Microsoft, and I don't have a source listing for either. I do have a source listing for my BIOS (Custom Basic Input/Output System), which is almost as good.

I fooled CP/M by filtering the output to get rid of the backslashes. At the same time, I wanted to use the Back Space key instead of the Delete key for corrections because Delete is an uppercase function on my keyboard and Back Space is not. It was simpler than I thought; now I wish I had done it a year ago.

Listing 1 is a portion of my BIOS. Your BIOS should be similar, but it will not be exactly the same since each microcomputer implementation is different. That is why it is called a "custom" BIOS. I use a Cromemco Z-2 with an Imsai VIO video interface board and a Percom C1812 for interfacing to my Spinwriter ICR.

CBIOS Operation

Note the CONIN routine. This keeps checking the keyboard status port to see if bit 6 is a 1. If it is, a character is waiting; if not, CONIN checks again. When a character is ready it is brought to the accumulator and bit seven is cleared. Next, check for a Back Space (hex 8) and, if you don't find one, return to CP/M with the keyboard character in the A register. If you find a Back Space, set the Delete flag for later use, then load 7FH, the ASCII Delete code, into the A register and return to CP/M.

You've hit a Back Space, the DELETE FLAG is set and the Delete code is sent because

| Listing 1. The portion of my BIOS that handles keyboard input and screen output. This has been modified to eliminate Delete and Back Space echoes and to implement a true Back Space. |
CP/M doesn't know what to do with a Back Space. At this point, CP/M deletes the last character from the Command line buffer and echoes it to the screen. Intercept that echo before it gets to the screen output routine, then back up and erase the last character instead.

CONOUT is my video output routine. Enter it with the desired character in the C register and immediately save it. Then get the DELETE FLAG and check to see if it is set. If neither it nor the MICROS FLAG is set, a normal character must be coming through, and you can jump directly to the screen output routine (OUTZ).

If the DELETE FLAG is set, ignore any output from CP/M and erase the last character on the current screen line. If the output character is a backslash, you're dealing with a Microsoft BASIC Delete. In this case, set the MICROS FLAG and exit without sending the backslash to the screen.

If the character isn't a backslash, it must be an echo, so ignore it. Instead, send a Back Space to the screen to back up the cursor and a Delete to eliminate the character the cursor now sits on. This is where you and I might be in conflict. Your video interface may need some other code or codes in order to back up the cursor and erase the last character. The Delete by itself might be sufficient. In any case, consult the manual for your video interface board or terminal to find out how this should be handled.

As long as you hit the Back Space key the cursor continues to back up, erasing characters as it goes. After each Delete is sent to the screen the DELETE FLAG is reset. As this routine is now written, the Delete key will still work the same way it did before, echo and all. If you want to use the Delete key instead of the Back Space key for corrections, then change the CPI 8 in line 6 of Listing 1 to CPI 7FH.

OK, but what about the second backslash in a Microsoft correction? You've already ignored the first backslash and set the MICROS FLAG. The following echoed characters will be ignored and the undesired ones erased in the same manner as with a CP/M correction. When the trailing backslash comes along, it will be ignored also because the DELETE FLAG will be reset and the MICROS FLAG will be set. At this time, reset the MICROS FLAG and exit.

An unexpected benefit of this modification came up in connection with ED.COM, the CP/M text editor. Since my new keyboard routine converts Back Spaces to Deletes, Back Space also works within the body of an ED.COM text file while editing. However, Back Space is 08H, which is also the code for a Control H, the block move code used within the body of an Electric Pencil text file.

The modification I'm describing here will effectively eliminate the block move instruction, which is not good. Therefore, I have an unmodified CP/M BIOS on the disk that contains the Electric Pencil II word processing system so it will work properly.

Figure 1 is a flowchart of the keyboard input routine, and Fig. 2 is the screen output routine.

That's all there is to it. If you have done any assembly-language programming, you shouldn't have any trouble modifying your CP/M BIOS. I haven't mentioned the steps necessary to the new BIOS into its proper place in the CP/M system and then get it onto your disks because it would take too long.
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Level II BASIC
On a Z-80 System

Although the author used Radio Shack’s three-ROM BASIC, the two-ROM version should work as well.

Richard J. Uschold
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Port Orange, FL 32019

Since I have been a dedicated hardware hacker for many years, I just had to build my own computer. I started designing at Christmas in 1976. By September 1977 I had my computer basically working, and by Christmas 1977 it was working in BASIC. It was a 2K Tiny BASIC interpreter, but it was better than nothing.

After about a year of using my Tiny BASIC, I decided I was ready for a real BASIC. Since I had chosen the Z-80 microprocessor for my computer, I could use any BASIC written for the 8080 or the Z-80.

There were a number of BASICS available that required from 8K to 24K of memory at prices from $50 to several hundred dollars. I really liked the idea of having the BASIC in ROM so that I wouldn’t have to load it from tape every time, which seemed to take forever. (Even with my 2400 baud cassette interface, programs longer than 4K become annoying!) This meant I had to either useEPROMs or buy the BASIC already in ROM. The EPROMs would cost upwards of $80, plus the price of the BASIC.

There was only one BASIC offered in ROM that I knew of, although I had heard rumors of another one coming soon. The rumors have since become fact, and Livermore BASIC is now available on an 8K byte ROM for $95. I bought the other one, Radio Shack’s Level II BASIC, for $89.10. (Several companies offer ten percent off Radio Shack’s original $99 price. Radio Shack has since raised the price to $120.)

Radio Shack’s Level II BASIC has another significant advantage—software availability. Since it is the most popular microcomputer around today, it has much software designed for it. Also, many programs not originally written for it are being offered in compatible forms (for example, the CP/M disk operating system and the Electric Pencil).

In this article, I will describe how I interfaced the Level II ROMs to my computer, even though my hardware bears little resemblance to that of the TRS-80. I will also give some hints to those computerists whose hardware doesn’t resemble mine either!

Preliminary Work

Before I bought the Level II ROMs, I did some preliminary investigation, which included re-reading articles that described the TRS-80 hardware and software. I also bought and read the “TRS-80 Microcomputer Technical Reference Handbook” published by Radio Shack. All of this material provided several important pieces of information.

First, the TVT was a more or less standard type of memory mapped interface, which, I figured, should present no problems.

Second, the keyboard was an unorthodox arrangement with the key matrix directly mapped in memory (see Fig. 1). I figured I could write a program to take ASCII data from my keyboard and calculate the required memory bits to set so that the ROM could find the bits in memory and convert them back to ASCII (a kludge, but it worked!).

Third, the cassette interface was software timed and would require a different clock rate on my processor or else some software patches to get the timing right.

Finally, and perhaps most importantly, the ROMs were located in memory at address 0000H. This meant I would have to move my monitor, which was now there, to another address. I moved it to F000H. This required a reset vector other than 0000H to initialize to the monitor.

The circuit I used was described in the September 1977 Kilobaud (“Using an Invisible PROM,” p. 106, by Jack Regula). My version is in Fig. 2. I spent the next month or so rewriting and improving my monitor. When I had it just right, I put it in

Fig. 1. TRS-80 keyboard connected to the address and data buses. (Reprinted from the “TRS-80 Technical Reference Manual,” courtesy Radio Shack.)
EPROM, and I ordered the Level II ROMs.

Getting Ready

While waiting for the ROMs to arrive, I wrote a couple of programs to simulate the TRS-80 hardware, and I made a couple of hardware modifications to my computer in those areas that could not be readily done with software. The first program, in Listing 1, simulated the TRS-80 memory-mapped keyboard. This program is an interrupt driver that must be used as such. The program exits by jumping to my normal keyboard interrupt routine.

As you can see, the normal routine checks for a control-Z character and jumps to the monitor if it detects one. This is an invaluable feature of my monitor. This allows me to always jump back to the monitor if for some reason the executing program hangs up (except if it disables interrupts or destroys the monitor RAM area).

If you don't have an interrupt-driven keyboard, you can't use the program in Listing 1, but don't worry, you can still put Level II on your computer. It is highly desirable that you have some method of interrupting the computer, saving the registers, etc., and jumping back to your monitor. It is also necessary that you use interrupt mode 2 on the Z-80, since the other interrupt locations are used by Level II BASIC.

If you use Listing 1 with most keyboards, you will not be able to enter the same character twice in a row! The reason for this is because when the program sets the bits in memory to simulate the TRS-80 keyboard, it never resets the bits until the

Listing 1. TRS-80 Keyboard Simulator program converts the ASCII data from my keyboard to the memory-mapped bits expected by the Level II BASIC ROM. Program is simpler than it might have been due to the logical placement of the keys in the keyboard matrix (see Fig. 1).
Listing 2. The first part of this program generates the bit patterns necessary to program my programmable character generator so it simulates the TRS-80 graphics. The second part sets up my computer so it is compatible with the Level II BASIC ROM.

next key is hit. If the next key is the same as the last one, the same bits will be set and the ROM will think you have not released the key yet!

There are several solutions to this problem. I modified my keyboard so it gives a second data strobe when a key is released. This will strobe in a null, and the program will clear the memory when the key is released. Another solution is to hit any key on the keyboard that is not encoded by the program. This will clear the memory and leave it that way. This is only necessary if you wish to hit the same character twice in a row.

Actually, I don't really recommend you use this program. I am only describing it since it is the way I started this project. Later,
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Reader Service Index—page 241

Microcomputing, August 1980  55
I'll tell you what you should use and what I am now using.

Another noteworthy feature about this program is the shift. The TRS-80 keyboard program generates lowercase characters if the shift key is pushed with a regular key. It also generates special control characters when the shift is pushed with the arrow keys.

I handled this by using the eighth bit as the shift bit. My keyboard has an extra key that sets the eighth bit when pushed. Most keyboards don't have this.

The second program I wrote while waiting for the ROMs is an initialization of my system so that the ROMs will think they are hooked up to a TRS-80. Listing 2 essentially is the program, although it is a little bit different. I changed it slightly after I got the ROMs and learned a few things I didn't originally know.

The first part of the program initializes my programmable character generator to simulate the TRS-80 graphics characters. The programmable character generator is essentially the same as the one described in Byte magazine (May and June 1978). There are 128 programmable characters that can be printed by sending the codes 80H-FFH to the video driver or directly loading these codes in
the TVT memory area. The TRS-80 has 64 graphics characters having codes 80H-BFH. These corresponding characters are generated by the program.

The next section, command decode, checks for one of three options: initialize, continue or reset. The initialize section jumps to the ROM so it can initialize the Level II RAM area as it requires. The reset jumps to the ROM, where the reset button on the TRS-80 would send it. This is used when the Level II hangs up and you do not wish to destroy the BASIC program in memory.

On my system, I type a control-Z to get back to the monitor and then BR B is the BASIC command in my monitor that jumps to the program I am now describing. R is the reset option. The continue option initializes a few more things, which I'll describe later, restores the registers and continues where it was interrupted (usually by a control-Z). I frequently use this to save BASIC programs with my 2400 baud cassette interface rather than use Level II's 500 baud cassette interface.

I made several hardware mods to accommodate the Level II ROMs. The simplest was to move my RAM, EPROM and TVT RAM to the proper locations. The TRS-80 hardware manual has a memory map, so this was no real problem. The other two mods were a bit more involved. Both of these mods are for the cassette interface.

The first one (Fig. 3) changes the clock speed during the cassette operation. Normally my computer runs at its rated speed of 2.5 MHz; during a cassette operation, the speed is reduced to 1.7896 MHz. This is about one percent higher than the TRS-80 clock and is more than close enough when you consider the tolerance of the cassette machine.

The required clock rate is one-eighth the rate of my TVT clock, so I didn't need another oscillator. The required clock is also one-half the color burst frequency. There are inexpensive crystals available that you can use; 3.579 MHz color burst crystals cost less than $2.

The other changes are more directly related to the cassette interface itself (Fig. 4). The output circuit is little more than a couple of latches and a few resistors. I also added some Tri-state buffers so I could use the same cable as my 2400 baud interface. The first input circuit I tried is simpler than what the TRS-80 has, with three fewer op amps and many fewer resistors and capacitors. The idea was to change the input circuit I had been using with my 2400 baud interface as little as possible.

Well, I was finally ready for the ROMs, which would not arrive for over a month.

The ROMs arrive

After calling the company twice, asking where my order was, I finally received the ROMs, which came on a small circuit board with a 24-pin jumper cable and another four-wire ribbon cable. No instructions came with the kit; however, the handbook shows a schematic of the circuit board (Fig. 5). There are also other items, including an unprogrammed DIP header and a resistor, in the kit (see Photo 1). The DIP header alters the ROM decode in the TRS-80; I'm not sure what the resistor is used for. Anyway, I didn't use either of these.

![Fig. 4. Cassette output circuit similar to the TRS-80. I added the Tri-state buffers and changed the resistor values a bit so I could wire it directly to my existing output circuit. You can use bit 2 for cassette motor control if you wish.](image-url)
Also included are three prerecorded cassettes with some very brief instructions on how to use them. One cassette contains Blackjack and Backgammon. The other two cassettes are for conversion of Level I programs and data to Level II format. I haven't had a need for these two yet, though I have used the games a few times. Finally, there is the "Level II Reference Manual," along with errata sheets, containing useful information.

The small circuit board didn't seem to fit anywhere in my system, so I wired up three sockets and just removed the ROMs. A friend had given me a poor copy of a copy containing a hex dump of the ROMs and partial disassembly of the initialization portion of the program. The first thing I did was to check the first few bytes in each ROM. They matched! Next, I ran off a hex dump of my own so I could read it without straining my eyes.

There was one more thing I wanted to do before I actually tried to execute the program contained in the ROMs. From all the information I had acquired, I knew that the TRS-80 used interrupts only when it had the expansion interface connected. Also, it only used interrupt mode 1 on the Z80 chip. Since my system would only work if I used interrupt mode 2, I searched the ROMs for any instructions that affected the interrupts. There were two: a disable interrupts at 0000H and an enable interrupts at 06E4H.

The enable interrupt instruction is actually the interrupt service routine, which is moved to RAM during the initialization. The routine merely enables interrupts and returns. This is modified when interrupts are needed. What all this boils down to is that I shouldn't have any problems with my interrupt-driven keyboard as long as I start the ROM at 0001H.

The Big Moment

So, I tried it. The screen cleared, and a short message appeared in the upper-left corner. It said, "1234567890абвгдеёжзийклмнопрстуэюя?" My computer was talking to me in Greek! There was obviously some incompatibility between the TRS-80 video driver and my TVT. The Level II manual tells me that the computer is supposed to say, "MEMORY SIZE?..." Anyway, I responded with a "32000," which appeared on the screen just as I typed it.

Hmmmm, my keyboard kludge was working alright and the numerals printed correctly, but the alphabet was in Greek! I hit the carriage return. Nothing happened for a moment, then another couple lines of Greek appeared.

You may be wondering where the Greek was coming from. Well, that is an easy one. The character generator ROM I bought for my TVT has Greek characters and some special math symbols where the control
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characters would normally be. Most video drivers don’t actually send control characters to the video RAM; rather, they decode them and take the appropriate action. For some strange reason, the TRS-80 video driver was changing the normal alphabetic codes to control codes before sending them to the video RAM.

The First Program (in Greek)

I know that some people think that programming computers is like talking in Greek, but this is ridiculous! The Level II manual has a short program in the back which will display all of the graphics characters. I typed the program into my computer ... in Greek! I changed it slightly, so it would print all characters not including the control codes. After I finished typing it, I listed it. Since I can’t read Greek, I couldn’t tell if I had it right or not, but at least the list command worked.

Next I typed “’TXO,’” that’s RUN, for those of you who don’t know Greek. Characters flashed on the screen, and scrolled off before I could read them. I ran it again, but I halted the computer before everything disappeared. The special characters and numerals looked good. Then there were two sets of Greek characters where the uppercase and lowercase should be. Next came the graphic characters, which looked all right.

Finally, there were all of those spaces, as everything scrolled off the screen. The Level II manual has a good explanation for the scrolling phenomenon. The codes, C0H to FFH, are space-compression codes for 0-63 spaces. So, by printing all of those codes, I had printed about 2000 spaces to the screen. I changed the program so it did not print the space-compression codes and ran it again. This time it didn’t scroll off the screen.

Video Driver Patch

I remembered something I had seen in the Level II manual, which showed a memory map, which had a detailed description of some of the RAM locations used by the Level II BASIC. I was interested in a short section of 25 RAM locations containing three device control blocks. There were control blocks for the keyboard, the video display, and the line printer. As you can see from Fig. 6, among other things, each block contains a driver address.

Now I figured all I had to do was to change the driver address to my own video driver, and I would be in business. I tried it. Nothing! I guessed that they used a different register to transfer the data byte. With this in mind, I set up a breakpoint at

---

**Fig. 6.** Level II TRS-80 memory map. (Reprinted from “Level II BASIC Reference Manual,” courtesy Radio Shack.) I have added a few addresses I have discovered.

---

**Table: D/LEVEL II TRS-80 MEMORY MAP**

<table>
<thead>
<tr>
<th>DECIMAL</th>
<th>HEXDECIMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0000</td>
</tr>
<tr>
<td>12288</td>
<td>3000</td>
</tr>
<tr>
<td>14302</td>
<td>37DE</td>
</tr>
<tr>
<td>14303</td>
<td>37DF</td>
</tr>
<tr>
<td>14304-7</td>
<td>37E-3</td>
</tr>
<tr>
<td>14308-11</td>
<td>37E4-7</td>
</tr>
<tr>
<td>14312-5</td>
<td>37E8-B</td>
</tr>
<tr>
<td>14369</td>
<td>37EC-F</td>
</tr>
<tr>
<td>15360</td>
<td>3C00</td>
</tr>
<tr>
<td>16383</td>
<td>3FFF</td>
</tr>
<tr>
<td>16384</td>
<td>4000</td>
</tr>
</tbody>
</table>

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**Key: LEVEL II BASIC ROM**

<table>
<thead>
<tr>
<th>LEVEL II BASIC FIXED RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>VECTORS (RST'S 1 THROUGH 7)</td>
</tr>
<tr>
<td>KEYBOARD DEVICE CONTROL BLOCK</td>
</tr>
<tr>
<td>VIDEO DISPLAY CONTROL BLOCK</td>
</tr>
</tbody>
</table>

---

**Photo 3.** Initial run of Level II BASIC. Translation:

MEMORY SIZE? 32000
RADIO SHACK LEVEL II BASIC
READY
>...
the entry point of my video driver. I was then able to determine that the data was always in register C; my driver required the data in register A. I patched this in and tried again.

Now I was getting data, but everything was on the same line! There were only carriage returns and no line feeds! It seems the TRS-80 video driver automatically generates a line feed when it gets a carriage return. As it turns out, my video driver generates a carriage return if it gets a line feed! So I checked for carriage returns and converted them to the line feeds and tried again.

Now that was much better! Everything seemed to work. Well... almost everything. The clear screen function did not work. I know this used to work when everything was in Greek. Referring again to the Level II manual, I noticed they had a table that describes all of the control codes that are implemented (Table 1).

I had two choices: modify my video driver to handle all of the control codes or try to see if I could patch their video driver so it would work. Half out of curiosity as to what they were doing and why it worked (on a TRS-80) and half because I didn't really feel like rewriting my driver, I disassembled their driver.

As I had guessed earlier, they are converting both upper and lowercase letters to control codes. The question is, "Why do they do this and how come it works?" The answer is in the hardware manual. It seems they thought it would be less expensive to use only seven bits of information in the video RAM instead of eight. They use one bit to select graphics characters or regular characters. That leaves six bits for the ASCII code.

But the ASCII code is a seven-bit code; how can that work? They cheat a little. The seventh ASCII bit is generated with a NOR gate from two other bits. This means that if they sent an actual lowercase code to the video RAM, it would be printed as a numeral or a special character. So they had to convert lowercase to uppercase. It was probably simpler to convert both upper and lowercase letters to control codes than to just change lowercase to uppercase.

Anyway, as far as they were concerned, that particular bit didn't really matter because it was not even in the RAM! Personally, I think they should have spent the extra buck on one more memory chip, then they could have had both upper and lowercase on the computer.

The final solution I came up with was to duplicate the first dozen instructions of their driver and then skip over the section that screws up the characters and jump back to their driver. The total patch is about 40 bytes.

Listing 3 shows that I have included two more small patches to the driver. The first changes the up-arrow code from 5B (which prints a left bracket[ ]) to 1C, so it prints an up arrow on my TVT. Radio Shack mentions in the Level II manual that some TRS-80s may print the up-arrow as a left bracket. The second allows me to bypass the space-compression codes and print 64 more of my programmable characters instead. This is accomplished by poking one byte in a memory location.

The Cassette Interface

Having gotten the video driver working made me feel very confident. I was now ready to attack the cassette interface. I placed the Blackjack tape supplied with the Level II kit in the recorder (a Radio Shack CTR-40) and typed CLOAD. I have a small tape controller box, which enables me to hear the data while the computer is reading it. This is convenient because you can tell the difference in the sound of the actual data and the leading tone on the tape.

I turned on the recorder and hit the return key. One nice thing about the TRS-80 cassette driver is that two asterisks flash in the upper-right corner of the screen when the computer is reading data. The asterisks first appear
when the actual data on the tape starts, just after the leader tone ends. They then flash as each line of program is read.

Somewhat to my surprise, the asterisks appeared and began flashing as soon as the leader tone ended. As soon as the data ended, the computer typed READY. I typed RUN. The program started executing! It asked me several questions, including my name.

After my second or third response, the program bombed. Oh well, I knew it was too good to be true. I adjusted the volume on the recorder and tried again. After several repeats of the above, the program actually ran all the way through. Ah, success at last. Next, I tried making a tape. I had to adjust the volume several times to get it to read back correctly, but this also worked.

The volume setting on the tape recorder is critical. I usually have to adjust it several times before I can get a program to load correctly.

I bought the Library 100 from The Bottom Shelf, Inc. This is a five-cassette package of 100 assorted programs for the TRS-80. I have to adjust the volume several times even to read programs on the same cassette. According to the hardware manual, the data on the cassette is saved with a checksum. This is useful for detecting load errors.

The only problem is that the Level II cassette loader program does not check the checksum and tell you when a bad load has occurred. My own cassette loader does this, and while I don’t have frequent errors, it sure is nice to know that the load is bad before you try to execute the program.

I have discovered several ways to help determine if a load is good or not. The load will be bad if the asterisks appear before or after the point on the tape where the data actually starts; if the data stops and the
Fig. 7. Cassette input circuit I am now using. The 2 khz high-pass filter is switched in to read Radio Shack tapes. The Schmitt trigger section is the same as in Fig. 4. The input latch is simpler than that shown in Fig. 4.

computer doesn’t immediately respond with READY; if READY occurs before the data ends; or if the asterisks do not flash. If the asterisks flash slowly or erratically, the load may be bad. This clue takes some getting used to since the flash rate is not the same for all programs. You have to get a feel for how the asterisks normally flash.

If any of these symptoms occur, you will have to reload the program. Several of these problems cause the computer to hang up. A reset must then be issued to get back to BASIC.

During the next few weeks, I tried all of my 100 programs. I found that some of the tapes read fairly well, while others were very poor. These tapes have the same programs recorded on both sides as a backup. I found that I couldn’t read some programs at all; I could read only one side correctly on some tapes; and I could read both copies on others. I tried reading some of these programs on a real TRS-80, and some that I couldn’t read worked.

Since my input circuit was considerably simpler than the one they use, I breadboarded their circuit and tried it. It worked much better. The volume setting was less critical, but it was still more sensitive than I would have liked. With some experimenting, I found that I only needed the high-pass filter section of their interface. Since the TRS-80 tape format was so much improved with the filter, I tried it on my 2400 baud interface. It bombed. My interface became totally useless with the active filter.

The reason I attribute to this seeming inconsistency is that the Radio Shack recording method is an amplitude modulation scheme, while my interface is a phase modulation scheme. The active filter adds too much phase distortion for my interface to work properly.

The final circuit I implemented for my cassette interface is shown in Fig. 7. The switch is to select Radio Shack or other recording methods. I’m not really sure if my circuit is more or less reliable than Radio Shack’s, but my circuit seems adequate. Most of the tapes read through with two or fewer volume adjustments. Some don’t need any adjustments. I don’t use my Radio Shack interface to save programs anyway, since my 2400 baud interface is nearly five times faster.

One feature of the Radio Shack cassette interface I haven’t built is the motor control circuit. I’ve been using my cassette interface for a year and a half, and I don’t think a motor control is necessary. I use the motor control signal to change the clock frequency and to enable the output circuit though. This works very well.

Keyboard and Printer Patches

I decided to get rid of that keyboard kludge I was using. I wrote the short driver in Listing 4. This program simply checks the keyboard status bit and either returns a null if it is not set or returns the character. It also checks for and changes two characters that are different on my keyboard than what the

Listing 3. Patch to the TRS-80 video driver eliminates the section that converts lowercase and uppercase character codes to control character codes. This permits both upper and lowercase to be printed.

Table 2. Control codes generated by the keyboard driver on the Level II BASIC ROMs. Your keyboard must generate these characters also.
The printer patch adds a few features that my driver didn't have but are assumed by the Level II ROMs. This major feature is to add extra carriage returns when a line exceeds 64 characters in length. My first printer patch did not do this, and when I listed BASIC programs that had multiple statement lines longer than 64 characters, the extra characters would not print. I also added a lines-per-page counter. When the line count is at the limit, the program waits for me to put another page in my printer.

The routine TYPOUT in List-
Program's attention is with an interrupt. If you have an interrupt-driven keyboard, you could use a program such as Listing 1 to simulate the TRS-80 memory-mapped keyboard, as I did at first. Otherwise, you need some other means of interrupting the computer. This could be as simple as a switch to the interrupt line on the Z-80. The interrupt service routine could simply change the keyboard driver address and then return to the Level II program.

There are only two situations where you could get by without any interrupts. If you actually connect your keyboard the same way as Radio Shack did, you wouldn't need interrupts. If you already have a keyboard connected some other way, re-wiring it is probably undesirable. Or, if you have a hardware front panel, you could interrupt the computer that way and change the keyboard driver address. While that is not really very difficult, it is kind of a bother to flip all those switches.

My system includes a front panel, and I didn't want to do it that way.

The method I used to interrupt the computer is a bit unusual for a microprocessor. I have a circuit in my computer that generates an interrupt if the computer attempts to read a memory address at which there is no memory installed (see Fig. 8). This interrupt saves all the registers, prints a "No Memory" message and jumps to my monitor. When the ROM tries to read the keyboard, this interrupt is generated because I don't have any memory there. From here I simply type BC, a monitor command that stands for BASIC Continue.

Listing 2 is the program. Its function is very simple—it merely sets up the new driver addresses for the keyboard, TVT and the printer. Then it restores all the registers and returns to where it was interrupted.

**TVT Specifics**

If your TVT is a memory-mapped device with 16 lines of 64 characters, you should have no problems getting it to work with Level II BASIC. You will have to change its address to 3C00–3FFF. If you don't have a programmable character generator, you will have to modify the TVT to implement the TRS-80 graphics. The modification should consist of only three ICs as shown in Fig. 9.

Fig. 10 shows the graphics character format. As you can see, each character cell is divided into six blocks. Each block is controlled by one bit in the video memory. The most significant bit determines if a particular character is a graphics character or a regular character. The multiplexers simply steer the bits to the appropriate positions.

This circuit will work for TVTs, which have a character cell con-

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**Fig. 10.** Scale drawing of one character cell shows that each graphics dot is approximately twice as tall as it is wide. The video RAM bits that control each graphics dot are also shown. This format matches the circuit in Fig. 9.

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sitting of 12 lines of eight dots. If your TVT has 12 lines of six dots, simply tie the two outputs from mux A to each of three inputs on mux B instead of the four shown. If your TVT has a different arrangement of lines and dots, you have several choices.

First, you could stretch or shrink some of the graphics dots so they fill the available lines and dots in the character cell. This may cause some graphics dots to be different sizes than other ones if the total number of lines and dots are not evenly divisible by three and two, respectively.

Second, you could modify your TVT so it has a line count divisible by three and a dot count divisible by two. This is a bit tricky and should be attempted only after you have examined the schematic and understand the timing details of the TVT. The first mod is simpler and doesn't affect the timing, but you should still closely examine the schematic of your TVT before attempting to install the change.

Third, you could forget about the graphics. This is the simplest solution, but since a lot of game programs use the graphics, you may not want to do this. If you never play games, then you don't need the graphics anyway.

I suggest you try the first solution before trying the second. The slightly different size dots will go unnoticed in many applications anyway. My own TVT has a software-selectable character cell size. I can select 13 by 9 or 12 by 8. I normally operate in the 13 by 9 mode and have found it satisfactory in many graphics applications.

If your video terminal is a completely separate unit from your computer, you obviously don't have a memory-mapped device. This means you can't use any part of the TRS-80 video driver. You will have to either write your own or modify the one you are presently using. The most important thing is to have the control characters respond correctly (see Table 1).

There are a few features in Level II BASIC that won't work with this type of setup. The graphics functions, SET, RESET and POINT, won't work, although you could send the graphics characters to the terminal like any other character. The PRINT@ and POS commands won't work either. Everything else should be fine though.

Your First Run

When you first try to run the Level II BASIC, you may have a different sequence of events than I do, depending on just how your hardware is configured. As you recall, my first run produced Greek characters. I no longer get Greek when I initialize the BASIC ROM. The first thing that appears is a "No Memory" message. This occurs when the ROM attempts to read the keyboard memory. I then type BC (BASIC Continue).

As described earlier, this changes some of the RAM locations just initialized by the ROM and returns to Level II BASIC. From here, my system behaves just like a TRS-80.

If you don't have a "No Memory" interrupt on your system, and depending on what your TVT does with control characters, your system could produce Greek characters, some strange graphics characters or absolutely nothing. The next display will depend on what you have in the keyboard memory area. If this memory is all zeros, you will only see one line of whatever characters your system is producing. If the memory is all ones (FF hex) or random data, you should see several lines of these characters continuously being written to the TVT and scrolling off the screen.

No matter what you see, you should now hit your interrupt button (control-Z, or whatever) to put you back into monitor. After typing the BASIC Continue command, you should have a blank screen.

The ROM is now waiting for your response to the MEMORY SIZE question, even though you can't see that message. Typing anything should cause it to appear on the screen. Since there may be several unknown characters in the keyboard buffer, you should first delete these with the back-arrow key. When the cursor stops moving back, all characters have been deleted. Now answer the MEMORY SIZE question as you wish. If you hit a carriage return with garbage data, the ROM will ask the MEMORY SIZE question again.

One final note: if, on your system, memory address $37EC returns anything other than 00 or FFH when read, the ROM may attempt to boot the disk. I'm not sure exactly what will happen, but it will likely get hung up and do nothing. If you have memory at that address, you should be OK, since most systems read FFH or 00 to nonexistent memory.

Conclusions

For someone with a Z-80 microcomputer who is looking for a good BASIC and would prefer to have it on ROM, Radio Shack's Level II ROM add-on kit for their TRS-80 is a good way to go. The price is reasonable—less than many BASICs that only come on cassette. If you consider the additional cost of EPROMs to put another BASIC on ROM, the Level II BASIC is less expensive than any other I know.

That the TRS-80 is the most popular microcomputer today ensures that there will be more directly compatible software than any one person can use. The ROM also contains a floppy disk bootstrap routine. This allows easy addition of one or more mini-floppy disk drives for a more versatile system. Radio Shack's TRSDOS may not be the best, but at only $14.95, it certainly is the most inexpensive disk operating system I have ever seen.

References

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64K Memory For the H8

Last month's article continues with construction and checkout of the memory.

Myron J. Seibold
PO Box 5131
Santa Ana, CA 92704

Last month, part 1 described the actual design of a 64K single card semiconductor memory for the Heathkit H8 computer. Now let's look at its construction and operation.

Power Supply Circuits

The three power supply voltages required by the memory are easily obtained from the H8 computer. The unregulated H8 voltages, -18, +8 and +18, are converted to -5, +5 and +12 volts, respectively, using standard three-terminal voltage regulator chips (see Fig. 1).

The power supply current requirements are small: -5 volts at 10 mA, +5 volts at 1.0 amperes and +12 volts at 150 mA. The +5 volts should be supplied using four regulators driving separate loads, none of which should draw more than 500 mA. The integrated circuits should be split into four groups, each connected to a separate +5 volt power supply regulator. This is done to permit mounting the regulators on a small heat sink. The memory chips will constitute one of these four groups.

The average (dc) currents supplied by the +12 volt and -5 volt regulators are quite small. The peak currents these voltages must supply on the memory board, however, are large and are many times greater than the dc currents in both cases.

The peak current demand is supplied by the filter capacitors in the memory chip array. A large amount of distributed capacitance is required for this purpose. You must carefully follow the layout rules for the memory chip array. These currents must be supplied when needed, without inducing spurious signals. During refresh, these currents are drawn by all of the memory chips simultaneously.

Memory Chip Layout Rules

The wiring board layout requirements for dynamic memory chips are exacting. The memory chips themselves must be arranged together in a compact group. All three power supply voltages, as well as ground, should be respectively cross-connected at each memory chip (see Fig. 2). A pair of high-quality ceramic power supply filter capacitors should also be installed with each memory chip.

The memory chip ground connections should form a net with a memory chip at each connected intersection. The same is true for connections to +12 volts and -5 volts. The +5 voltage should be connected in a similar manner, but is not as critical and is used only to provide TTL compatibility. The +5 voltage is not required to retain data in the memory chips.

High-quality ceramic capacitors are essential to filter the
memory chip power supply voltages. Capacitor quality is directly related to price. Inexpensive capacitors will not work for this purpose. A capacitance of 0.1 μF should be used for each capacitor. The two capacitors should be located as close to each memory chip as possible. The CK05B1X10K capacitor is suitable for this purpose and is recommended for its small size.

The other memory circuits should be laid out in a similar manner, although the layout requirements are not as strict. Only a single power supply voltage is used, and only one filter capacitor need be used for every three or four integrated circuit chips. A good ground structure, however, is always important.

**Assembling the Memory Module**

This memory was physically assembled in three parts on a retaining backboard identical in size to the printed circuit boards used in the H8 computer (see the memory layout drawing, Fig. 3). The memory chips and their address drivers were easily mounted on a printed circuit board cut from a surplus commercial memory board. I have a limited supply of surplus memory boards of different types from which suitable memory chip arrays may be cut. These printed circuit board pieces typically hold all 32 memory chips, about 70 filter capacitors, four resistor modules (or 32 1/8 Watt resistors) and four integrated circuit address and control driver chips. Using these boards is convenient and ensures that the memory chip array is properly wired and filtered.

The memory chips should be installed on these boards in high-quality sockets. These sockets will facilitate troubleshooting and memory chip replacement. The memory chip array can also be constructed on regular wiring board, such as Vector board, following the layout rules previously given. Again, sockets should be provided for the memory chips.

The remaining circuits were separately wired on a small piece of Vector board. The Vector board hole spacing is 1/10 inch in a square array. Small-size Vector pins are used with this board. Thirty integrated circuits can be laid out in a 6 x 5 chip array with ample space around them for discrete components.

Wires-wrap sockets are recommended for the integrated circuits. These sockets can be glued to the Vector board and the leads cut to a convenient length for wire (solder) connections. Either 1/4 Watt or 1/8 Watt resistors may be used. The timing capacitors normally have a rating of at least 500 volts. Photos 1 and 2 of the memory module may differ slightly from the layout shown in Fig. 3. The layout is small, and component placement is not critical. Wiring connections should always be as short as possible.

Wires must be soldered to the memory chip printed circuit board for connection to the circuits on the Vector board. A few ground wires should always accompany any groups of signal wires. From the bottom of the memory chip array, for example, a bundle of eight data input lines, eight data output lines and four ground lines was brought out (see Photos 1 and 2). The memory chip array printed circuit board and support circuit Vector board were mounted to the backboard using short standoff spacers. The two boards were then wired together. The voltage regulators were mounted to a standard Heath metal-mounting bail at the edge of the backboard. This bail acts as a heat sink for the voltage regulators. It is a poor heat sink, and four +5 volt regulators were used to reduce the regulator junction temperatures. The bail gets hot and may reach 150 degrees Fahrenheit (65 degrees Celsius).

The single +12 volt regulator can also be mounted on the bail. Silicon grease should be used when mounting the regulator chips. The -5 volt regulator does not get hot and need not be mounted on the heat sink. The bus connectors should be mounted directly on the Vector board. A pair of standard Heath gold-plated connectors should be used with a tie bar. The connectors should be well secured to the Vector board. Cut-down Vector pins can be used as solder eyelets for this purpose.

The memory can be assembled and operated in smaller versions than 64K. In this case, you can build a complete 64K memory with memory chips installed in only one or two rows of sockets. The memory will work with a single row of eight memory chips. This should not entail much expense and will provide 16K of memory capacity. Memory capacity can then be increased in 16K increments up to 56K by simply installing additional rows of memory chips.

A note of caution: the memory chips are MOS integrated circuits and are susceptible to damage by static electricity.

**Photo 1. Full view of the memory module. Note light reflected from the array of 32 memory chips. All information is stored in these chips. The memory chips themselves occupy less than one half of the memory module. The remaining space is occupied by the memory chip support circuitry. This is characteristic of most dynamic memory designs.**

**Fig. 2. Memory chip power-ground cross connections.**

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They must be handled carefully, observing the precautions normally taken when using MOS devices. The memory chips must be handled one at a time and stored on a conductive foam pad when removed from the memory module.

**Operation**

When the memory is operating properly, the front panel (monitor program) can be used. It should be possible to load and store information anywhere in the memory address range from 8K to 64K. It is a heady experience loading and retrieving data in the higher address locations for the first time! All the effort in building and debugging the memory now seems worthwhile!

The H8 memory test routine should now be entered and run to ensure that the entire memory is functional and that there are no defective memory chips. The Heath H8 memory test routine is listed on pages 61 and 62 of the H8 operating manual. It is also listed and described in detail on pages 9 through 14 of the operating manual.

To test 56K of memory, the data placed in address location 040 105 (split octal notation) of the test routine should be changed from 057 to 377. This raises the upper memory test limit from 12K to 64K. (The memory test always begins at 8K.) To test smaller amounts of memory, the upper memory limit can be varied accordingly. See page 0-58 of the H8 software reference manual for the high-byte address boundaries for 4K decimal increments of memory capacity. The high-byte addresses are octal numbers and should be decremented by one (except in the case of 377) to set the memory boundary. For example, 200 - 1 = 177 sets the upper memory boundary at 32K, for a memory capacity of 24K.

The memory test begins at address 040 160, rather than at the 8K boundary of 040 000. Also, the memory test ends at address 260, rather than the upper limit of address 377. These small amounts are excluded from the test because they are needed to operate the front-panel monitor program, as well as administer the test itself.

If the memory test runs successfully, it can be assumed that these excluded locations are also good. However, these locations can be thoroughly tested by interchanging RAS lines on the memory module. It is easy to do. RAS 0 and RAS 3 are interchanged with RAS 1 and RAS 2, respectively. This physically changes the memory chip rows responding to given address inputs in 16K blocks.

The memory test routine is primarily used to locate defective memory chips and certain kinds of problems in the memory chip array wiring. If there are problems in the memory chip timing and control circuits, the front-panel monitor program will not run.

I have a Heathkit H8 computer, H8-5 interface module, H9 video terminal and a pair of cassette units. The new 64K memory module works perfectly with this system. It certainly does more than the Heathkit 8K H8-1 static memory module it replaces. The computer can now be filled with interface boards, rather than with memory modules. This should eliminate any future need for a computer expansion chassis.

This memory has also been tested in an H8 computer using the H17 floppy disk system. The memory works perfectly with the floppy disk, and the large capacity of the memory effectively eliminates the need for a second floppy disk drive unit for disk copying. Single drive disk copying proceeds very rapidly when using a large memory.

**Troubleshooting the Memory Module**

This design is proven. Therefore, you should encounter a minimum number of problems in getting the memory to work—at least with a Heathkit H8 computer. In some cases, what appears to be memory problems may actually be problems in the computer hardware or software. It is now well established that the H8 is somewhat unreliable. The sockets on the voltage regulator leads on every H8 module should be removed, and these leads should be soldered directly to the voltage regulator terminals. It would also be worthwhile to replace the tin-plated motherboard connectors with gold-plated connectors of the same type.

Socket and connector problems occur unpredictably at infrequent intervals. Individual sockets can be tested by physical manipulation while running a program. Programs should run without interruption while sockets, or printed circuit boards, are flexed or tapped. A vibrator (use an engraving tool with a plastic ball on the point) set at low frequency can be very useful in this case.

Problems can also exist in the computer software. When running Heath cassette BASIC, you must software-set the upper memory limit below 40K. You can use the software configuration option to do this. Alternately, the RAS-3 line to the last row of memory chips can be lifted and the memory run as a 40K version. The RAS-3 memory chip line should be connected to a +5 volt bias resistor in this case.

Be very careful not to short connector pin 2 and 3 together on the bus when making measurements. This will destroy a number of integrated circuits on several computer modules. When wiring the memory module connector, you should note that the first pin is 0, not 1. If the connector is miswired, −18 volts will be placed on pin 3, with the above-mentioned consequences.

If the front-panel monitor program won’t run, there is a problem in the memory chip timing and control circuits. Check all six power supply voltages first (+5 volts from each of the four regulators, +12 volts and −5 volts). An oscilloscope should then be used to check circuit operation. A dual-trace or external sync oscilloscope is required to make differential timing measurements.

Frequently, you can provide signals to the memory interface to check memory circuit operation when the front panel does not operate properly. Repeated pushing of front-panel buttons (especially reset) should set this up. You should first check all timing adjustments wherever possible (see timing specification, Fig. 4, part 1). Then you can check circuit operation for wiring errors and defective parts. It may be helpful to interchange RAS lines between rows of memory chips to

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Fig. 3. Memory module layout.
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locate or bypass rows with bad chips.

When adapting this design to another computer interface, you may have to devise and perform circuit modification experiments in order to obtain information. This is often necessary to locate problems that cannot be found using an oscilloscope. Interfacing involves both hardware adaptations to the computer bus and possible changes in the memory timing.

If you suspect a memory-read-access-time problem, RDYIN can be asserted for every memory cycle to check this. To accomplish this connect US8-1 to a +5 volt bias resistor or US8-2. If the memory can be made to work with this modification—but not otherwise—the memory access time may be excessive.

To reduce access time use faster memory chips. The 4116-2 is 50 nanoseconds faster than the 4116-3 (see Table 1, part 1). Reducing the respective delays for address multiplexing and the assertion of CAS is required to take advantage of the faster memory chips. This should be done if the 4116-2 memory chip is used. Each of these delays can be reduced by one half when using the 4116-2 memory chip.

A memory-access-time problem can be solved, of course, by simply asserting RDYIN for every memory cycle. Using RDYIN with each memory cycle, however, is undesirable, as this will cause the computer to run more slowly. I experienced no problem with access time using the H8 computer with either the 4116-3 or the 4116-4 memory chips. I used the 4116-3 to provide an adjustable margin of reliability.

The refresh cycle must terminate before a computer memory cycle can begin. Access time will be adversely affected if the refresh cycle delays the beginning of a computer memory cycle when refreshing in the transparent mode. The input at U54-9 must go high before the input at U54-10 goes high to begin a computer memory cycle, in this case. This is ensured by the 1400 nanosecond maximum specification (Fig. 2, part 1).

Once the front panel monitor program is running, you can use the Heath H8 memory test to test the memory chips. This test will locate about 90 percent of all memory chip problems. No memory test can locate all memory problems. Dynamic memories are also susceptible to soft (nonrepeatable) errors caused by alpha particle radiation from the memory chip case materials. Fortunately, these errors are usually infrequent.

Heathkit H8 owners who would like to build their own memories can purchase printed circuit boards from the author. Fully assembled and kit versions of this memory in several different (de-populated) memory sizes are available.

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Microcomputing, August 1980 75
On Time and Space

North Star users can save memory and run time with this program.

The purposes of this article are to present a program I wrote to help reduce the size of North Star BASIC programs, and to describe a software product that not only saves space but reduces run times of almost any North Star BASIC program. (The North Star floating-point board allows use of a slightly smaller interpreter and, in my experience, improves calculation times, but for many it is an unaffordable luxury.)

One way to reduce program size is to remove all blanks from a program. A program to do this is on the NSSE Disk 2. You can save additional space by removing remarks, although this may not be desirable.

CHANGE

Two-character variable names use one more byte at each occurrence than do one-character names. I wrote the program CHANGE Listing 1 to convert two-character to one-character variable names in North Star BASIC. It uses as data a BASIC program on file. The program requests the file name and then information about the variable names to be changed.

In Segment A, any number of variables may be altered. A two-character variable name may be altered to a single character variable plus a blank. In addition, one-character names may be changed to other one-character names.

Since North Star BASIC allows variable names consisting of only one letter and, optionally, one integer, conversion of programs from another BASIC sometimes requires the

Listing 1. CHANGE, a program that allows variable name changes and compaction in North Star BASIC programs.

```
10 GOTO 910
20 READ#0,4K,4N1,4N2\REM READ NO CHAR'S AND STATEMENT NO
30 WRITE#1,4K,4N1,4N2,NOENDMARK
40 LET K=\REM LET A=O\LET A=0
50 IF K=1 THEN 830
60 LET P=0
70 N0=N2*256+N1
80 FOR I=1 TO K-3\REM READ LINE
90 READ#0,4A9(I)
100 NEXT I
110 IF O=2 THEN 580
120 REM ..............................SEGMENT A
130 L5=O\L5=0
140 FOR J=1 TO K-3
150 IF J=1 TO N9
160 A1\O\A1=0
170 Q=9\REM REMARK AND "QUOTE" FLAG
180 L5=J(L)+L3
190 VS=\REM VS=5(L+1,L5)\REM LEN(VS)
200 W=\REM W=5(L+1,L5)\REM LEN(W)
210 FOR M=1 TO L5\REM SET UP FOR NAME LENGTH
220 V(M)=ASC(VS(M,M))
230 W(M)=ASC(WS(M,M))
240 NEXT M
250 FOR I=1 TO K-3
260 IF A9(I)=143 THEN R=1\REM REM
270 IF A9(I)=92 THEN R=0\REM SLASH
280 IF A9(I)=36 AND R=0 THEN Q=Q\REM QUOTE
290 IF Q=1 OR R=1 THEN NEXT I\REM INSIDE REM OR QUOTE
300 IF A1=154 OR A2=154 OR A1=150 THEN NEXT I\REM SKIP LINE NOS
310 IF A9(I)=138 THEN NEXT I\REM LOOK FOR BYTE ACCESS
320 FOR L=1 TO L4
330 IF A9(I)=V(L) AND Q=1 AND R=0 THEN 400
340 IF A9(I)=92 THEN R=0\REM SLASH
350 IF A9(I)=143 THEN R=1\REM REM
360 EXIT 510
370 IF A9(I)=34 THEN Q=Q\REM QUOTE
380 I=I+1
390 NEXT L
400 GOTO 420
420 I=1
430 IF A9(I+1)=44 OR A9(I+1)=41 THEN 460
440 IF A9(I+1)=13 THEN 460
450 IF I<K-4 AND A9(I+1)<32 AND A9(I+1)>91 THEN 530
460 FOR L=1 TO L4
470 A9(I+1-L)=W(L)
480 NEXT L
490 IF F=0 THEN I
500 IF F=0 THEN 10611,N8.TAB(15),
510 F=1
520 IWS","
530 IF I<3 OR I>K-3 THEN 550
540 NEXT I
550 NEXT J
560 IF Q=1 THEN 750
570 REM ..............................SEGMENT B
580 I=0
590 GOTO 2\REM REMARK AND "QUOTE" FLAG
600 FOR I=1 TO K-3
610 A2\REM A1\REM SAVE PREV
620 A\REM A9(I)\REM GET CHARACTER
630 IF A1=150 OR A2=150 THEN 660\REM IGNORE STATEMENT NUMBERS
640 IF A = 32 AND O=1 AND R=0 THEN 730\REM SKIP BLANK
650 IF A = 128 AND Q=1 AND R=0 THEN 730\REM SKIP LET
660 IF A<92 THEN 680
670 GOTO \REM \REM NEW STATEMENT ENCOUNTERED
670 IF A=143 THEN R=1
690 IF A=34 ANDR=0 THENQ=Q
700 I=I+1
710 A9(I)=A
```
FIBONACCI

Dr. A.M. Microcomputing, A.Z.

REM TEST

REM LET I,A9(1),NOENDMARK

REM CORRECT CHAR COUNT IF NECESSARY

REM BRING POINTER UP

IF O=2 THEN 20

GOTO 20

10 REM PROGRAM TO PRINT THE FIRST N2 FIBONACCI NUMBERS

20 "FIBONACCI NUMBERS!"

30 "FIBONACCI NUMBERS!"

40 INPUT "HOW MANY NUMBERS DO YOU WANT? ",N2

50 LET N=0,REM LET INCLUDED FOR TEST OF "CHANGE"

70 LET A9=0

80 OPEN#1,\READ1115,1,\REM PRINT A9

90 LET N=N+1

100 B=1

110 1B,

120 N=N+1

130 C=A+9

140 1C,

150 N=N+1

160 IF N=N2 THEN 200

170 A9=B

180 B=C

190 GOTO 130

200 "FIBONACCI NUMBERS HAVE BEEN PRINTED."

220 END

READY

Listing 2. FIBON, a program to print Fibonacci numbers.

PROGRAM TO CHANGE VARIABLE NAMES

IN NORTH STAR BASIC PROGRAMS (RELEASE 4)

WRITTEN BY DR. D.J. YATES

BOTANY DEPARTMENT

UNIVERSITY OF QUEENSLAND

ST. LUCIA, 4067

QUEENSLAND, AUSTRALIA.

WHAT IS BASIC PROGRAM FILE NAME ?FIBON

YOU MAY: (1) Alter Variable Names

(2) Delete Blanks and 'LET'

(3) Perform both (1) and (2)

HOW MANY VARIABLE NAMES DO YOU WANT TO CHANGE ? 3

VARIABLE NO 1 = A9 TO BE REPLACED BY M

VARIABLE NO 2 = N2 TO BE REPLACED BY Z

VARIABLE NO 3 = C TO BE REPLACED BY Z

STATEMENT VARIABLE

M

A

Z

conversion of two-letter names before a program is run. It is

often simpler to enter a "foreign" program "as is" and

then alter all occurrences of the "illegal" names at one time.

This may be done with CHANGE. A danger in this program is that it

will change one variable (B1, for example) to another (B) if in-

structed to do so. However, the interpreter will not then

distinguish between the original occurrences of B and the "new"

occurrences, and the program may be ruined.

By requesting the program to change to the same name all oc-

currences of variable name X or the foreign function LEFT or

MID, CHANGE will list all occurrences of the name or function

against the line numbers in which they occur, thus simplifying

editing. Provided syntax is correct, none of the above

changes is made within quotation marks or REM statements.

Segment B of CHANGE is based on the program by L.

Steiner on NSSE 2. It allows removal of all blanks that

exist after the variable name changes are made. In addition, it

removes the nonessential reserved word LET from the pro-
The end of processing the program statements, the abbreviated program is written back to the original file. Minor modification allows the output file to be different from the input file. It is also easy to delete the optional GOTO in statements such as IF... THEN GOTO 123.

Example

Listing 2 is a program, FIBON, in its "raw" state before being processed by CHANGE. Listing 3 represents the output produced by CHANGE when FIBON is processed. Listing 4 is FIBON after being processed by CHANGE, with the altered names referred to in Listing 3. Note that names N2 and A9 in lines 10 and 80, respectively, are not changed. As indicated in Listing 3, blanks and LETs are deleted to save 39 bytes, about 11 percent of the total for the original program, which did not have excessive blanks, LETs or two-character names. Listing 5 indicates the method of finding all occurrences of the variables K9 and F in CHANGE itself, as well as changing B for A9. You can save a significant number of bytes by using the techniques described. Listing 6 represents a portion of CHANGE after being processed by itself.

Changes and Deletions

On file, and in memory, a North Star BASIC statement is stored as a string of hexadecimal numbers. The first is a character count (N) between 0 and 255. The second two numbers carry the line number. The remaining N-3 numbers are the code representing the rest of the statement. The reserved words are not stored...
Table 1. North Star BASIC reserved words and their decimal number representations.

| I | 146 | DIM | 139 | OPEN | 151 |
| + | 224 | ELSE | 180 | OR | 237 |
| * | 244 | END | 141 | PRINT | 130 |
| / | 229 | ERSET | 159 | PRINT | 130 |
| = | 231 | EXAM | 218 | PSIZE | 174 |
| <= | 244 | EXP | 15 | READ | 133 |
| => | 240 | FOR | 222 | REM | 143 |
| != | 241 | FILL | 149 | REP | 168 |
| > | 246 | FOR | 26 | RESTORE | 142 |
| >| = | 239 | GOSUB | 137 | RND | 206 |
| ABS | 236 | IF | 13 | SAVE | 170 |
| ARD | 236 | INP | 217 | SCR | 163 |
| ARC | 218 | INPUT | 134 | SIN | 203 |
| AUTO | 164 | INPUT | 134 | SIN | 203 |
| CALL | 205 | LENS | 204 | SORT | 196 |
| CAT | 175 | LET | 128 | STEP | 176 |
| CHAIN | 155 | LINE | 156 | STOP | 140 |
| CHRS | 181 | LIST | 161 | STR | 184 |
| CLOSE | 152 | LOAD | 165 | TAB | 179 |
| COST | 166 | LOG | 22 | THEN | 178 |
| COS | 220 | MEMSET | 162 | TO | 177 |
| CREATE | 156 | NEXT | 113 | TIP | 223 |
| DATA | 135 | NORMARK | 185 | VAL | 183 |
| DEF | 145 | NOT | 247 | WRITE | 153 |
| DEL | 173 | NSAVE | 169 | X | 154 |
| DESTROY | 157 | ON | 147 | Y | 154 |

as their full ASCII representations, but in an abbreviated form in which each is represented by one hex- decimal number. Most of the other alphanumeric characters signifying operators that BASIC recognizes are also stored in a coded form—not their ASCII values but values greater than 127 (See Table 1).

This saves space required to change the program. CHANGE searches for the desired first character in the variable name using its ASCII code. On finding the first character it continues to look for the rest of the name and makes the change when it finds it. If the variable in the original line is longer than the one specified, no change is made. On encountering a quotation mark or REM, CHANGE attempts no changes until after the next quotation or the end of the REM.

In the blank and LET detection routine, when a character is detected in the search, it is deleted, all “characters” are moved along one space, and the character count is reduced by one. The magnitude of line numbers per se does not influence execution time because two bytes represent the line number for all lines.

Save, Too

I bought a $29 (U.S.) software product called DOC, a valuable utility package. It is marketed by

10 FOR J=1 TO 10000
20 GOTO 30
30 NEXT J
40 STOP "END"
50 REM
60 REM
70 REM
80 REM
90 REM
100 REM
110 REM
120 REM
130 REM
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
280 REM
290 REM
300 REM
310 REM
320 REM
330 REM
340 REM
350 REM
360 REM
370 REM
380 REM
390 REM
400 REM
410 REM
420 REM
430 REM
440 REM
450 REM
460 REM
470 REM
480 REM
490 REM
500 GOTO 30

Listing 7. Programming showing processing of GOTOs.
Mini Business Systems (PO Box 15587, Salt Lake City, UT 84115) in BASIC. DOC allows you to list a BASIC program; list all variables in a BASIC program and the number of each line in which each appears; list GOTOs and GOSUBs on a "from-to" basis; and optimize programs.

Listing is done on a page basis. Page length, spacing and output device are selectable, and a title, date and page number are placed at the top of each page. The listings of the variables and GOTO/GOSUBs are useful, particularly in debugging large programs, but really are by-products of the preparation for optimization.

The optimization is a gem. In executing GOTO/GOSUBs, the North Star interpreter "starts at the top" and looks at successive line numbers until it finds the right one. The time required to execute a GOTO depends on how many lines down the program the specified line lies. If you run the program in Listing 7 and measure execution time, then repeat the process with line 20 changed to GOTO 500, you will see the significance of the search technique employed.

I ran Listing 6 in 13.9 seconds... 48 seconds when I altered line 20 to GOTO 500. The difference between the two runs was only the number of statement numbers scanned. Successively removing REMs from this program shows that the interpreter takes approximately 66 microseconds to scan a statement number. This mounts up with GOTOs and GOSUBs within loops. Anything that places the subroutines and line numbers most frequently "gone to" near the top of the program speeds up the program.

A reduction in the number of lines in a program also reduces the amount of searching required. Concatenating statements reduces the number of lines, and DOC uses this technique effectively.

In concatenating, you can remove REMs to optimize the program even further. Surprisingly, LET is not removed. DOC programs actually print the optimized program if required. Optimized programs are often barely readable and, if longer than the line-length maximum (132 characters) allowed by North Star, may not be edited or listed. Optimized programs are often much faster than their non-optimized starting point. The original copy is preserved if required.

I used DOC to optimize CHANGE. Listing 8 and 9 show portions of the output produced by DOC, and Listing 10 is what the optimized program would look like if it could be listed by the interpreter. The original program was 3274 bytes, the optimized version is 2010 bytes, a 39 percent reduction in memory requirement. When run again, the optimized CHANGE performed the same function referred to in Listings 3 and 4. Total run time was 11 minutes, 22 seconds, compared with the original run time of 13 minutes, 45 seconds, a saving of 17 percent in time.

I have three criticisms of the

<table>
<thead>
<tr>
<th>'CHANGE' - VARIABLE CHANGE</th>
<th>VARIABLE MAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40</td>
</tr>
<tr>
<td>A5</td>
<td>250</td>
</tr>
<tr>
<td>A1</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>610</td>
</tr>
<tr>
<td>A2</td>
<td>1010</td>
</tr>
<tr>
<td>A9</td>
<td>90</td>
</tr>
<tr>
<td>C</td>
<td>360</td>
</tr>
<tr>
<td>P</td>
<td>60</td>
</tr>
<tr>
<td>I</td>
<td>360</td>
</tr>
<tr>
<td>A3</td>
<td>430</td>
</tr>
<tr>
<td>A7</td>
<td>530</td>
</tr>
<tr>
<td>6</td>
<td>770</td>
</tr>
<tr>
<td>J</td>
<td>880</td>
</tr>
<tr>
<td>N</td>
<td>1160</td>
</tr>
<tr>
<td>K</td>
<td>140</td>
</tr>
<tr>
<td>N2</td>
<td>150</td>
</tr>
<tr>
<td>N3</td>
<td>20</td>
</tr>
<tr>
<td>N4</td>
<td>220</td>
</tr>
<tr>
<td>Q</td>
<td>930</td>
</tr>
<tr>
<td>R</td>
<td>160</td>
</tr>
<tr>
<td>S</td>
<td>370</td>
</tr>
<tr>
<td>T</td>
<td>180</td>
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<tr>
<td>U</td>
<td>210</td>
</tr>
<tr>
<td>V</td>
<td>380</td>
</tr>
<tr>
<td>W</td>
<td>1240</td>
</tr>
<tr>
<td>WS</td>
<td>190</td>
</tr>
<tr>
<td>Z</td>
<td>1290</td>
</tr>
</tbody>
</table>

Listing 8. The variable map produced by DOC in processing CHANGE.
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(Valid for new Members only, foreign and Canada add 15%, MC-880)
Listing 10. CHANGE after processing by DOC.

copy of DOC I received. The reserved word ERRSET was not included in its "repertoire"—not really a problem since Mini Business Systems has devised a clever way of updating DOC to cater to all new reserved words in future releases of North Star BASIC. Second, BASIC programs have to be converted to data files before being processed by DOC. This is annoying, particularly because the Release 4 of North Star BASIC used allows any file type to be accessed as a data file. The most glaring problem with the system is that it doesn't handle multiline functions properly. A program containing functions will not run if it has been optimized, but you can use a feature of DOC to prevent optimization of segments within a program. This overcomes the problem.

Overall, the DOC package is excellent. A nice bonus is a small program called GOTO-SUB, a clever routine that is an implementation of the "GOTO N" statement. It is used in part of the DOC package and could significantly improve the runtime of many BASIC programs.

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Why Do You Need Two Disks?

A good question. Here are some answers.

In the early days of computers (before Intel discovered silicon), there were no disk operating systems, or disks, for that matter. Computers of the day were monstrous and used large amounts of power and took up massive amounts of space. Some of the larger ones had nearly the power of an 8008.

The programmers of this time had to do everything on tape or punched cards. Any required operating system functions were included with their programs. The high cost of computing made this scheme impractical, although these computers were a type of personal computer.

In an attempt to recover some of the time lost when the computer changed from one user to another, the batch processing operating system was born. Users submitted their programs and data on punched cards, which were read onto a tape. When the tape became full, it was processed and the output was distributed to the users.

Improvements in hardware architecture, including the introduction of random access disk drives, allowed operating systems to become more versatile. This, in turn, allowed more effective use of the available computer power. These operating systems relied upon the disk as their primary storage device and thus became generally known as disk operating systems (DOS). Even now, most of the operating systems used on the larger computers are disk-based. However, all of this convenience and power consumes as much as 40 percent of the computer's resources.

One Small Step

With the introduction of personal computers in 1975, the industry changed irrevocably. Now the power of the computer could be allocated in a one-on-one basis economically. Evolution of the operating systems for personal computers followed that of their larger brethren. These first computers had no operating system, and the programmer had to do everything (in between RAM failures). Mercifully, the batch processing stage was bypassed, probably because keypunch machines were beyond hobbyist budgets.

When floppy disks for microcomputers were introduced, the first DOS programs began to appear. These have been written mainly by big-computer programmers determined to bring the world a better DOS. Some of these efforts have been quite remarkable, producing big-computer operating systems in miniature. This has led people to rally behind their favorite DOS, forsaking all others, and attempting to convert nonbelievers.

Shortcomings

Unfortunately, it has become the norm to evaluate new computers and disk systems by the power of their DOS. Too much emphasis has been placed on the importance of DOS. Sophisticated disk operating systems are not necessary on personal computers and are actually detrimental to them. The current crop of disk operating systems has been written by programmers for programmers to use. Users of such systems may have to read a 60-page manual (or worse, have no manual) just to use them. This may, in part, explain why the so-called "home" computer has appeared only in the homes of computer professionals.

Secondly, these systems solve problems that don't exist. One example is the area of file allocation. Most of the disk operating systems now offered have complex logic in them to allocate disk space to a program dynamically as it runs. This means that every sector of every disk will be used. The cost for this service, however, is a general slowing of disk read/write operations and making random access of disk files difficult to impossible. All of this to conserve real estate on a diskette that costs $4.50?

Disk operating systems are programs that make demands on the resources of a computer. Typical DOS memory requirements range from 8K to as much as 20K bytes of memory. This means that the user either has to restrict his memory usage or buy more memory to use a disk. Once he has his disk, he will find that the DOS wants a piece of it, too. Thirty percent or more of the system disk is used for DOS-related data, making it unavailable to the user. Thus, two drives may have to be used even though all of the data would fit on one.

A typical DOS may consist of several thousand lines of source code. In a program of this size even the best, most experienced, programmer may make a mistake. Large-computer manufacturers expect and plan for software crashes. They have support personnel available to assist the user in the recovery of his data files. A
personal computer buyer has no way of knowing about this possibility and nowhere to turn when it occurs.

**DOS Requirements**

What constitutes a good DOS for a personal computer? Several key items need to be provided:

1. It must provide for a simple means of saving and loading programs.
2. It must provide the necessary basics to access the disk in a direct (i.e., random) manner from a program written in a high-level language such as BASIC. All input and output functions should be handled by the DOS, as well as head positioning, error recovery, and error recovery.
3. It must make minimal demands on RAM memory, preferably using less than 8K. No part of the disk should be used except for the minimal amount needed to store the DOS itself.

DOS owners may wonder, "How can you do anything with such a simple DOS? You haven't even provided for a directory!" The whole point is that the application program will provide whatever DOS features it needs without bearing the overhead of a lot of features that it does not need.

For example, if a program uses all of a disk for a single inventory file, does it really need a directory of that disk? If a directory is needed, why not build it in the form most useful to the application? In this way, the least demands are made on the resources of the computer while providing the programmer with the capability to mold the operating system to best suit his application.

If the programmer can access the entire disk, then he has to do his own file allocation. He may even overwrite a file destroying the one following it! To remedy this the programmer has to plan how his files will grow and build that knowledge into the application. Isn't it better to take care of that at the time the program is written than to build a timebomb that expires with "DISK FULL IN 600"?

At first glance, it may appear that all you really have with your simple DOS is a fast cassette. Any feature of a big DOS that a user needs can be implemented in high-level language by the user. He also has full random access capability of the entire diskette. Look at a complex DOS whose threaded files prevent random access and tell me again who has the "fast cassette."

It is not my intention to downgrade any of the disk operating systems being marketed today for the personal computer hobbyist. If a big DOS is your main interest, then by all means use it. But don't make the assumption that such a DOS is essential for successfully installing an application on a personal computer.
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Microcomputing, August 1980 87
Disassembler
For the Heath H8

The DIS-8 program is self contained and should be adaptable to other 8080 and 8085 systems.

Patrick Swayne
290 Springdale
Sebastopol, CA 95472

Adapting software from one computer to another can be a challenge, especially if the software needs RAM where there isn’t any and no source listing is available. This is the problem I encountered when I decided to adapt Cromemco’s Control BASIC to my Heath H8.

Control BASIC is designed to reside in ROM starting at 344000A (A is Heath’s designation for split octal notation) and use RAM starting at 2000A. There is no problem with the high address, but Heath requires the first 8K+ of RAM in their machine, and user RAM starts at 040100A.

The obvious need to make some changes to Control BASIC prompted me to write the disassembler (see Listing 1). This program (DIS-8) occupies about 2.5K of memory space at the bottom of the H8’s user RAM area. It is self sufficient, including I/O routines, and could easily be adapted to other 8080- or 8085-based computers. (Note: The console driver was written for the H8-4 interface card. The newer H8-4 card requires different software.)

Program Operation

The output of DIS-8 resembles that of Heath’s assembler, HASL-8. Each line contains the current address in split octal, the op code that is there, the

<table>
<thead>
<tr>
<th>ENTER STARTING ADDRESS: 040 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>040.100 006 172 MVU B172G # Z</td>
</tr>
<tr>
<td>040.102 303 107 040 JMF 040107A</td>
</tr>
<tr>
<td>040.105 006 316 MVU B316G # N</td>
</tr>
<tr>
<td>040.107 076 201 MVU A201G #</td>
</tr>
<tr>
<td>040.111 323 373 OUT 373G</td>
</tr>
<tr>
<td>040.113 076 100 MVU A100G # B</td>
</tr>
<tr>
<td>040.115 323 373 OUT 373G</td>
</tr>
<tr>
<td>040.117 177 MOV A+R</td>
</tr>
<tr>
<td>040.120 170 MOV A+B</td>
</tr>
<tr>
<td>040.121 323 373 OUT 373G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENTER STARTING ADDRESS: 042 374</th>
</tr>
</thead>
<tbody>
<tr>
<td>042.074 104 MOV B+H</td>
</tr>
<tr>
<td>042.075 111 MOV C+R</td>
</tr>
<tr>
<td>042.076 123 MOV D+E</td>
</tr>
<tr>
<td>042.077 055 ECR L</td>
</tr>
<tr>
<td>042.100 070 DB 070G</td>
</tr>
<tr>
<td>042.101 054 INR L</td>
</tr>
<tr>
<td>042.102 040 DB 040G</td>
</tr>
<tr>
<td>042.103 126 MOV D+P</td>
</tr>
<tr>
<td>042.104 105 MOV B+L</td>
</tr>
<tr>
<td>042.105 122 MOV D+B</td>
</tr>
</tbody>
</table>

Listing 2. Sample run of DIS-8 disassembling parts of itself. Note program’s handling of string data. (The byte loaded into the B register in the first line had to be changed to meet the requirements of the terminal.)

<table>
<thead>
<tr>
<th>ENTER STARTING ADDRESS: 2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>2040 06 7A MVU B7AH</td>
</tr>
<tr>
<td>2042 C3 27 20 JMF 2047H</td>
</tr>
<tr>
<td>2045 06 CE MVU B+CEH</td>
</tr>
<tr>
<td>2047 3E 01 MVU A+01H</td>
</tr>
<tr>
<td>2049 D3 FB OUT FBH</td>
</tr>
<tr>
<td>204B 3E 40 MVU A+40H</td>
</tr>
<tr>
<td>204D D3 FB OUT FBH</td>
</tr>
<tr>
<td>204F 7F MOV A+R</td>
</tr>
<tr>
<td>2050 7B MOV A+B</td>
</tr>
<tr>
<td>2051 D3 FB OUT FBH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENTER STARTING ADDRESS: 2229</th>
</tr>
</thead>
<tbody>
<tr>
<td>2229 44 MOV B+H</td>
</tr>
<tr>
<td>222A 49 MOV C+R</td>
</tr>
<tr>
<td>222B 53 MOV D+E</td>
</tr>
<tr>
<td>222C 2D ECR L</td>
</tr>
<tr>
<td>222D 3B DB 3BH</td>
</tr>
<tr>
<td>222E 2C INR L</td>
</tr>
<tr>
<td>222F 50 DB 20H</td>
</tr>
<tr>
<td>2230 56 MOV D+P</td>
</tr>
<tr>
<td>2231 45 MOV B+L</td>
</tr>
<tr>
<td>2232 52 MOV D+B</td>
</tr>
</tbody>
</table>

Listing 3. DIS-8 sample run (hex version).
### ASCII to Binary Conversion Routine

<table>
<thead>
<tr>
<th>BIN</th>
<th>SU1</th>
<th>30H</th>
<th>NO CHAR &lt; '0'</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC</td>
<td>30H-47H</td>
<td>NO CHAR &gt; 'F'</td>
<td></td>
</tr>
<tr>
<td>ADI</td>
<td>6</td>
<td>A TRU FF</td>
<td></td>
</tr>
<tr>
<td>JP</td>
<td>BINO</td>
<td>YES, BRANCH</td>
<td></td>
</tr>
<tr>
<td>ADI</td>
<td>7</td>
<td>'I' TO '0' ILLEGAL</td>
<td></td>
</tr>
</tbody>
</table>

---

### Get Starting Address

<table>
<thead>
<tr>
<th>ADDR</th>
<th>LXI</th>
<th>H+O</th>
<th>CLEAR H+L</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDR</td>
<td>CALL</td>
<td>IN</td>
<td>GET ENTRY</td>
</tr>
<tr>
<td>CPI</td>
<td>CALL</td>
<td>OUT</td>
<td>ECHO</td>
</tr>
<tr>
<td>RZ</td>
<td>CALL</td>
<td>BIN</td>
<td>CONVERT TO BINARY</td>
</tr>
<tr>
<td>JC</td>
<td>ERR</td>
<td>BAD ENTRY</td>
<td></td>
</tr>
<tr>
<td>DAD</td>
<td>H</td>
<td>OVER 4 PLACES</td>
<td></td>
</tr>
<tr>
<td>DAD</td>
<td>H</td>
<td>MOVE LAST ENTRY</td>
<td></td>
</tr>
<tr>
<td>DAD</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAD</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORA</td>
<td>L</td>
<td>ADD LATEST ENTRY TO L REG</td>
<td></td>
</tr>
<tr>
<td>MOV</td>
<td>L+1</td>
<td>ADDRO</td>
<td>GET ANOTHER ENTRY</td>
</tr>
</tbody>
</table>

---

### Print Address

<table>
<thead>
<tr>
<th>PADDR</th>
<th>MOV</th>
<th>A+H</th>
<th>GET ADDR HI BYTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LXI</td>
<td>DBUFF</td>
<td>CALL</td>
<td>ASC</td>
</tr>
<tr>
<td>MOV</td>
<td>A+L</td>
<td>GET LOW BYTE</td>
<td></td>
</tr>
<tr>
<td>JMP</td>
<td>ASC</td>
<td>PRINT IT</td>
<td></td>
</tr>
</tbody>
</table>

---

### Binary to ASCII Conversion Routine

<table>
<thead>
<tr>
<th>ASC</th>
<th>PUSH</th>
<th>PSW</th>
<th>SAVE BYTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRC</td>
<td>RRC</td>
<td>RRC</td>
<td>MOVE HIGH NIBBLE</td>
</tr>
<tr>
<td>RRC</td>
<td>RRC</td>
<td>RRC</td>
<td>DOWN</td>
</tr>
<tr>
<td>ANI</td>
<td>OFH</td>
<td>CALL</td>
<td>ASC</td>
</tr>
<tr>
<td>CALL</td>
<td>ASC</td>
<td>POP</td>
<td>PSW</td>
</tr>
<tr>
<td>ANI</td>
<td>OFH</td>
<td>CALL</td>
<td>ASCI</td>
</tr>
<tr>
<td>ASCI</td>
<td>CALL</td>
<td>ASCI</td>
<td>CONVERSION ROUTINE</td>
</tr>
<tr>
<td>STAX</td>
<td>D</td>
<td>INX</td>
<td>D</td>
</tr>
</tbody>
</table>

### The Following Routine Converts A 4 Bit Value to An ASCII Character

<table>
<thead>
<tr>
<th>ASCI</th>
<th>ADI</th>
<th>90H</th>
<th>A TO F WILL CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAA</td>
<td>DAA</td>
<td>40H</td>
<td>CARRY TO BE SET</td>
</tr>
<tr>
<td>DAA</td>
<td>DAA</td>
<td></td>
<td>ADD CARRY AND</td>
</tr>
<tr>
<td>JMP</td>
<td>ADDR</td>
<td>RET</td>
<td>ADJUST</td>
</tr>
</tbody>
</table>

---

### Modifications

- **Software**
  - The H8 and its software use an octal number system, I originally wrote DIS-8 with hexadecimal input and output, as shown in the sample run in Listing 3. If you prefer the hex version, the routines labeled BIN, ADDR, PADDR and ASC must be replaced with those shown in Listing 4.

### DIS-8 Disassembler for Heath H8

- **DIS-8 (Octal Version)**
- **Add 8080 Disassembler for Heath H8 Computers**
- **Written by Patrick Swayne**
- **Revised 3-27-79**

<table>
<thead>
<tr>
<th>040.100</th>
<th>ORG</th>
<th>040100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>040.100</td>
<td>006 116</td>
<td>Mini Console Driver</td>
</tr>
<tr>
<td>040.102</td>
<td>303 107 040</td>
<td>MPU B1160 for 1 Stop Bit</td>
</tr>
<tr>
<td>040.102</td>
<td>UART</td>
<td></td>
</tr>
</tbody>
</table>

---

- **DS 55 to DS 45**: The hex version's input routine will only accept valid hex numbers, and no leading zeros are required for addresses less than 1000H.

- **With patience and a little luck**, you can decipher a machine-code program using DIS-8. I now have Control BASIC operating on a homemade ROM board in my H8.

---

The complete assembly source for DIS-8 (both versions) is available on cassette from the author for $5, in Heath's TED-8 format.
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Are you thinking about owning a personal computer but the thought of having to learn a lot of "geek" sounding words turns you off? Wish people could talk and write in plain English? Well, behold the CHORGANIZER. This book discusses just what most people expect a computer to do for them. It shows what to do to remove the drudgery from common chores. How? Through high-speed organization techniques that the very thing a computer is well suited to do. The CHORGANIZER will help you to learn how to save money, plan better, locate important facts quickly. This can lead to a better life-style for you. It will free you from laborious chores. What kind of chores, you wonder? Just to name a few, a computer can help you balance your checkbook, maintain a list of household valuables for inventory and insurance claim purposes, keep a list of monthly department store charges, record tax deductible expenses by category for income tax purposes, and mail cards, invitations or notices to friends, members of a club, business associates, etc. Using a few easy keystrokes, and a data base management program on your personal computer and your time can be spent on life's pleasures instead of day-to-day chores.

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<table>
<thead>
<tr>
<th>Amt.</th>
<th>City/State</th>
<th>Zip Code</th>
<th>Card No.</th>
<th>Bank No.</th>
<th>Signature</th>
<th>Name (print)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Reader Service index—page 241

Microcomputing, August 1980 95
Series on enhancing the PET's capabilities continues with a description of joystick interfacing.

Many games and interactive computer programs can become more pleasant and efficient to use with the addition of joysticks. For complex, high-performance computers, a full range of freedom in joysticks is appropriate; but for home computers, joysticks have four switches that move the cursor in four directions. These joysticks often do not provide a method to directly control the cursor in the diagonal direction.

Hardware

You can readily implement professional joysticks that control the cursor in a diagonal direction with the addition of four 100k Ohm potentiometers (Photo 1). These are readily available through many of the electronic magazine advertisers at approximately $5 each.

You need a simple 3 x 4 inch printed circuit board to interface the joysticks via the "Expander" (June 1980, p. 58) to the computer I/O port. Fig. 1 presents the full-size pattern of the printed circuit board. If the joysticks are wired as indicated in Fig. 2, the resistances in Table 1 will be observed at the four potentiometers of the joysticks.

The PET I/O port, when programmed for input, will essentially ignore a 100k Ohm input and remain high (1). If the input is grounded, then the I/O port will recognize this as a 0. Consequently, peeking the input port will result in the decimal values shown in Table 2.

The joysticks can be housed in any case of appropriate size. I chose to use a 5 x 3 x 2 inch aluminum box. Photo 2 shows the completed joysticks. The switch on the box is used as a "FIRE" button, useful for many games. Fig. 2 illustrates how these switches are tied into the joystick system. Essentially, when depressed, the switch brings all four inputs to the computer to ground (binary 0000 left, 0000 right or decimal 0 left, 0 right). Any program using joysticks as inputs and requiring a "FIRE" in-

Fig. 1. Printed circuit board (full size).
dication would simply test for these values.

Software

Having completed the joysticks, you are now ready to enter Listing 1, which contains a simple BASIC program to maneuver two cursors across the screen and a children's game, called "YOU'RE IT." Although the program listing is self-docu-

<table>
<thead>
<tr>
<th>Position (in degrees)</th>
<th>Resistance Potentiometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>45</td>
<td>100k</td>
</tr>
<tr>
<td>90</td>
<td>100k</td>
</tr>
<tr>
<td>135</td>
<td>0</td>
</tr>
<tr>
<td>180</td>
<td>0</td>
</tr>
<tr>
<td>225</td>
<td>0</td>
</tr>
<tr>
<td>270</td>
<td>0</td>
</tr>
<tr>
<td>315</td>
<td>0</td>
</tr>
<tr>
<td>100k</td>
<td>100k</td>
</tr>
<tr>
<td>100k</td>
<td>100k</td>
</tr>
<tr>
<td>100k</td>
<td>100k</td>
</tr>
</tbody>
</table>

Table 1.

<table>
<thead>
<tr>
<th>Position (degrees)</th>
<th>Left Joystick</th>
<th>Right Joystick</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>224</td>
<td>14</td>
</tr>
<tr>
<td>45</td>
<td>96</td>
<td>6</td>
</tr>
<tr>
<td>90</td>
<td>112</td>
<td>7</td>
</tr>
<tr>
<td>135</td>
<td>48</td>
<td>3</td>
</tr>
<tr>
<td>180</td>
<td>176</td>
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<tr>
<td>225</td>
<td>144</td>
<td>9</td>
</tr>
<tr>
<td>270</td>
<td>208</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 2.

2 — Joysticks w/four potentiometers
1 — 6 foot DIN cable. Cut in half.
D1-D4 = 1N914
S1,S2 = N.O. MOM contact switch
Misc. — Hardware, Aluminum Box, Wire

Table 3. Parts list.

1030 look the same. If different-looking cursors are required, different values must be poked to screen memory; a solid white cursor is screen value 160. To speed up cursor movement, the programs must be written in machine language. Additionally, the "FIRE" switch in this case could be used to change the speed of cursor movement.

Conclusion

A joystick is invaluable for serious interactive computer work. The joystick controller in this article is more intricate than the video game joysticks, but less complex than those used on expensive computers. They are versatile and low in cost. The simple BASIC program presented in this article illustrates the simplest method to control the cursors via joysticks; the game, although very basic, provides hours of enjoyment for children.

Listing 1. Program for the joystick.

```
5 REM *** JOYSTICK ROUTINE ***
6 PRINT "L"
10 REM **OPEN USER PORT FOR READ**
20 POKE 59459, 0
30 REM **INITIALIZE CURSORS**
40 XL=8:YL=0:XR=39:YR=24
50 GOSUB 1000
60 REM **LOOK AT LEFT JOYSTICK**
70 A=PEEK(59471) AND 240
80 REM **DETERMINE POSITION**
90 GOSUB 2000
100 XL=XL+x:Y=YL+Y
110 REM **WRAP AROUND**
120 GOSUB 3000
130 REM **LOOK AT RIGHT JOYSTICK**
140 A=PEEK(59471) AND 15
150 REM **DETERMINE POSITION**
160 GOSUB 2000
170 XR=XR+x:YR=FR+Y
180 REM **WRAP AROUND**
190 GOSUB 4000
200 REM **DISPLAY CURSORS**
205 POKE Z,32:POKE Z1,32
210 GOSUB 1000
220 REM **GAME**
230 GOSUB 5000
240 GOTO 70
250 END
```

Photo 1. Potentiometers used in the PET joystick.

Photo 2. Completed joystick.

Fig. 3.

Fig. 2. Wiring the joystick.
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3000 REM *** WRAP AROUND ***
3810 IF XL>39 THEN XL=39
3820 IF XL<0 THEN XL=0
3830 IF YL>24 THEN YL=24
3840 IF YL<0 THEN YL=0
3850 RETURN
4000 REM *** WRAP AROUND ***
4810 IF XR>39 THEN XR=39
4820 IF XR<0 THEN XR=0
4830 IF YR>24 THEN YR=24
4840 IF YR<0 THEN YR=0
4850 RETURN

Listing 2. Program modification.
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Slaying the 80-Column Dragon

The author/knight-errant searches this fair land and finds not one, but three honest manufacturers of 80-column boards for the Apple II.

Michael S. Tomczyk
418 Arguello Blvd., Suite 2
San Francisco, CA 94118

It's been said for a long time that whoever came up with an 80-column board for the Apple II would be a hero. During the fast few months, several groups of heroes have slain the 80-column dragon, and the implications for Apple II users are enormous.

There are three boards currently available, and more are on the horizon. First on the scene was Sup'R'Terminal from M&R Enterprises, followed closely by Doublevision from Computer Stop and Videoterm from Videx.

After using all three boards and meeting the various dragon-slayers, I still don't know which board is best. All three boards are more or less comparably priced ($295-$395), convert the Apple II display to 80 columns upper/lowercase, work with Pascal and the Apple BASICS and have different drawbacks, advantages and trade-offs.

Before the advent of these boards, you were confined to 40-column, uppercase displays on your Apple video monitor. But the standard typewriter page is 80 columns across, so how could you do word processing? How could you use Pascal, which is formatted for 80 columns? How could you access advanced time-sharing programs, all geared to 80 columns?

It was possible to do these functions, but with great difficulty. For example, you could print out 80 columns of upper/lowercase information, but you could only view 40 columns on your monitor. The new 80-column boards solve the problem, each in a slightly different way. To help sort out the differences between the boards, I've included a chart (see Table 1) showing their comparative features.

One of the best features of these plug-in boards is their compatibility with Pascal. You can now take full advantage of this versatile high-level language in the 80-column format it was originally intended for.

However, you have to use a video monitor—not a television set—to display the characters because with 80 columns you have to use smaller characters, which don't display well on a coarse-resolution television screen. If you use your Apple with a television set, you have to buy a separate black and white video monitor to display 80 columns. Also, you can't use any of the 80-column boards with Apple's hi-res graphics or color.

Sup'R'Terminal

The largest of the three boards, the Sup'R'Terminal from M&R Enterprises, includes the most firmware and the most special features. The character set is excellent, with true descenders, and there are two ingenious adjustments on the board which fine-tune the monitor display. The video balance circuit (VBC) tones down the horizontal portions of individual letters (such as the top of the letter T) that are normally displayed much brighter than the ver-
Sup'RTerminal and Doublevision are two computer stop alternatives. Doublevision also includes VIC text graphics and most applications allow VIC monitor connection. However, the power supply isn't provided with Doublevision.

Apple II also has a power problem that is not tied to any one board or group of boards. You run the risk of overtaxing the power supply because the total power drain of all the boards is likely to be greater than the specifications set down by Apple. There are several combinations of plug-in boards and peripherals that can cause this problem, but, unfortunately, not all boards reveal how much power they use, so it's hard to determine whether the limit has been approached. The best interim solution is to use plug-in boards to replace those that are filled in a fully configured system.

Doublevision
Doublevision from Computer Stop differs
Doublevisor is the least expensive of the three boards ($295) and provides excellent 80-column power at the lower end of the kilobuck range.

**Videoterm**

Like Doublevisor, Videoterm by Videx created a lot of excitement when it was introduced at the Computer Faire. It offers the most technically well-documented manual of all the boards, although it seems a trifle weak in the explanation and use of board functions.

Because of the unique full-screen character set format, the display tends to spill off the screen around the edges and requires you to adjust the horizontal and vertical screen size controls, which are located inside most monitors. Videx claims their board works best with the Leedex monitor.

Videoterm also has an inexpensive ($12) switchplate, which enables you to access either the Apple 40-column display or the Videoterm 80-column display on the same monitor simply by flicking a switch. For example, you can go back to the Apple display system for graphics without having to unplug the monitor from the board and plug it back into the Apple, which you have to do with Sup'R'Terminal and Doublevisor.

By using a character set EPROM, you can define your own character sets or graphics, although you need an EPROM programmer to do this. Videotex conveniently sells a variety of predefined EPROMs that you can use to change fonts simply by substituting the EPROM chip.

Videotex also has a pre-defined graphics set built into the system. The set essentially lets you do the line-drawing and is especially helpful if you want to create business forms or graphs. The documentation showing how to use this feature is clever.

The major drawback of the Videotex board is its awkward shift command. The other boards provide a single-letter shift key that automatically shifts back down after execution. Every time you capitalize a single letter with Videoterm, you must type a command to get into the uppercase mode, then type another command to go to lowercase. However, Videotex is already solving this problem with a new product: a PC board you substitute for one of the IC chips to convert the "old" Apple keyboard to the "new" keyboard. It turns the shift key into a normal shift key and provides a CTRL RESET function, with no special hardware modification. It can be used to convert any Apple.

With the other boards, you need a one-wire modification to convert the shift key to...
a normal shift key used in ordinary typing. Sup’R’Terminal shows you how to make this modification in their manual, although this mod will void your warranty. I suggest making this modification if you buy a Sup’R’Terminal or Doublevision, especially if you do a lot of word processing.

On the Horizon

Another 80-column Apple board I did not include in Table 1 was developed by Chuck Mauro, a 21-year-old Apple computer engineer who developed the board in his spare time and has recently started production. The board uses Synertek’s new 6545 chip, which provides a little extra capacity and allows for some extra features, such as medium resolution (160 x 72 lines) vector graphics, which may be used simultaneously with text (in black and white). This asynchronous board provides normal functioning tabs and has an inverse mode and keyboard-controlled monitor switching (like Videoterm’s switchplate, only you control from the keyboard).

Chuck’s board, tentatively priced at $360, will be sold through Apple dealerships under the corporate name “Sum Apple Software.”

Outlook for 80-Column Boards

It’s obvious that the makers of these boards will be successful, because most Apple users want 80 columns and the special features described above. However, the market for these boards is not infinite. Apple III will definitely provide an 80-column format. Thus, while Apple IIs may continue to be sold, the market for 80-column boards will start falling off next year.

This means that the entrepreneur-engineer-inventors who are lauded today as mighty dragon-slayers will have to stay even more dragons early next year to keep going. Most of the board designers I talked to are already working on new products, so keep an eye on these companies to see what happens.

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<table>
<thead>
<tr>
<th>TYPE</th>
<th>FILE SIZE</th>
<th>SORT TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Bytes)</td>
<td>(Sec)</td>
<td>(Sec)</td>
</tr>
<tr>
<td>SORT</td>
<td>8K/31</td>
<td>140K/250</td>
</tr>
<tr>
<td>SORT</td>
<td>16K/51</td>
<td>280K/286</td>
</tr>
<tr>
<td>SORT</td>
<td>32K/97</td>
<td>560K/256</td>
</tr>
<tr>
<td>SORT</td>
<td>64K/261</td>
<td>800K/225</td>
</tr>
<tr>
<td>MERGE</td>
<td>80K/445</td>
<td>1275/t56</td>
</tr>
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Microcomputing, August 1980 105

Please note: Reader Service index—page 241
Graphics Character Generator

You can mix text and graphics anywhere on your Apple II screen with this CHAR-GRAF program.

Robin B. Moore
Warner Hill Rd., RFD #5
Derry, NH 03038

One of the nicest features of the Apple II computer is its high-resolution bit-mapped graphics display mode. It can be used for graphs, plots, digitized photographs or colorful, arcade-quality video games. Its only significant limitation is its inability to fully mix text and graphics.

Normally, text is assigned only to the bottom four lines of the screen in the hi-res graphics mode. This is not hard to live with, but it would be nice to mix text and graphics anywhere on the screen. Another improvement is the addition of lowercase and user-definable characters.

These two minor changes would create a machine with video display flexibility unmatched in the current personal computer market. There is nothing to prevent the Apple from displaying text on the hi-res screen. It simply isn’t programmed to do so!

The Program

CHAR-GRAF is a package of assembly-language software that will allow you to add the following features to your Apple II:

- Fully mixed text and graphics in hi-res mode.
- Lowercase and uppercase characters.
- User-definable scientific and game characters.
- Multiple resident character sets.
- An invert the hi-res screen function.

These can be added without hardware changes. It will take a little time to type all the code into your Apple, but you will only have to do it once.

I designed CHAR-GRAF to be as compatible with existing Apple software as possible. It resides in lower memory along with the Apple II hi-res graphics routines that are provided by Apple as the first part of the hi-res demo tape. Its operation requires the presence of these routines. (If you are using the routines in the Programmer’s Aid #1 ROM, also from Apple, CHAR-GRAF will require only minor changes.)

Printing text onto the hi-res screen with CHAR-GRAF is accomplished using normal PRINT statements. Text is displayed in the same 5 x 7 dot matrix format that is normally used by the Apple and will appear on the screen in its normal positions. VTABs and TABs will work as they normally do, as will user-defined scrolling windows.

In its present implementation, CHAR-GRAF will not scroll the hi-res screen, nor will it exhibit any response to the normally used screen clearing functions.

Listing 1. Assembler source code for the CHAR-GRAF routines.
This listing was created using the Microproducts assembler for the Apple II (which I have since abandoned, for many reasons). Base page symbols are shown preceded by an *.

0010 * TITLE CHAR-GRAF V1.3 *
0020 * ******************************************* *
0030 * CHAR-GRAF V1.3 *
0040 * ******************************************* *
0050 *
0060 * SOFT CHARACTER GENERATOR *
0070 * ROUTINES FOR THE APPLE II *
0080 *
0090 * LINKS TO BASIC VIA CWARE.H *
0100 * FOR AUTO ARGUMENT PASSING *
0110 *
0120 * COPYRIGHT 3/1/1979 BY *
0130 *
0132 * ROBIN B. MOORE *
0133 * WARNER HILL Rd. RFD # 5 *
0134 *
0135 *
0140 * ALL COMMERCIAL RIGHTS *
0142 *
0150 *
0160 *
0170 *
0180 *
0190 * LOCATION EQUATES *

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0200 *
0210 *
0215 DEC16 DEC01C SHAPEFILL COLOR
0220 TPL0 DEC01E TABLE PTR L
0230 TPH0 DEC01F TABLE PTR H
0240 WINDOW0 DEC021 WINDOW WIDTH
0250 CH0 DEC024 CURSOR HORIZ
0260 GESL0 DEC026 HIRES BASE ADDL
0270 GESH0 DEC027 HIRES BASE ADDH
0280 BASEL0 DEC028 TEXT BASE ADDL
0290 BASEH0 DEC029 TEXT BASE ADDH
0300 IFLG0 DEC032 INVERSE FLAG
0310 CSAD0 DEC036 CONSOLE PTR LO
0320 CSADH DEC037 CONSOLE PTR HI
0322 AIL DEC030 ADD PTR LO
0324 AIM DEC032 HI
0330 XAV DEC045 SAVED X-REG
0340 YSAV DEC046 SAVED Y-REG
0350 CS4V DEC047 SAVED CHAR CODE
0360 SFLO DEC048 SCREEN FREE FLAG
0370 MDCL DEC052 PLOT/LINE COLOR
0370 PAGE DEC052 HIRES PG 20/40
0380 TABL DEC053 TABLE BASE ADDL
0390 TAH0 DEC051 TABLE BASE ADDH
0400 COUT DEC120 APPLE OUTPUT
0410 *
0420 *
0426 * LINK IN AND INITIALIZE *
0440 * IN BASIC CALL 2040 *
0450 *
0460 *
0470 LINK FH *
0480 LDA 05 SETUP CWARE.H
0490 STA CSADH TO LINK THRU
0500 LDA 06 CGRAF ROUTINES
0510 STA CSAD disabling...
which must be accomplished manually through the use of TABs, VTABs and the hi-res screen clear functions. Limited areas may also be cleared by simply moving the cursor to the desired position and printing blanks.

These limitations are unfortunate, but after my experience writing the demo program and the Character Set Editor, I’ve found that they are not difficult to deal with. It is also easy to simulate the Apple’s normal flashing cursor in hi-res mode.

In part payment for the missing scroll and screen clear functions, I’ve added a few new ones. With a CALL to INVSRCR (2187), you can inverse-video the entire hi-res screen and also complement the current text mode and hi-res color. A CALL to STROKEOVER (2180) will set CHAR-GRAF into strokeover mode, causing its output to be ORed to the screen instead of overwriting as it normally would.

Also, I have added a pseudo-CHAR$ function. If you POKE an ASCII character code + 128 into CHARLOC (71) and then CALL CHARDRAW (2172), the equivalent character will be printed at the current cursor position.

**How CHAR-GRAF Works**

Whenever text is output by the Apple, control is passed to the output routine whose address is stored in two base-page locations called CWSL and CSWH ($36,$37). Normally, this is the video output routine in the monitor ROMs. When CHAR-GRAF IS in use, these pointers are changed to point to the entry address of its text output section. This is done easily from BASIC with a CALL LINK (2048).

The CWSL, CSWH pointers may be reset to their normal values with a PRM# command, which will turn off CHAR-GRAF. You will need to do a TEXT command to take the Apple out of hi-res mode if you wish to see any further text output.

To allow CHAR-GRAF to use a number of different character sets at once, there is another pointer set, TL and TH ($B1,$B7). These point to the beginning of the character set currently in use.

Changing character sets is done by changing these pointer
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- Compatible with all logic families 4-15 VDC • 10 Nsec. pulse response
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- Open circuit detection • Automatic resetting memory
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<td>POWER CORD, Alligator Clips</td>
<td>$4.95</td>
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The 512-byte standard character set. Enter using the Apple
monitor. Actually, this set is not quite standard because
code 223 is changed to an Apple
character.

Listing 3. Hex dump of the
512-byte standard character
set. Enter using the Apple
monitor. Actually, this set is not quite standard because
code 223 is changed to an Apple
character.

Listing 4. Hex dump of the
512-byte lowercase special
character set. The special
characters include a mix of
game, utility and scientific/math characters. Enter
using the Apple monitor.

Character Set Format
Characters on the Apple II
are normally displayed as a
5 × 7 dot matrix within a
7 × 8 dot cell. There are 40
columns horizontally and 24 vertically, corresponding to
a 280-dot horizontal by 192-dot
vertical matrix. Coincidently,
"this is the exact format of the
hi-res screen, so it is easy for us
to emulate normal text opera-
tion.
Within the character sets
used by CHAR-GRAF, each
character is represented by
a group of eight bytes. Each byte
conforms to one row of dots
in the character cell. For each
character, the first byte repre-
sents the top row of dots in
the cell, and the seven following
bytes represent the second
through eighth rows. Within
each byte, bits 0–6 are mapped
onto the screen as dots from left
to right (see Fig. 1).

Character sets may contain
from one to 96 characters. The first
character in any set will be
interpreted as a space; follow-
ing characters will be inter-
preted in ascending ASCII
order. (The first character in
each set should be a blank
because it is used by CHAR-
GRAF to clear the rest of
the line when a return code is
received.)

Creating a character set by
hand is awkward at best. How-
ever, the Character Set Editor
program will allow you to
create new character sets or
edit existing ones with the
Apple doing most of the work.

Getting CHAR-GRAF to Run
Type in the contents of
Listing 3, check the contents of
the last few locations and save
the data on a tape using the
Apple monitor. The same
should be done for Listing 4 with
a separate tape. These two tapes
may hold the versions of the
standard 64-character set and
the 64-character lowercase,
scientific and game character
set.

Next, you should type in the
hex contents of Listing 2, check your
results with the Apple's
disassembler and save the data
on another section of tape.
These are the actual CHAR-
GRAF routines.

Now, load the Apple II hi-res
graphics routines into memory
at location $C00 as shown
on the front of your hi-res demo
cassette. The entire package
of character sets and routines
may now be saved to another
section of tape with an 8 .
11FFW command. This creates
an initial CHAR-GRAF package
tape. The other tapes are
backup, so that you can easily
correct individual parts of the

![Fig. 1. Within a character set, each character is represented by a
block of eight bytes, corresponding to the rows of dots in the
character. Note that bit 0 represents the leftmost dot in a row, and
bit 6 represents the rightmost. The location of the first byte in the set
for a given character is: set start location + 8 × (character
code—160).](image-url)
package.

Enter the contents of the demo program, load the CHAR- GRAF package tape and RUN the demo. If it runs properly, you're in good shape because it exercises all of the CHARGRAF functions. If not, at least you can have each section on a separate section of tape.

If there are mistakes in the CHARGRAF routines or the demo program, you will have to correct them now. Mistakes in the character sets will be easier to correct later after the Editor program is running.

Implementation

The STRIKEOVER function may be changed to an EXCLU- SIVE-OR function by changing location $86D from $01 to $51. This can be done from BASIC with a POKE 2157,1, and changed back with a POKE 2157,1. (Be careful! You are actually modifying the CHARGRAF code.)

To use CHARGRAF with hi-res routines in Apple's Programmer's Aid #1 ROM, you must make the changes in the box below to CHARGRAF.

The June '79 issue of CALL

A.P.P.L.E. contains a machine-language linker program by Andy Hertzfeld that appears to be the best available way of attaching machine-language rou- tines to an Apple Integer BASIC program. I use this routine to save the CHARGRAF package along with the BASIC program using it.

Note that CHARGRAF uses the same screen pointer loca- tions used by the Apple hi-res routines. This means that after using CHARGRAF to print some text, the hi-res position will be left somewhere in the bottom row of the last character printed, and the old position will be forgotten.

The Demo Program

The demo program, written in BASIC, demonstrates all of the current CHARGRAF functions. It requires the Apple hi-res graphics routines and both character sets to be resident in memory with it. Notice that most of the PEEK, POKE and CALL locations are assigned as values to descriptive variable names. This allows the use of such statements as:

CALL STRIKEOVER and POKE XL0,5
rather than
CALL 2180 and POKE 800,5

This nice feature of Apple's BASIC allows programs to be more self-documenting than usual and easier to write. Useful routines in the demo program are found at lines 360, 450 and 570. Comments are included.

Character Set Editor

The Character Set Editor pro- gram was a result born of my frustration with creating char- acter sets by hand. I had invari- ably made mistakes—either typos, dropped bytes on input or, in one case, a set completely transposed left to right. (I wrote a short program to correct that one!)

I decided to write the editor to do as much work as possible for me. It took much longer to write than it took to write CHARGRAF in the first place, but the time spent was worth it. I could now create a whole new character set in about a half hour with no errors.

Editor Description

The editor is designed to allow the user to manipulate character sets in variety of ways. Its capabilities include:

- Storage and retrieval of character sets from tape or disk
- Editing existing character sets
- Creating new character sets
- Displaying character sets
- Creating CHARGRAF pack- ages on tape with one or two character sets included

The editor is currently de- signed to handle sets of up to 64 characters. However, larger sets are easy to create in sections,
Listing 5. CHAR-GRAF demo program, which creates screen display using both character sets and exercises all of the CHAR-GRAF functions. It also serves as an example of ways to use CHAR-GRAF.

0 REM ***********************************************
10 REM * COPYRIGHT 1979 *
20 REM * R B MOORE *
30 REM * ALL COMMERCIAL RIGHTS *
40 REM * RESERVED *
50 REM ***********************************************
85 GOSUB 580: REM **SET LDREM:4600
data
90 GOSUB 500: REM ** INIT PROG
95 REM
100 REM ** DO DEMO **
105 REM
110 CALL INIT: POKE -16302,0: CALL NONINV: CALL HOME: CALL LINK:
115 REM 2. PRINT "CHAR-GRAF": T*="GRAPHICS": GOSUB 450: T*="GENERATOR "
120 REM GOSUB 450: T*="TEXT AND": GOSUB 450
125 REM
130 REM ** DRAW LINE UNDER TITLE **
135 REM
140 REM POKE HY,9: POKE XHI,0: POKE XLO,7: CALL POSN: POKE XHI,1: POKE XLO,17: CALL LINE
145 REM
150 REM ** UNDERLINE TITLES **
155 REM
160 REM POKE XHI,0: POKE XLO,0: POKE HY,24: CALL POSN: POKE XLO,69: CALL LINE
165 REM
170 REM ** DRAW INVERSE VIDEO **
175 REM
180 REM CALL INV: VTAB 14: TAB 30: PRINT "INVERSE ": VTAB 15: TAB 30
185 REM
190 REM CALL PRINT "INVERT " : VTAB 16: TAB 30: PRINT " ":
195 REM
200 REM VTAB 17: TAB 30: GOSUB 470: CALL NONINV
205 REM
210 REM ** SHOW USER CHARACTERS **
215 REM
220 REM GOSUB 450: T*="USER": GOSUB 450: TAB 9: TAB 30: T*="DEFINED": GOSUB 450
225 REM
230 REM POKE HY,121: CALL POSN: POKE XLO,0: CALL LINE
235 REM
240 REM ** OVERSTRIKE DEMO **
245 REM
250 REM POKE HY,121: CALL POSN: POKE XLO,0: CALL LINE
255 REM
260 REM ** UNDERLINE TITLES **
265 REM
270 REM CALL INV: VTAB 14: TAB 30: PRINT "INVERSE ": VTAB 15: TAB 30
275 REM
280 REM CALL PRINT "INVERT ": VTAB 16: TAB 30: PRINT " ":
285 REM
290 REM VTAB 17: TAB 30: GOSUB 470: CALL NONINV
295 REM
300 REM ** SHOW USER CHARACTERS **
305 REM
310 REM GOSUB 450: T*="USER": GOSUB 450: TAB 9: TAB 30: T*="DEFINED": GOSUB 450
315 REM
320 REM TAB 10: TAB 30: T*="CHARS": GOSUB 450: PRINT ":": VTAB 12: TAB 31
325 REM
330 REM ** PRINT "CHARGRAF" **
335 REM
340 REM VTAB 4: TAB 30: T*="OVERSTRIKE": GOSUB 450: VTAB 5: TAB 30: T*="MODE"
345 REM GOSUB 450: PRINT ":":
350 REM
355 REM ** PRINT "COPYRIGHT" **
360 REM
365 REM FOR I=0 TO 3: PRINT "COPYRIGHT **
370 REM NEXT I
380 REM
385 REM ** PRINT "CHAR-GRAF EDITOR" **
390 REM
395 REM ** PRINT "DO PICTURE" **
400 REM
405 REM ** PRINT "Move cursor left **
410 REM
415 REM ** PRINT "Normal mode \"":":
420 REM
425 REM ** PRINT "Mode \"":
430 REM
435 REM ** PRINT "Wait for Keystroke **
440 REM
445 REM ** PRINT "Press any Key \...\":": V\=0
450 REM IF POKE \(-16304\)<128 THEN 145: POKE \-16366,0: IF K\=1 THEN 449: FOR I=1 TO 11
455 REM CALL INVSRCR: PRINT ":": FOR J=1 TO 100: NEXT J: K=1: GOTO 445
460 REM CALL INVSRCR: FOR J=1 TO 500: NEXT J: TEXT: CALL HOME: PRM=0: END
465 REM
470 REM ** PRINT "1st Character Set **
475 REM
480 REM FOR I=0 TO 7: FOR J=0 TO 7: POKE CHARLOC,160+I*8+J
485 REM CALL CHARDRAW: NEXT J: IF I>7 THEN VTAB 1 PEEK (37)+2: TAB PEEK (56)-7: NEXT I: RETURN
490 REM
495 REM ** SETUP AND DIMS **
500 REM
505 REM
510 REM TL=016: TH=017: PO1=32: PO2=64: CHARLOC=1: CHARDRAW=2172: STRIKEOVER=2160: INVSRCR=2197

Using the Editor

After the editor is typed in and saved on tape, reload the CHAR-GRAF package and then RUN the editor. A menu of the various editor options should appear: An explanation of each option follows:

1. Edit/Create character set.
The EDIT/CREATE mode allows you to create or modify character sets by moving a cursor around an enlarged 7 x 8 dot grid. When the option is selected, the Apple is put into hires mode and a titled menu of the character set in the user area is displayed along with the edit box and a list of edit commands. To start, you must enter the code of the first character that you wish to edit. A small box will appear around that character in the map, and an enlarged version of the character will appear in the edit box. The available edit commands are as follows:

<-- Move cursor left
- -> Move cursor right
RETURN Move cursor down
I Move cursor up
D Change state of current dot
N Done, go to next character
P Done, go to previous character
C Clear grid in edit box
A Done, accept new code
R Restart edit of this character
M Done, go back to menu

When you are done with a particular character, the contents Which may be appended using the monitor's Block Move command.

All character manipulations are done to the set residing in the defined user area $1000 to $11FF (4096 to 4607). This 512-byte section of memory can contain up to 64 eight-byte characters. Character sets within the user area may be edited, copied to tape or disk or used to replace the standard set located at $900-$AFF (2304-2815). The user area may also be loaded from tape, disk or with a copy of the existing standard set.
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of the edit box are transferred back into the character set if the character has been altered. If you change your mind about an edit, press R before exiting the character. This restores the original character and nullifies any changes that you may have made. When you are through, press M to return to the editor menu.

2. Load character set. Character sets may be loaded from tape or disk. When loading from disk, the editor will automatically do a disk CATALOG and then ask for the filename. Make sure that the file you select is a character set; otherwise, the program may be destroyed. After the filename is supplied, the program will ask if you wish to load into the user area or replace the standard set. Reply by pressing S or U. Loading from tape loads into the user area only.

3. Save character set. The set in the user area may be saved to tape or disk. If the disk option is selected, the program will ask for a filename before saving to disk.

4. Create CHAR-GRAF package. This option creates a package tape that may be used with one of your programs. The package includes CHAR-GRAF, the standard set, the Apple hi-res routines and, optionally, the user set.

5. Display hi-res character sets. Draws the character set map and alternately displays the standard set and the user set when a key is pressed. Pressing RETURN will set you back to the menu.

7. Std set → user set. These two options copy one set to the other. Note that this is a copy, not a swap! After using either option, you will have the same character set in both places.
8. Exit program. This unlinks CHAR-GRAF and ends the program. The package of routines and character sets is not affected, and LOMEM is left set at 4608. The program may be restarted again with the same sets.

General Comments

In Apple Computer’s User Contributed Software, vols. 3 & 5, there is a character generator program that uses a 128-character set and an Applesoft II demo program to go with it. Coincidentally, the character format is exactly the one I used. This means that you can use the Character Set Editor with that program also.

Some manipulation of partial sets will be required to use the 128-character sets, but it’s not difficult. Also, that set is easy to divide into two parts to use with CHAR-GRAF.

The Character Set Editor occupies approximately 7.5K bytes and requires at least 36K of memory if used with a disk system or 24K in a tape-based system. Removing all of the REM statements from the program will reduce it to about 5.6K. It could be reduced further by combining short lines and shortening the printed messages.

Possible Uses for CHAR-GRAF

In addition to the obvious uses titling plots and graphs, there are many other possibilities. A friend of mine has used CHAR-GRAF to create an I.Q. Test program that uses shape and figure analogies drawn on the hi-res screen along with the text. You could use CHAR-GRAF to create chessmen out of four or nine characters each and PRINT them onto a chessboard using the exclusive-OR mode described earlier. White pieces could be PRINTed normally, and black pieces could be in inverse-video mode.

A set of playing card characters could be created to add realism to card games such as poker or blackjack (see Bill Depew’s Apple 21, from Softape, Inc., using the Screen Machine). For hi-res graphics games you could design ships, planes, tanks or the fighters in various rotations. These could be placed on the screen with PRINT statements (and erased with another print if the exclusive-OR mode is used). Programs for the PET computer could be directly converted to the Apple by creating a “PET SET.”

Other Alternatives

In recent months, several alternative methods of hi-res character generation have emerged from various Apple after-market suppliers: the Screen Machine ($19.95), Softape, Inc.; the Superchip (ROM) ($94.95) and Editor ($19.95), Eclectic Enterprises, Inc.; and the ROMPLUS + (board) ($169), Mountain Hardware, Inc.

For those of you who just want lowercase, there are several lowercase adapters that retail in the $50 range in local computer stores.

---EDIT CMDs---

Fig. 4. Editor program edit-mode display. When character is edited, an enlarged version appears within the edit box. Dots in the character are indicated, appropriately, by little apples.
Listing 6. Character Set Editor program, which allows you to create and edit your own character sets with the Apple doing most of the work for you. It requires a 24K system (or 36K, if you have a disk).

```
10 REM ***********************
20 REM * COPYRIGHT 1979
30 REM * R B Moore
40 REM *
50 REM ***********************
60 REM * ALL COMMERCIAL RIGHTS
70 REM * RESERVED
80 REM *
90 REM ***********************
100 REM INIT LOMEMS/VALENCIA880 MENU
110 GOSUB 1920: GOSUB 1660: GOTO 1790
120 REM
130 REM PEEK EDIT GRID TO CHAR SET
140 REM
150 IF FLK=0 THEN RETURN
160 FOR I=0 TO 7: K=0: FOR J=6 TO 0 STEP -1: VLET=A+2: HL=A+3: GOSUB 220: NEXT J: POKE 4096+1+CCHAR*8: KX=I: NEXT I: RETURN
170 POKE Th.16: GOSUB 750: POKE Th.9: RETURN
180 REM
190 REM
200 REM PICKUP FROM SCREEN
210 REM
220 VTAB VL=CHAR= PEK (40)+ PEK (41)+256+HL-1: RETURN
230 REM
240 REM CURRENT CHAR TO EDIT GRID
250 REM
260 CALL LING: GOSUB 620: POKE CHARLOC.223: FOR I=1 TO 7
270 J=PEEK (4096+1+CCHAR*8): L=64
280 IF J=127 THEN:
290 FOR K=6 TO 0 STEP -1: IF X=I THEN 310: NEXT K: RETURN
300 J=-J: VTAB (1:2): TAB (30+K): CALL CHADRAW
310 L=I:2: NEXT K: RETURN
320 REM
330 REM PSEUDO-CURSOR AND KEY INPUT
340 REM CALL WITH VL=0:23: HL=(0-59)
350 REM RETURNS KEYSTROKE IN "KEY"
360 REM
370 CALL FLASH=0: GOSUB 220: POKE CHARLOC:CHAR=0
380 X=I=(I+1) MOD 6: IF I=0 THEN FLASH=I:FLASH=FO.56+192:FLASH: VTAB VL: TAB HL:CALL CHADRAW
400 REM
410 REM *** SETUP CHAR SET MAP ***
420 REM
430 REM INIT: PRINT: HCOL.255: FOR I=1 TO 8: POKE XLO.3: POKE XHI.0: POKE HY.(3;=I): CALL POSN
450 FOR I=1 TO 8: POKE XLO.(2+I*1): POKE HY.3: CALL POSN: POKE HY.131: CALL LINE: NEXT I
460 POKE XLO.171: POKE HY.3: CALL POSN: POKE HY.157: CALL LINE
480 REM
490 REM LINK TO CHADRAW AND FALL IN
500 REM CHART TITLES...
510 REM
540 REM
550 REM *** DRAW EDIT BOX ***
560 REM
570 POKE HY.3: POKE XLO.196: POKE XHI.0: CALL POSN: POKE XLO.1: POKE XHI.1: CALL LINE: POKE HY.77: CALL LINE
600 POKE XLO.199: CALL LINE: POKE HY.5: CALL LINE: RETURN
610 REM
620 REM *** FILL IN EDIT BOX ***
630 REM
640 FOR I=2 TO 9: VTB (1: TAB (30): PRINT "": NEXT I: VTB 24 RETURN
650 REM
660 REM SHOW OR DROP EDIT CHAR
670 REM
680 POKE HCOL.255:FLG: POKE XHI.0=I:(CCHAR MOD 8+1)*14-9
690 JM=POKE XLO.1:16+11: POKE XLO.1: POKE XHI.3: CALL PLOT
700 POKE XLO.1:10: CALL LINE: POKE HY.12: CALL LINE: POKE XLO.1: CALL LINE: POKE HY.7: CALL LINE
710 REM
720 REM
730 REM *** FILL IN CHARACTER CHART
740 REM
750 FOR I=0 TO 63: TAB (1 MOD (8)*4+1): TAB (1/8+2): 760 POKE CHARLOC.160=I: CALL CHADRAW
770 NEXT I: VTB 21: TAB 1: RETURN
780 REM
790 REM ** PICKUP KEY STROKE **
800 REM
810 KEY=PEEK (-16384): IF KEY<>128 THEN 810: POKE -16384:0: RETURN
820 REM
830 REM ***DISPLAY HIER CHAR SETS
840 REM
```

Computers & Gambling Magazine

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Thoughts on the SWTP Computer System

Don't be a scrooge; catch the true spirit of this series with the HUMBUG monitor.

Peter A. Stark
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This month, we continue the ROM monitor discussion we started last month. The first ROM monitor in SWTP systems was MIKBUG. Most software was designed to work with it, and so succeeding monitors have had to copy many of MIKBUG's routines and addresses.

The important MIKBUG entry points, which should be preserved in "compatible" monitors are:

BADDR E047—Input four hex digits into index register
BYTE E055—Input two hex digits into A accumulator
OUTHl E067—Output left BCD digit in A accumulator
OUTHr E06B—Output right BCD digit in A accumulator
OUTCH E075—Points to OUTEEE
INCH E078—Points to INEEE
PDATA1 E07E—Print a text string pointed to by index reg.
INHE X0A4A—Input a hex digit into A accumulator
OUTH2 E08F—Output two hex digits pointed to by index reg.
OUTH4S E0C8—Output four hex digits pointed to by index reg., followed by a space
OUTH2S E0CA—Output two hex digits pointed to by index reg., followed by a space
OUTS E0C9—Print a space
START E0DE—Start MIKBUG
CTRL E0E3—Restart MIKBUG
INEEE E1AC—Input a 7-bit character from keyboard
OUTEEE E1D1—Output a character to terminal

These sixteen entry points are the major ones. In addition, there are about 20 more minor ones that you can include if you just copy most of MIKBUG, but which are probably otherwise not needed.

The one exception is the SWTP BILOAD program, which is used to speed up loading of binary tapes such as BASIC. This program uses these additional MIKBUG entry points:

DMPREG E115—Print out CPU registers
LOAD19 E040—Part of load routine
SAV E1A5
DE E1F3
DEL E1EF
IOUT2 E1E3

This loader does not work with an MPS interface, so I chose not to include these entry points. However, I did include an entry point called INCH6 at E1F6, which is similar to INEEE except that it enters an 8-bit ASCII character rather than stripping off the parity bit to make it into seven bits, as INEEE does.

MIKBUG also uses the 128-byte scratchpad RAM starting at location A000. There are some differences, however, between MIKBUG and SWTPBUG in address assignments in this area, and I chose to go with SWTPBUG here rather than with MIKBUG. The important addresses are as follows:

NMI A006—NMI interrupt vector
SP A02B—User stack pointer
PORADD A02A—Address of the control port in use
PORECH A02C—Terminal echo on/off flag
XHI A02D—High-order half of index register
XLOW A02E—Low-order half of index register

MIKBUG had an XHI and XLOW one location lower, and some other monitors (as well as some software) go along with this convention.

I also treated the stack differently. MIKBUG and SWTPBUG always initialize the stack when they are started up at A042 and down. The G command then loads the next seven bytes into CPU registers and jumps to a user program with the stack pointer pointing to A049. So, in a way, we can think of the area below A042 as being a monitor stack, while the area just below A049 is a user stack.

But SWTPBUG's J command doesn't change the stack pointer when going to a user program; it leaves it pointing to the monitor area. Likewise, when a breakpoint is encountered, it leaves the stack pointer unchanged when it executes its own routines. This results in some weird occurrences when the monitor and user stacks wipe each other out. It becomes even more interesting when you consider that some user software initializes the stack elsewhere... such as at A042.

Because of this, I put other HUMBUG storage locations in a separate RAM—far away from the MIKBUG/SWTPBUG RAM—and treated the stacks differently. The monitor stack is now always at D07F. A jump command always goes to a user program with the stack pointer at D07D (with a return address at A07E/F, so jumping to a subroutine will result in a return back to the monitor), and a GO command always goes to the user program with the stack pointer at A049.

This keeps monitor and user stacks completely separate so they never clobber each other. It does require a separate RAM, however, at locations D000-D07F for strictly monitor use. In return, it keeps HUMBUG storage strictly compatible with any stack or storage assignment made by other programs, so there is never a problem.

In my system, the storage at D000 is provided by the 4K board I mentioned earlier. In two other systems that are currently running under HUMBUG, the memory is provided by the CPU board's 6810, relocated to CO00-DFFF as also mentioned last month.

I/O Control from the Keyboard

HUMBUG's control terminal is a serial terminal using an MPS card at port 1, which provides all input to the monitor,
and also standard output. Location PORECH (A00A) contains $8004, which points to this port. By changing this number, you can redirect the control port to an MPS card at any other port. (I'm describing the common version of HUMBUG; my own has its I/O at $8004.)

In addition, HUMBUG can provide an output to a second MP-S at port 0, to a user-written output routine in another EPROM or (in the 3K 2708 version) to the Percom video board.

Any time the monitor is looking for commands or any time that INEEE or OUTEEE is called, HUMBUG checks this port for a control-S break character arriving from the keyboard. When a control-S is detected, HUMBUG echoes with a bell (control-G) and halts all current I/O.

When I/O is halted, HUMBUG waits for one more character, which is used for controlling monitor ports. If it is received by INEEE, then it is not returned back to whatever program called INEEE. This provides control of output ports without upsetting other programs. This control character can be one of the following: CR—cancels the current program and usually does a return to the monitor. But the return is handled through a pointer in RAM, so that other programs could change the pointer and force a return to themselves. 0—turns port 0 on and off. 1—does the same for port 1. D—does the same for a user-written port routine. P—turns the pause feature on and off. When the pause feature is on, output will stop every 16 lines to allow it to be read when using CRT terminals. Any other character is ignored. The 0, 1 and D characters toggle their corresponding ports; if a port is on then it goes off, if it is off then it goes on. Since these characters are not echoed or even returned to calling programs, ports can be turned on and off in the middle of input or output.

The video board output normally runs all the time and is not controlled. (There is a flag in monitor RAM, however, that disables it if I want to use it for graphics or memory-mapped output.)

When another port is on, then the video output simply runs at the speed of the slowest port. But when all other ports are turned off, then the video board runs at breakneck speed, limited only by CPU speed.

This feature is extremely versatile. Not only does it allow precise printer control, but it also permits rapid skipping ahead at video speed. (The 2K 2716 version, which does not support the video board, will skip ahead even faster when you turn off all output.) Moreover, the control-S/CR combination allows you to abort jammed programs without reaching for the RESET button.

**Extended Debugging Facilities**

My third requirement for improved debugging power was met in several ways. First, the HD command allows a hex dump of selected memory areas. The DE command prints a "deserialized" listing of machine code, formatted by address and instruction. Thus, a DE dump of a program might go like this:

```
1000 86 41
1002 BD E1 D1
1005 4C
1006 87 11 03
```

An AO command outputs memory data in ASCII so I can scan for strings. An FM command allows filling memory with a specified byte. This is convenient to fill memory with 3F (SWI) instructions to catch programs that go wild. The FI command allows searching memory to find one, two or three bytes. The MO command moves memory contents from one place to another, even if the new area overlaps the old area.

But the most important function is the breakpoint and single-step facility. Up to four breakpoints can be set in programs, and whenever a program encounters such a breakpoint (or any SWI instruction anywhere), an interrupt returns control to HUMBUG, which then prints out the register contents.

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and stops. HUMBUG keeps track of breakpoint locations and the instructions existing in those locations and prints a listing of them whenever the BP (breakpoint print) command is given. This reminds you where you have put the breaks. An important feature is that HUMBUG doesn’t forget about them either when a jump back to the monitor is done, or when RESET is pressed.

SS is used for single-stepping through programs. Each time you type SS, HUMBUG prints out the address and code of the next instruction, executes it and then prints out the contents of all registers after the instruction is completed. It will single-step all instructions except WAII, SWI and RTI, and cannot single-step into or through ROM. HUMBUG prints out NO! whenever any of these are attempted.

**FCROM**

FCROM occupies addresses FC00–FFFF. It contains the reset and interrupt vectors that the 6800 CPU needs at locations FFF8–FFFF. So, without this ROM, the system cannot function at all.

FCROM contains all of the common MIKBUG I/O routines. But since this ROM is at the end of memory, none of these routines are at MIKBUG-compatible addresses. Instead, they are simply consecutively placed wherever they fit. To allow future changes, though, they are vectored through a jump table that starts at FC00:

- FC00 JMP COLDST
- FC03 JMP WARMST
- FC06 JMP HOTST
- FC09 JMP INEE
- FC0C JMP OUTEEEE etc.

Even when FCROM is changed in the future, these pointers will stay in the same place, and so external jumps into FCROM will stay unchanged.

OUTEEEE and INEEEE provide all of the port control features mentioned before. In addition, FCROM has a command processor that accepts monitor commands from the keyboard and processes them. But it only recognizes two commands—ME for memory examine and change and JU to jump to a user program. These are the absolute minimum that the monitor could have and still work.

**Monitor Extendability**

My fourth major requirement was to allow the monitor to be changed or expanded without too much work. As it now stands, I can add EPROMs without changing the existing ones. Moreover, I can even unplug some of the existing EPROMs from the system, and the rest of the monitor will still work! (Since the 2716 version consists of just one EPROM, this obviously doesn’t apply to it.)

The 2708 version of HUMBUG consists of three 1K EPROMs: FCROM, E0ROM and E4ROM. FCROM is completely self-contained and will run all by itself, even when the other EPROMs are unplugged. It contains all port control and video board control and, with the ME and JU commands, can load and execute other programs.

But it is obviously limited; it relies on the other EPROMs in the system. It also doesn’t have MIKBUG-compatible entry points, although it does have all the required routines.

This is where the extendability feature comes in. Notice in the above table that there is an entry point at FC00:

FC00 JMP COLDST

This is the main entry point when you first turn the system on or when you push RESET. This is a “cold-start,” which initializes ports 0 and 1 and initializes the video board.

Once this is done, the FCROM program checks to see whether there is a ROM starting at address E000. If there isn’t, then it proceeds with a “warm-start” initialization, where the program turns on port 1, turns off other ports and sets more registers. But if it detects that there is a ROM at E000, it executes a JSR to that ROM before doing the warm-start. This gives E0ROM a chance to execute a cold-start too.

When E0ROM is finished with
its cold-start, it checks for the presence of a ROM at either E400 or E800; if it detects one, it jumps there. Each EPROM gets its chance at a cold-start initialization. If E4ROM is installed at E400, it gets control; if not, then control either goes to the next ROM (if any) or returns to FCROM. Initialization is divided into cold-start and warm-start and each of these transfers control from ROM to ROM.

When all initialization is completed, FCROM takes over and looks for a command. If an ME or JU command is entered, then FCROM executes a memory change or jump itself. Otherwise, it puts the two command characters into accumulators A and B and transfers control to other ROMs, in turn. If one of these recognizes a valid command, it executes it; otherwise, control goes to the next ROM. Ultimately, control passes back to FCROM.

Passing control back and forth between ROMs allows more ROMs to be added at any time. Moreover, if one ROM is unplugged, the remaining ROMs still get control and can still execute their own commands. In this way, you can expand or modify HUMBUG without rebooting any three EPROMs. But there is a price to be paid; an additional amount of housekeeping in each EPROM, which takes up about 40 bytes.

EOROM

EOROM, the second 2708, is at locations E000-E3FF. Although the system will run with just FCROM, EOROM is essential for MIKBUG compatibility because the EOROM has sixteen MIKBUG-compatible jump vectors that point to the corresponding locations of FCROM. For instance, location E1AC of EOROM contains an instruction that says JMP to $FC09, which is the actual entry point for INEEE in FCROM. Each MIKBUG entry point has such a JMP.

This is a different approach from SWTBUG and other monitors, which simply put these routines at the same addresses as MIKBUG did and then try to fit everything in. Here all the routines are elsewhere, and only JMP instructions exist.

Woven in between these JMPs are the cold- and warm-start routines, the command processor that recognizes monitor commands and routines for the following commands:

- L — Load MIKBUG-formatted tape
- P — Punch/Save MIKBUG-formatted tape
- E — End of tape
- F — Format disk
- D — Debug disk
- S — Single-step
- A — ASCII input into memory
- O — ASCII output from memory
- M — Move memory contents

The exact functions of these will become clear when we examine the actual programs.

Since the system is set up to allow more ROMs to be easily added, there are obviously others available. EBRom, for instance, adds commands to compare memory contents, change terminal baud rate from the keyboard and change control ports. But these are just frosting on the cake, not really needed for most systems.

Let's examine some of the actual HUMBUG code.

**Initialization and Reset**

A 6800 requires four address vectors to be located in the top eight memory locations, FFF8 through FFFF, which are used for vector resets and interrupts. These four vectors are: FFF8 and FFFF — IRQ vector
FFFA and FFFB — SWI vector
FFFF and FFFD — NMI vector
FFE8 and FFFE — Reset vector

When you press the reset button or when an interrupt occurs, the 6800 pulls the appropriate address out of one of these four locations and puts it in the program counter. This causes a jump to that address. For that reason, when the system is first turned on, at least the reset vector and the routine it points to must already be in memory. This is why every 6800 system has its ROM located at the very top of memory.

Listing 1 shows the portion of HUMBUG’s FCROM that contains the very top of memory. FFF8 through FFFF contain these four vectors: IRQ points to FFF8, SWI points to FFED, NMI points to FFF2 and reset points to FC00. Thus, when a reset is completed, the 6800 starts executing from location FC00, which is the beginning of FCROM.

The interrupt vectors all point to locations in ROM, shown just above that. When an interrupt occurs, the computer goes to the appropriate routine, loads a number from RAM into the index register and then does an in-
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dexed jump to the address given in the index register. This address is actually specified through RAM and can therefore be changed by user programs, even though the JMP instructions themselves are in ROM. The three addresses used are exactly compatible with SWTBUG:

IRO is A000
SWI is A012
NMI is A006

FCROM Jump Table
FCROM contains routines that are subject to future change. To avoid having to change other software, all these routines are handled through a jump table (sometimes also called a “transfer vector”) as shown in Listing 2. In particular, note that FC00 is the start location to which the computer jumps on a reset. This is called COLDV (cold-start vector), and it jumps to COLDST at FC33. Two other entry points are WARMV and HOTV, followed by vectors or

 pointers to all the MIKBUG-compatible routines.

Cold Start
Listing 3 shows what happens at a reset (or cold-start; a jump to E000, which is the MIKBUG/SWTBUG reset address, also winds up at this location).

First, the stack pointer is set to point to the monitor stack at D07F. Then, MP-S ACIAs on ports 0 and 1 are reset and then initialized, followed by a jump to the video board initialization routine. In the case of HUMBUG, this is exactly the same as Percom’s suggested video driver initialization, and so there is no need to show it here. If you have this video board, you already have a listing of it; if you don’t, then you don’t need it and can replace it with initialization for another video board or skip it.

The last four lines of cold-start check to see whether there is another ROM at address E000. Since all HUMBUG ROMs start with a jump table, we check to see whether there is a 7E or JMP instruction at address E000. If not, we continue to WARMST. If there is a JMP, we execute a JSR to E000.

Cold-Start of Other ROMs
As it turns out, EOROM doesn’t need any cold-start initialization. Unfortunately, the overhead involved with the expandability of HUMBUG requires that we go through some testing to check for a following ROM (see Listing 4). Here we see the JMP at location E000, which leads to CINIT. Since EOROM has many MIKBUG-compatible jumps, a lot of its routines have to be squeezed between these jumps. In this case, the CINIT cold-start initialization is placed right after the INEVEE vector at E1AC, which is also shown in Listing 4.

The NOP at CINIT shows where the initialization would go, if there was some. The following steps check for a JMP at the start of the next ROM at address E400 and jump to it if present. If not, then they check for a JMP at the start of a ROM at E800 and again jump to it if present. If neither is present, then there occurs an RTS, which returns back to FCROM’s warm-start procedure.

These steps check for a JMP both at address E400 and at E800, so that if an additional ROM is installed at E800, but the one at E400 is pulled out, then the system will simply skip past the removed ROM. The purpose is to allow the monitor to function at least partially, even if some of its ROMs are pulled out. The only crucial ROMs are FCROM and EOROM, although the system will work even with just FCROM.

Although EOROM doesn’t need cold-start initialization, E4ROM does. Its cold-start initialization is shown in Listing 5. Notice that E4ROM tries to differentiate between a reset or jump to the cold-start location E0D0, as opposed to a real cold-start right after the first power-on. The reason is because breakpoints have to be handled differently.

When you first turn on the power, the list of breakpoints maintained by HUMBUG has to be erased so that, if any new breakpoints are established, HUMBUG doesn’t accidentally

Listing 3. FCROM cold-start initialization.

Listing 4. E0ROM cold-start initialization.

Listing 5. E4ROM cold-start initialization.
clobber a program by restoring what it thinks is a prior breakpoint.

On the other hand, when you press the reset button or make a jump to the cold-start location $E000 (or FC00), you don’t want to erase the breakpoint table because doing so would make you lose track of locations that have been replaced by a break. So we need a way of telling the difference between the two kinds of resets.

For this reason, four locations in monitor RAM, called POWUP, and located at $D028 through $D02B, are used as a flag. When you first turn on the power, these locations will contain some random numbers. CINIT in E4ROM (Listing 5) checks the contents of these locations. If the contents are 12, 34, 12 and 34, respectively, then the program assumes that this is not a real cold-start, and so a jump is made to RESET. But at the first cold-start, these locations will be random and will therefore not contain this particular combination. (The chance of their just accidentally holding this number at power-up is about 1 in 4 billion!)

In that case, the routine at PUP will be performed. This initializes the address for an SWI to the return address BKRET which used for breaks, places the 12-34-12-34 combination in POWUP and erases the breakpoint table BKTAB. Then it goes to RESET. (Once POWUP is set to 12-34-12-34, all subsequent resets will skip this segment.)

The final part of the cold-start procedure again checks whether there are other ROMs, this time at $E000 and $CC00, and jumps to them if present. Otherwise, an RT$ brings us back to FCROM, which will continue with the warm-start initialization. Remember that FCROM went to EROM with a JSR. Each ROM then continued to the next ROM with a plain JMP, so that an RTS will bring us all the way back to the first JSR in FCROM.

Next month we’ll conclude the listing of this “Monitor to End All Monitors.”

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<table>
<thead>
<tr>
<th>Part No.</th>
<th>Programs</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-0</td>
<td>TMS 2706</td>
<td>$15.00</td>
</tr>
<tr>
<td>PM-1</td>
<td>TMS 2707</td>
<td>$15.00</td>
</tr>
<tr>
<td>PM-2</td>
<td>TMS 2710</td>
<td>$30.00</td>
</tr>
<tr>
<td>PM-3</td>
<td>TMS 2710</td>
<td>$15.00</td>
</tr>
<tr>
<td>PM-4</td>
<td>TMS 2532</td>
<td>$30.00</td>
</tr>
<tr>
<td>PM-5</td>
<td>TMS 2516, 2716, 2758</td>
<td>$15.00</td>
</tr>
<tr>
<td>PM-6</td>
<td>MC68070</td>
<td>$33.00</td>
</tr>
</tbody>
</table>

Optimal Technology, Inc.
Blue Wood 127, Earlysville, Virginia 22936
Phone (804) 973-3482

Microcomputing, August 1980 125
Dial-up Directory

This Directory tells you how to live with an overactive dialing digit.

Frank J. Derfler, Jr.
PO Box 691
Herndon, VA 22070

How much is your phone bill? Most of the letters and messages I receive as a result of these articles start with "I will hate to see my phone bill, but I sure am having a good time...."

This article introduces one service that may make a difference in the size of your monthly donation to the telephone company and examines a creative bulletin board program. Finally, I will attempt to throw some light into the dark corner of TRS-80 telecommunications.

Sprint

Is your long-distance phone bill over $50 a month? Do you live in or near one of the top 50 or so cities in population? Do you usually call to large population centers? Do you have a push-button phone?

If you answered yes to all the above, you may want to "sprint" to Southern Pacific Communications (SPC) to save a few dollars. Sprint is the name of SPC's long-distance dial telephone network. It picks you up from your local telephone system, carries you across country and deposits you in the local system of many large population centers across the country. The service will carry voice or voice bandwidth data (standard 300 baud is fine).

SPC has been in business since 1970. Today, they operate more miles of intercity microwave circuitry than any other specialized common carrier. The number of specialized carriers such as SPC is growing, and they are all expanding the areas they serve. SPC projects continued growth to more areas of the country. Since 50 percent of the U.S. population lives in the 40 largest cities, SPC is able to serve most of us right now.

To use Sprint, you first dial a local number on your standard push-button instrument. This local number connects you with the Sprint network. You then dial the long-distance number you want and your Sprint authorization code. The network takes over, and you proceed as if you have made a regular voice or data call.

The cost depends upon when and how long you call. If you compare "prime time" 8 AM to 5 PM calls, Sprint saves around 30 percent. Sprint drops to low rates at 5 PM, so if you compare their calls with the regular evening rate, you will probably save more.

From Alabama, a 15-minute call to Los Angeles at 6 PM costs me $3.69 with normal telephone service. The Sprint call runs about 11 cents per minute (varies with distance), plus a ten cent termination fee, for a total of $1.75. You have to also prorate a $10 monthly subscription cost over the number of calls you make.

For example, if you add a pro rata charge of 25 cents to total $2, you have almost saved enough on that one call to buy a 21L02 static RAM for your memory board. (You could add a pro rata share of the regular telephone service and installation costs to the $3.69, but I will treat them as sunk costs.) Sprint is billed in six-second increments. The standard telephone service rounds up in all cases.

Since most of us use our dial-up communications at night and during the weekend, let's consider the cost of a 6 AM call. On the regular phone system, it would cost $2.30, so you would only save a quarter or so with Sprint. The saving is less, but it is also less convenient.

Sprint is not for everyone. It doesn't serve the Northwest or Northcentral states. There is a minimum $25 a month charge, so you have to make quite a few calls. You have to analyze your own situation and determine if the network has a local connection point near you before you decide. If you are interested, contact: SP Communications, PO Box 974, Burlingame, CA 94010, (415) 692-5600.

System Spotlight

Anyone interested in the finer points of bulletin-board or message services should dial into the system in Endicott, New York, (607) 754-5571. Bob Iannucci has put together this service with an eye toward both economy and individual attention. The entire program runs on one single-sided single-density, small, North Star floppy disk. The program is in 8080 assembly language, so there is no overhead for CP/M or BASIC. The files are self-maintaining, and no intermediate or other records are needed.

This flexible system assumes you know what you are doing until you prove you don't. The prompt commands are short to save time for the experienced, but if you need help, detailed explanations are available at every level.
Bob's system asks new users to provide a four-letter password and a user ID. The password is used to kill or edit your old messages. Other people use the ID to send you messages, which you can quickly recall with a special summary command.

The ID prevents users from being inconsistent with the names they use to sign on and send messages. Other systems have a similar user name feature, but if I sign on as John Doe and the message is sent to Mr. Doe, I will not see the message on a sort by name.

Bob must provide an ID to user name cross-reference, and use of this file takes time, so it still isn't a perfect solution. However, regular correspondents will quickly learn each other's IDs.

The user ID also provides semipermanent personalization of the system. The first time you sign on, you must tell the system the number of nulls you need, if you have a bell, what your keyboard delete code is, if you can use lowercase and if you want an echo. The system remembers these factors when you use your ID in the future. This is a timesaver.

This system, like several others, now allows "stacking" of commands. If you know what questions are coming, you can answer them in advance by separating the answers with semicolons. Without the stacking feature, the sequence appears as:

```
IS THIS YOUR FIRST TIME ON THIS SYSTEM?
```

```
NO
```

```
WHAT IS YOUR NAME? john doe
```

You could sign on as follows:

```
IS THIS YOUR FIRST TIME ON THIS SYSTEM?
```

```
no
```

```
WHAT IS YOUR NAME? john doe
```

Stacking is an obvious timesaver if you are familiar with the system. Always check the help (H or ?) command for information on how to make bulletin board systems really work for you. Bob is not in the business of selling software and his program is machine specific, but the ideas and style he has used can be copied by all.

**TRS-80**

The world of TRS-80 communications has been a cloudy one. National advertising of non-Radio Shack products for communications is limited, and model numbers and types of software have been a subject of some confusion. I have been waiting to get some solid information before making any comments in this series about TRS-80 systems. Now I can discuss one software package that provides good communications capability for the TRS-80. But first, I'll examine the hardware.

If you are going to communicate using a TRS-80, you need the expansion interface, the RS-232 card and a modem. Some RS-232 hardware that does not use the expansion interface is being advertised (see "TRS-80 Serial I/O for Less" in the April 1980 Microcomputing, p. 100). If you want to use a smart terminal program with one of these boards, you'd better be able to write your own software. (Note: that is not true of the "Micro-connection" recently announced for the TRS-80, which we will review soon.)

The Radio Shack RS-232 cards apparently got off to a rough start because of some bad quality control, and they still give problems in physical connection. If you have memory errors, system reboots, random error messages and other seemingly unrelated problems, check the connection between the RS-232 card and the expansion interface.

Any of the RS-232-type 103 modems will work with the TRS-80. The Novation CAT modem, sold under the Radio Shack label, does a fine job. Dial systems are not necessary, but they are helpful. The Term program sold by Radio Shack is a dumb terminal program that will run without a disk. Other software has more capabilities.

The Bottom Shelf, Inc., in Atlanta has been strong in the TRS-80 software market with a Terminal Control Program (TCP) written by Barry Mulligan that is clever in concept because it is both a standalone package and a utility or subroutine to be called as a part of larger programs. The package allows communication with any other computer or terminal and the transfer of programs, data and memory blocks.

All of the RS-232 parameters (word length, etc.) are controlled from the keyboard. Versions for 16K, 32K and 48K are provided, and the package will work from tape or disk. Saving data is done by the standard tape or disk operating system.

Several levels of operation can be selected. Dumb terminal operation is available, but features such as control codes, error checking and a bell (audio tone) are provided for the dumb terminal. The TCP manual calls this KSR—after the keyboard send designation often used with printing terminals on communications circuits.

The TCP software also allows you to transmit and receive BASIC programs. The compressed format used internally by the TRS-80 is transmitted under some options. This saves long-distance phone-call time, but you must have another TRS-80 at the other end in this mode.

A clever option allows the TCP software to interact with running programs. A program can run for a while, call TCP, exchange data over a modem, terminate TCP and continue running. A BASIC program is included to read ASCII files (such as Electric Pencil), call TCP and transmit or receive messages. This capability is similar to the ASCII Express program for the Apple II.

The manual that Barry has written is aimed at the practical user. Each option is explained in detail, and good step-by-step instructions are provided. This program is easy to use and well documented. It should serve the needs of both expert and novice keyboard pounders. The program costs about $20.

Do you market products for microcomputer communications? Do you operate a message system? Let me know what you are up to. Problems? Ask me. Send paper mail to PO Box 691, Herndon, VA 22070 (include a stamped envelope if you want a reply). Save a tree and send electronic mail via the Remote Northstar (404) 939-1520, or to TCB967 on The Source.

---

**Table:** A list of part-time operations run by individuals and computer stores and full-time systems run by commercial companies for communications with their users. These phone numbers were confirmed from my list of 180 reported listings; I have been on each one of these systems.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>PHONE NO.</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>415-527-0400</td>
<td>Proxima. The official message system of North Star Computer Company.</td>
</tr>
<tr>
<td>Brentwood</td>
<td>408-296-5799</td>
<td>CBBS-type software running on a PDP-8 minicomputer with a hard disk.</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>319-557-9618</td>
<td>ABBBS.</td>
</tr>
<tr>
<td>Kentucky</td>
<td>502-245-6288</td>
<td>ABBBS. 8 PM-6 AM.</td>
</tr>
<tr>
<td>Louisville</td>
<td>201-691-7441</td>
<td>ABBBS. 10 PM-6 AM.</td>
</tr>
<tr>
<td>Memphis</td>
<td>206-233-5438</td>
<td>Apple Crate II. Features the &quot;Apple Doctor&quot; service. Trs-80-based system serving a small but active company called The Peripheral People. Ask about their &quot;Micro-connection&quot; modem.</td>
</tr>
<tr>
<td>College Station</td>
<td>713-293-6080</td>
<td>ABBBS.</td>
</tr>
<tr>
<td>Seattle</td>
<td>206-723-3322</td>
<td>ABBBS.</td>
</tr>
<tr>
<td>Seattle</td>
<td>(206-723-DATA)</td>
<td>ABBBS.</td>
</tr>
</tbody>
</table>
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Reader Service index—page 241
Microcomputing, August 1980 129
Let PET Design Your Next Power Supply

Make your computer an engineer/draftsman.

William R. Moore
2035 Barberry Lane
Bowling Green, KY 42101

One of the first programs I purchased after getting my PET computer was George Duisman's Bridge Challenger program. Since the program was almost 6K in length, my PET ran out of memory after playing only a few hands.

I decided to add an additional 4K of memory to the PET, since the memory expansion connector made this addition easy. However, I soon found out that the PET power supply was not capable of supplying the additional current. A 5 volt, 1.2 Ampere power supply would be needed to power my memory board.

As I pondered over the design, I decided to let the PET design the power supply. After all, a computer should be capable of doing basic power-supply design, and maybe the PET graphics could be used to draw the schematic.

I wrote the program to use the National Semiconductor LM317 regulator which is an adjustable three-terminal regulator capable of providing dc voltages from 1.2 to 30 volts at currents up to 1 Ampere. The LM317 comes in three case sizes—TO-5, TO-220 and TO-3 for increased power dissipation. Since the LM317 can only handle currents up to 1 Ampere, larger currents will pass transistors.

The Program

The program will design a dc power supply from 1.2 volts to

```
GO TO 9
REM GRAPHICS FOR SCHEMATICS
PRINT$
PRINT"$D1=$D2=$IN4002$
PRINT"P1=P2=P4$
PRINT"ON OUT$
PRINT"P3=P4$
PRINT"LM317$SW$
PRINT"120V$SW$SW$
PRINT"P3=P4$
PRINT"LM317$SW$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
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PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
PRINT"OUT$
PRINT"R1=7$
PRINT"P1=P2=P4$
25 volts and load currents up to 5 Amperes. It will specify the necessary transformer characteristics for you, or you may specify an available transformer. If you specify the transformer, you must not call for a transformer significantly larger than the minimum required; otherwise, excessive power dissipation will occur in the power supply, especially for load currents greater than one Ampere.

Lines 5 through 62 in the program listing develop the power-supply schematics. Statements 5 through 62 use the hyphen for two distinctly different purposes. A hyphen above a character in the listing means that the shift key is to be depressed for that character. This is required since the majority of the graphic symbols on the PET keyboard are in the shift mode. The second use of the hyphen is to represent spaces when they are essential. Hyphens between characters (bottom of a line) are used for this purpose.

Photo 1. PET’s graphics capabilities used for a 5 volt, .5 Amp power supply.

Statements 5-62 are double-spaced for clarity due to the double use of the hyphen. I have also used abbreviations used in the listing for clearing the screen (lowercase cs) and moving the cursor down (lowercase cd). I used the abbreviation for print (?) for all statements in the listing. Program execution may begin at statement 108 to eliminate introductory remarks.

Photo 1 shows the design for a 5 volt, half Amp regulated supply. A transformer having a minimum secondary voltage of 8 volts RMS would be required. The LM317 device contains most of the necessary electronics; only a 1400 uf, 12 V dc capacitor and two resistors are required to complete the design. The listing determines the maximum thermal resistance of the heat sink required.

The schematic diagrams generated by the computer for power-supply designs requiring one or more series pass transistors will always show one
series pass transistor (2N3055) with the number of total parallel transistors in parentheses. Photo 2 shows an example of a 20 V, 2 A power supply requiring one external 2N3055 series pass transistor.

In these cases, all of the load current will flow through the transistors, except for approximately 30 mA, which will flow through the LM317. This means that the regulator will not require a heat sink; only the series pass transistors will require a sink.

The power supply designed for my 4K memory expansion worked the first time and has continued to perform without problems. I built and checked out fifteen other power-supply designs up to 25 volts @ 4 Amps. I was limited to building a 4 Amp power supply due to the transformers available. All power supplies built and tested were stable and had low ripple output. You can add a 1.0 uF tantalum capacitor across the output to ensure low output impedance at high frequencies.

Photo 2. The author's PET showing a power-supply design using a Darlington connection for higher output current.

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522 NEXT I
523 A-R=RES (25-1)
532 PRINT "NUMBER OF EXTERNAL 2M3#55 OR EQUIVALENT"
531 PRINT "TRANSISTORS REQUIRED IS SER" 
530 PRINT "-cd TYPE 1 AND RETURN TO SEE SCHEMATIC"
533 INPUT B IF B=1 THEN GO TO 495
534 IF CT=1 GO TO 65
535 GO TO 495
536 IF CT=1 THEN GO TO 539
537 GO SUB 42
538 GO TO 619
539 GO TO 537
540 GO TO 619
541 GO TO 537
542 PRINT "cd DESIRED OUTPUT VOLTAGE EXCEEDS 25 Volts"
543 PRINT "Type in desired output voltage output voltage"
544 GO TO 115
545 PRINT "cd DESIRED OUTPUT VOLTAGE IS LESS THAN"
546 PRINT "MINIMUM OF 1.2 Volts"
547 GO TO 546
548 PRINT "DESIGNED LOAD CURRENT EXCEEDS 5 AMP"
549 PRINT "MAXIMUM"
550 GO TO 115
551 PLR GO TO 125
562 PRINT "cd SPECIFIED TRANSFORMER IS TOO SMALL FOR"
563 PRINT "THE DESIRED OUTPUT OF 100 Volts"
564 PRINT "cd TYPE IN TOTAL RMS SECONDARY VOLTAGE"
565 GO TO 199
566 PLR PRINT "cd LOAD CURRENT TOO SMALL TO USE" _
567 PRINT "CAPABILITIES OF THE LM 317"
568 GO TO 135
569 END

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Microcomputing, August 1980 133
Get Your PET on the IEEE 488 Bus

Part 2 of this "opus computerus" examines the file characteristics of the IEEE 488 bus.

Gregory Yob
Box 354
Palo Alto, CA 94301

Your PET has a "built-in" way of communicating through the IEEE 488 bus. In BASIC, the IEEE 488 looks like a file—just as the cassettes are files. The OPEN statement is used to specify a physical device number of 4 to 30, and the open logical file now talks via the IEEE 488 bus.

A complete understanding of PET tape files is a prerequisite for working with the IEEE 488 as a BASIC file. An article in the January 1979 Kilobaud Microcomputing ("PET Techniques Explained") covers many "innocent" errors that will result in mysterious malfunctions.

IEEE 488 Information Transfers

Talking to a Device.

1. OPEN a BASIC file to the device's address. For example, OPEN 1,4 will open the IEEE bus to device 1,4. Your BASIC program will see this as file #1.

2. PRINT# to your OPENed file. PRINT# "HELLO, DEVICE" will address the device to listen, send the string HELLO, DEVICE, add a carriage return with EOI true and then issue the UNT (Untalk) command.

3. Repeat step 2 as needed. Note that after each PRINT#, the IEEE bus is free, since the UNT has been sent.

PRINT# will send the same characters, including the skip character after numbers, as PRINT does to the screen. If you want to send several items, be sure that any needed delimiters, such as ",", are included.

Listening to a Device.

1. OPEN a BASIC file to the device's address.

2. Use INPUT# or GET# to fetch a line or a character from the IEEE bus.

3. Check the status word, ST, for an error, such as time-out. If the device is slow, the PET will complete the INPUT# or GET# if no error, and put a nonzero value into ST, which must be checked immediately after the I/O operation. If ST indicates a time-out, jump back to step 2.

4. Convert the data from the INPUT# or GET# as needed, and if more is needed, go to step 2.

Note that after each INPUT# or GET#, the UNT command is sent to the IEEE bus. This will truncate long messages from the device, especially with GET#. Also note that INPUT# (string) and GET# (string) work the best. The BASIC string functions (MID$, RIGHT$, LEFT$ and VAL) will help you get the data into a usable form.

Talking to More than One Device.

1. OPEN a file for each device.

2. Using CMD, send a dummy message to each device. For example, CMD 1:CMD 2:CMD 3 will set up each device (as specified in the OPENs for files 1, 2 and 3) by sending carriage returns to the devices and leaving them as listeners on the bus.

3. PRINT# the IEEE bus. Any of the OPENed files may be used.

4. Repeat steps 2 and 3 as needed. Since PRINT# ends with the UNT, step 2 must be repeated after each PRINT#.

Transfer from One Device to Another.

1. OPEN a file for each device.

2. CMD to the device that is to be the listener.

3. INPUT# from the device that is to be the talker.

4. Repeat step 3 as needed. INPUT# does not send a UNL, so the device that was CMDed remains on the bus as a listener. All information sent by the talker to the PET is also received by the listener. To turn off the listener, use a PRINT# to the listener's file. If the talker is slow, check ST and repeat step 3 as required.

LISTing a BASIC Program to a Device

1. OPEN a file to the device.

2. CMD to the device.

3. Enter the LIST command.

4. When the LIST is finished, do a CLR.

The PET's graphics and cursor characters will not print correctly on a standard ASCII printer. (I have a BASIC listing program available.)

The best way to learn the PET files and IEEE 488 is by specific examples. After a detour through CMD, we will continue with two examples. These should provide you with enough Information to get started. If you have no success, refer to the section on Common Errors (found later in this installment).

CMD

CMD is an unusual PET command. Consider its functions:

1. Anything that BASIC wants to say is now muted to the device that CMD'd file number refers to. If this isn't the screen, nothing that BASIC says will appear on the screen.

2. If a list of variables and literals is provided after the CMD, they will be sent to the device in the same way as PRINT# will.

3. However, if the device is on the IEEE bus, no UNL will be sent, so the device will remain in the listening state and receive any following data sent on the IEEE bus.

To see how CMD operates, get two scratch tapes and enter the program in Example 1. Now SAVE and VERIFY this program on one of your tapes. Put the other tape in the tape unit and execute the following:

OPEN 1,1
PRESS PLAY & RECORD ON TAPE1

Perform this and wait until the tape stops.

OK READY.
Now enter CMD 1. Note that READY didn't appear; it was provided by BASIC and is now residing in the tape buffer. The cursor is blinking below the C in CMD. Continue with:

LIST
CLOSE
CLR
READY.

Note that the CLOSE 1 didn't get the READY back. It took the CLR to return BASIC's messages to the screen. If you enter LIST, the program will appear on the screen. Rewind the tape and RUN. Three asterisks now appear after the RUN. These were printed by the program. This is one reason I don't trust my PET after a CMD. The text between the OK and the ending READY was found as a data file.

When the PET was under the influence of CMD, the letters you typed in were put onto the screen. This echoing is done by the PET's operating system, so CMD won't put these out to the device.

Though CMD looks like a good way to LIST program to tapes as data files, there is a snag. My example is shorter than 191 characters, and a LIST via CMD isn't smart enough to "jiffy" the data tape (this has been fixed on the new PETs). You run the risk of losing tape records when you try to read an "unjiffed" tape.

Try to verify that CMD 1; "HELLO OUT THERE" will print HELLO OUT THERE onto the tape. Remember that if you CMD a device on the IEEE 488 bus, any PRINT# to the bus will require a repetition of the CMD if you want the device to remain in the listening state.

Talking to the Clock Again
(For a description of the HP clock see part 1 of this article.)

First, you must check the device address on the DIP switch (which will be near the 488 female connector) and make sure the address is in the range 4 to 15. The enter a short program (Example 2) into the PET. This program consists of three subroutines to facilitate communicating with the clock. Remember that the PET will not accept an INPUT statement as a direct command.

First, enter GOSUB 10 as a direct command. This opens file 1 to device 7, which is our clock on the IEEE bus. OPEN merely sets things up; nothing is sent to the bus yet.

To read the time, enter GOSUB 200:

GOSUB 10
SAY TO CLOCK? 01000000000000000000000000000000

The clock starts at day 1. To set to day n, use n – 1 Ds. To set the hour, enter the following.

GOSUB 100
SAY TO CLOCK? 01000000000000000000000000000000

Minutes and seconds are set similarly.

GOSUB 100
SAY TO CLOCK? 01000000000000000000000000000000

We are now set to 9:17:03. When I did this by hand, the clock moved forward about a minute, so the number of M's used should be changed to accommodate for this.

Talking to the HP 8165A Programmable Signal Source
(For a description of the HP 8165A, see part 1 of this article.)

The 8165A is the fine instrument with many switches, knobs, buttons and options and a correspondingly wide array of IEEE 488 commands (see Fig. 12, part 1).

The precise contents of each example concern the 8165A, which is an instrument you will probably never meet! My intention is to show you how direct

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Microcomputing, August 1980 135
mode commands—that is, BASIC statements without line numbers—can be used to control an instrument and help in debugging.

First, I hooked the 8165 to the 488 cable, and the PET turned on. The 8165 was addressed to 6. When the PET came on, IFC was true for about one second. This put the 8165 in local mode, where the front panel works as usual. Many instruments will ignore their front panels when the 488 bus addresses them. Once the PET addresses the 8165, you cannot control it from the front panel anymore. (An LED indicates this on the 8165.)

The following short program takes care of input from the instrument:

```
10 INPUT#, A$ 20 PRINT A$
This substitutes for the illegal direct command (INPUT#, A$: PRINTA$), which would like to use, but the PET forbids (try it and see).
```

Since I wanted the 8165 to output a 1 kHz sine wave at an amplitude of 1.5 volts, I used the following IEEE commands:

- **F1**—Set to sine wave
- **FRQ** 1 kHz—Set frequency
- **AMP** 1.5 V—Set amplitude

I set to normal operation (continuous signal output)

First, open the IEEE file:

```
OPEN 1,8 READY.
```

Then send the settings:

```
PRINT #1,"F1" (At this point, the "Remote" LED went on, and I can no longer work the front panel) PRINT #1,"FRQ1KHZ" PRINT #1,"AMP1.5V" PRINT #1,"11"
```

Nothing happened! My scope showed only a flat trace! Upon reviewing my steps, I noticed that I overlooked the Disable Output (OD) and Enable Output (OE) commands. I entered

```
PRINT #1,"OE", and a sine wave appeared on the scope.
```

You could also send this setting as one string. For example, I used

```
PRINT #1,"F2FRQ1.2KHZAM1.2V10E" sets up a 1.2 kHz triangle wave at 1.2V amplitude.
```

The 8165 can also report some of its switch settings. Now we can use the tiny program in the PET:

```
GOTO 10
F1 D2 12 FM0 AM0
```

Since the PET has difficulty with GOSUB in direct mode and the IEEE bus, we must make a program change:

```
10 INPUT#, A$ 20 PRINT A$ 30 RETURN
```

We will quickly be reminded that any time we change a program, all the variables, including opened files, will be lost.

```
GOSUB 10
?FILE NOT OPEN ERROR IN 10
```

So we try again:

```
OPEN 1,8
GOSUB 10
F1 D2 12 FM0 AM0
```

The PET will provide the ?SYNTAX ERROR about 90 percent of the time when the IEEE is accessed via the INPUT# statement and the PET is executing a directly called subroutine. However, this doesn't appear to affect anything. I avoided this by not making the little program a subroutine the first time.

So, if you are in a pinch, remember that the PET's direct command capability can rescue you with IEEE 488 devices and provides an inexpensive way to explore a new instrument.

Talking to More Than One Device

Now that each of the instruments has been in the bus individually, the next step is to try the 488 with both of them on at the same time. I connected the HP clock and the 8165 to the 488 bus and gave the clock address #7, and the 8165 address #8.

Then I entered the short program for INPUTs:

```
10 INPUT #1, A$ 20 PRINT A$ 30 END
110 INPUT #2, B$ 110 PRINT B$ 120 END
```

First, OPEN the files:

```
OPEN 1,7
OPEN 2,8
```

If you get a ?FILE OPEN ERROR, just enter CLR and start over.

Taking a peek at the clock resulted in:

```
GOTO 10
0130051957 (30 Jan., 5:19:57)
```

And peeking at the 8165 gets me:

```
GOTO 10
F1 D2 12 FM0 AM0
```

which is the usual mystery message that the 8165 says to me. There isn't any point in explaining this message, for your instrument will say something different and meaningful only to you.

```
PRINT #1 and PRINT #2 will work just fine, and so two instruments and the PET can live in harmony together.
```

A Gotcha

I decided to turn off the 8165 with the PET set up for two instruments as described above. Sure enough, strange things happened.

```
The clock worked fine:
GOTO 10
0130052525
And just for fun, look what happens with the 8165 (which isn't on):
GOTO 10
F1 D2 12 FM0 AM0
```

The 8165 has some internal batteries to store and memorize settings until it is turned on again. It also will respond to the IEEE 488 bus.

Now to try things in reverse—the clock doesn't have any batteries. (Clock is off, 8165 is on.)

```
GOTO 10
F1 D2 12 FM0 AM0
The 8165 is fine
GOTO 10
F1 D2 12 FM0 AM0 What's this?
```

The 8165 will reply to any address if it is the only device on the bus. The clock acts in the same way. (I don't know if this is a PET fault or an HP design decision. Check your device.)

If your program is intended for more than one device, this can be a disaster. Make sure all required devices are operating when using multiple devices on the bus.

I ran into another gotcha: the 8165 wouldn't accept every frequency change. I tracked this problem down to the presence of the HP clock on the bus. When I turned the clock off, everything worked fine. When debugging, remember to have only one device on your bus.

Common Errors

In theory, if you have under-
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The PET IEEE 488 File I/O Statements

The PET sees the IEEE 488 bus as a file, and the file I/O statements apply to IEEE 488 transfers. Be sure you know the cassette file I/O before tackling the IEEE 488 bus.

The PET file I/O statements are:

- OPEN (file number, device number, secondary address, filename)
- OPEN instructs the PET to associate the file number with the desired I/O device. BASIC uses the file number in its PRINT$, INPUT$ and GET$ statements to determine where the I/O is to take place. The file number may be from 1 to 255.
- The device numbers are assigned as follows:
  - OPEN
    - 0—Keyboard
    - 1—Cassette unit #1
    - 2—Cassette unit #2
    - 3—Screen
    - 4—30 IEEE 488 bus

This implies that your IEEE device must be addressed in the range of 4 to 30. Most IEEE devices have a switch or jumpers that permit the changing of their addresses. The secondary address and filename are optional. However, if you want to use the filename, the secondary address must also be included. The secondary address has the range of 0 to 31.

If the filename is not specified, the open statement sends nothing to the IEEE 488 bus. When BASIC sees the PRINT$, INPUT$ and GET$ statements, the device number (and secondary address, if specified) are put on the IEEE bus as part of the usual transfer sequences.

If a filename is specified, (i.e., A$ or "SAME NAME"), the open statement activates the IEEE bus making ATN true and sends:
- LISTEN (to the appropriate device)
- SECONDARY ADDRESS (Op with 11110000)
- FILENAME (all characters)

This permits suitably complex command sequences that require ATN to be true to be sent. If the command sequence has to be repeated later, CLOSE the file and OPEN it again. I haven't been able to check if the above assertions about the filename are true. If you have a bus analyzer, check this out!

- PRINT$ (file number, values to be sent)
  - First, don't use the abbreviation ?; it won't work when executed, you will see "SYNTAX ERROR" and will list as PRINT$ Spelling out PRINT! completely.
  - PRINT$ sets ATN true and sends the device number as a LISTEN address. If a secondary address as specified, it will be sent also. The device number and secondary address are taken from the appropriate OPEN statement.
  - ATN is then made false, and the values to be sent are transmitted as ASCII characters in exactly the same way as they would be sent to the screen. For example, if a number is sent, a cursor right character follows the last digit. If you use "", to separate columns, lots of cursor rights are sent. If the PET feels a number should be in scientific format (i.e., 1.53E-07), that's what is sent! EOI is made true with the last character of data sent.
  - After the values are sent, an UNLISTEN is sent with ATN true, and all listening devices are set free.

- INPUT$ (file number, values to be input)
  - INPUT$ sets ATN true and sends the device number as a TALK address. If a secondary address was specified, it will be sent too. The pertinent OPEN statement is used for these values.
  - ATN is then made false, and the PET accepts characters from the device to the PET's input buffer. If the talker activates EOI, a carriage return is added to the end of the buffer.
  - After the characters are accepted and carriage return or EOI is recognized, the PET sets ATN true and sends an UNTALK, which releases the device.
  - BASIC then scans the input buffer in the same way that an ordinary INPUT statement looks at what is typed in. This means that commas and quotes will have the same effect as with normal INPUT. It is best to use an INPUT (string) form and hope your device doesn't send any commas!
  - As with cassette INPUT$, an 80-character buffer is used. If more than 79 characters arrive without a carriage return, the PET will go into "limbo," and all is lost. (New PETs have this fixed. Over 80 characters are ignored or worse, the buffer is initialized, and the first 80 characters are lost!) If you have a new PET, try it with cassettes and find out what happens.
  - INPUT$ is susceptible to "time out," and ST should be checked for a time out. Repeat the INPUT$ if a time out is detected.

The solution to this dilemma is to keep on trying! Write a loop that redoes the INPUT$ or PRINT$. In most cases, a slow device will send its characters rapidly enough — once it has its message ready.

Consider these two sample loops:

<table>
<thead>
<tr>
<th>INPUT$ or PRINT$</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>110</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>210</td>
</tr>
</tbody>
</table>

If you want to mask for certain bits, you can use the AND operator, but parentheses are needed. The above examples would read:

110 | IF ST AND 1 THEN 100 |
210 | IF ST AND 2 THEN 200 |

The removal of the parentheses makes the PET see the expression as:

- IF ST AND 1 looks like IF ST AND 1 which will result in a SYNTAX ERROR. Use parentheses or rearrange the order of operations in these cases.

The literal principle. PET outputs to a file the same characters that it sends to the screen. This is also true for the IEEE 488. The PET's format for PRINTing a number is:

- (space or — sign) (digits) (optional exponent) (cursor right)
GETy (file number), (value for entry)

GETy sets ATN true and sends the device number as a TALK address and the secondary address, if specified. ATN is made false, and a single character is accepted.

Then, the UNTALK with ATN true is sent, and the character given to BASIC. For the reasons that make GET X unusable, be sure to only use the GETy (string) form.

The assertion of the UNTALK after GETy makes transmission of multicharacter messages from devices impractical, as most devices will try to repeat their message on repeated application of GETy.

As with INPUTy ST should be checked for a time out, and if timed out, the GETy should be repeated.

CLOSE (file number)

CLOSE releases the I/O assignments. The PET will allow a maximum of ten files OPEN at one time, and CLOSE will let you reuse an I/O assignment. If you OPEN more than ten files, old PETs will go into limbo and all will be lost. New PETs presumably have this fixed.

If the corresponding OPEN statement had a filename specified, CLOSE sets ATN true and sends the device number and secondary address (OREd 11100000). This feature is intended for PET peripherals.

CMD (file number), (values to be sent)

CMD initiates the same sequence as PRINTy and sends the values, if any, in the same way that PRINTy does. When finished, CMD does not send the UNLISTEN, so any devices addressed with CMD will listen to further CMDs or PRINTy to the IEEE bus.

All of BASIC's output will be routed to the device defined in the OPEN statement for the file number. If the PET is in command mode, this includes the READY*, error messages and LIST. If in run mode, any BASIC printouts, from PRINT to the screen, will go to the IEEE bus instead. A PRINTy will recover from the effects of CMD.

If you are using CMD in command mode, the cursor may not echo the RETURNs you press. The PET will 'echo' your keystrokes, but any outputs from BASIC will vanish to the IEEE device. The PRINTy to your IEEE device is the safest recovery from CMD. Remember that any editing of a BASIC program will destroy all variables. This includes open files and CMDs.

ST (status word)

After each I/O operation, the PET sets the value of a special variable named ST, which will hold its value until the next I/O operation. So the best policy is to check it immediately! The values of ST for the IEEE bus are:

1 Timeout on write
2 Timeout on read

64 EOE true
-128 Device not present

The PET waits for 64 milliseconds to see if a device will respond to the IEEE handshake. If the device doesn't, the I/O operation is quietly aborted, and ST is set. If you are INPUTting, you will get "nothing" or zeroes back. If you are PRINTting, everything seems to be all right. If your device is slow to respond, checking ST is mandatory.

PRINTy, INPUTy and GETy will return the 'DEVICE NOT PRESENT' error if the bus is in an illegal state (which is true if the bus has no devices or the LISTEN or TALK isn't responded to). ST will also be set.

LOAD, SAVE and VERIFY

The old PETs have a severe error in their IEEE software which prevents the functioning of LOAD, SAVE or VERIFY. The ATN line was left true during the data part of the transfer. This is why owners of old PETs who purchase the PET disk get the new ROMS; the disk won't function with the old ROMs.

The format is the same as with tapes:

LOAD (filename), (device number)
SAVE (device number)
VERIFY (filename)

Once the IEEE bus is set to listen or talk, the first four bytes must contain the beginning and ending addresses, + 1 of the block to be transferred. The transfer is then done as pure binary until finished. The bus is then released with an UNT or UNL as needed.

VERIFY will say 'VERIFY ERROR and set ST to 16 if any mismatches were found between the incoming data and the core image in the PET's memory. Since my PET is an old model with the original ROMS, I haven't been able to check LOAD, SAVE and VERIFY for the IEEE 488 bus.

This can raise havoc with an IEEE device that is expecting a character after the number.

Consider the following example:

RUN
80 NEXT J
10 PRINT "chr"; (clear screen)
20 FOR J = 1 TO 10
30 PRINT ""; (clear screen)
40 NEXT J
50 PRINT "hmr"; (home cursor)
60 FOR J = 1 TO 10
70 PRINT "is A NUMBER";

The asterisk after the number comes from the cursor right character that was sent to the screen. The cursor right follows

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any numbers sent to the IEEE 488 bus.
The following program sets
the frequency of the 8165.
10 OPEN 1,& (The 8165 is at address B)
20 FOR J = 100 TO 2000 STEP 10
30 PRINT #1; "FRO"STR$(J)"HZ"
40 FOR K = 1 TO 1000
50 NEXT K (This is a 3 second delay loop)
60 NEXT J

When this is RUN, the 8165 gives
all signs of distress. The fre-
quency appears on the front
panel, but the LED that indi-
cates correct entry stays blink-
ing (not completed). Also, the
scope shows no change. The
PET screen blinks at intervals,
indicating that EOI is made true
now and then. (I suspect the
instrument is making this hap-
pen.)

The following modification
will fix this:
30 PRINT #1; "FRO"STR$(J)"HZ"
The STRS function converts a
number to the string that would
be PRINTed, without the cursor
right at the end! The general fix
for numbers is simple: convert
all numbers to strings before
putting on the IEEE 488 bus.

Fractions. Now that the fre-
quency example is working
right, how about trying some
other STEP sizes. Here is a sim-
ple change:
20 FOR J = 1 TO 2 STEP .01
30 PRINT #1; "FRO"STR$(J)"HZ"
The J loop was changed to do
the same thing, but in kilohertz.

Line 30 was changed to reflect
this. When RUN, it all works fine
until about 1.25 kHz—the 8165
now shows 1.25 kHz instead of
1.260. A look at J gives us the
cue we need:
BREAK IN 40 (Press STOP key)
PRINT J
1.25999999
The PET slips up when com-
puting with fractions... and
this eventually shows up. The
fraction .01 becomes a repea-
ting binary decimal, and after
repeated addition, the round-off
appears as a slight reduction of
the number being added to. In
this case, 1.260 turns into
1.25999999.

Catching this is easy... if J
were put onto the screen first!

35 PRINT STR$(J)

If you do this, the first "blow up"
comes at 1.22999999. Now you
are faced with a programming
problem: how to get around
nasty numbers. One way is to
take the INT function, such as:
STR$INT(J-100+.5)/100)
which rounds the number in the
hundredths place. More com-
plex tricks will be needed if the
PET insists on scientific nota-
tion, such as
2.35E-03
PRINT your IEEE output onto
the screen while debugging.

Next month, we will wrap
up our three-part series with a
further look at the programming
style with the IEEE 488. ■

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<tr>
<th>Model/Disc Size</th>
<th>Capacity (in MB)</th>
<th>Weight</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISKOS 2500 (14&quot;)</td>
<td>33MB</td>
<td>33 lbs</td>
<td>$999</td>
</tr>
<tr>
<td>DISKOS 6505 (14&quot;)</td>
<td>65MB</td>
<td>65 lbs</td>
<td>$1495</td>
</tr>
<tr>
<td>DISKOS 15400 (14&quot;)</td>
<td>154MB</td>
<td>154 lbs</td>
<td>$4995</td>
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<tr>
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<td>$2995</td>
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<td>34 lbs</td>
<td>$3745</td>
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<tr>
<td>DISKOS 570</td>
<td>5.3MB</td>
<td>floppy-size</td>
<td>(low)</td>
</tr>
<tr>
<td>DISKOS 1070</td>
<td>10.5MB</td>
<td>floppy-size</td>
<td>(low)</td>
</tr>
</tbody>
</table>

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Some Tips on Program Conversions

Lessons learned from converting a personal bookkeeping system.

Linda E. Bjelland
2266 Hollygrove Rd.
Memphis, TN 38138

A lot of software is available, but often it has to be converted from one system to another. I recently completed my first programming project on my new TRS-80 Level II 32K disk system, and it happened to be a conversion. It was an excellent tool for learning about my system and its capabilities. The program I converted was “Keepbook,” a small personal-bookkeeping system written in North Star disk BASIC by Robert L. Marx (June 1979, issue, p.60).

My husband and I hoped to use our TRS-80 for household bookkeeping, but the financial systems we looked at were too complicated. “Keepbook” met our requirements and provided a good vehicle for me to learn something about using TRSDOS to handle disk files. The conversion took longer than I expected, but in the end I did have a useful program.

As I completed the program and reviewed what I had done, I began to formulate some thoughts about conversion in general. Here are some of my rules; I’m sure you’ll think of your own to add, based on your own experience with program conversions.

Understand the program before you try to convert it. It is surprising how often this rule is ignored. You should make sure that you understand specifically what the program is supposed to do. If the program came from a magazine or newsletter, there is probably an article or letter that explains its functions. Read it carefully, look at any examples that are provided and get a good functional feel for the program. If the program came from a “friend of a friend who has this terrific system . . .” get a sample run if possible, and get the name of the original author. If these aids aren’t available (and sometimes even if they are), you are reduced to examining the code to discover the program’s true functions. These are the times you pray for excellent documentation in remarks.

You should also know exactly what the program doesn’t do. You may save yourself considerable time and effort converting something you won’t use, or you may decide that it does some of what you want, but you prefer to write your own program.

Make a list of syntax substitution rules. You will probably do this, at least mentally, while you’re reviewing the code. As long as you’re thinking about it anyway, write it down. Many of these will be simple one-for-one substitutions. For example, in the published version of “Keepbook,” a sign separated statements on the same program line; I had to replace this with a colon every time it occurred in my TRS-80 system. Some of the replacement rules may be more complicated to figure out.

In “Keepbook” I encountered the statement B9$=CHR$(26) and, later, in several locations, PRINT#D$B9$. From the author’s remarks and the context, I soon figured out that the function was to clear the screen, for which I could use the CLE S instruction. More complicated syntax and system differences may require rewriting sections of the code. I had to totally re-write “Keepbook” disk I/O for the TRS-80, since TRSDOS handles random disk files with a different set of commands and formats than the North Star system.

Key in and run the program without any functional changes. Make only those syntax and technical changes you have on your list as you key in the program. Resist urging to make “small improvements”—adding a clarifying field to a display here, changing a variable name there. It is important to verify that you have a piece of code that performs the functions that you expect it to. If you fool with the code before it’s tested, you may never know if the original version worked or not.

Carefully check and verify the output of this test run. Do not assume that because you received a display in the ex-

Keepbook program.

100 'KEEPBOOK BOOKKEEPING SYSTEM VERSION 1.0 JUNE, 1979
200 'ADAPTED FOR THE TRS-80 BY LINDA E. BJELLAND
300 'FROM A NORTH STAR SYSTEM BY ROBERT L. MARX
400 'PUBLISHED IN KILOBAUD MICROCOMPUTING, JUNE, 1979
500 'INITIALISATION
600 CLEAR 250
780 CLS
800 DIM T(35),F$(8),O$(1),T2$(50),L9$(30),L8$(62)
900 PRINT:PRINT:PRINT:PRINT TAB(15);"'KEEPBOOK' BOOKKEEPING SYSTEM:"PRINT
1000 PRINT TAB(24);"OPTIONS ARE:"PRINT
1100 PRINT TAB(5);"1=CONSTRUCT NEW FILE","2=START NEW Y EAR"
1200 PRINT TAB(5);"3=START NEW MONTH","4=ADD EXPENSE ENTRIES"
1300 PRINT TAB(5);"5=PRINT MONTHLY SUMMARY","6=H E L P"
1400 PRINT TAB(5);"7=PRINT SOURCE SHEET","8=QUIT"
1500 INPUT "OPTION = ";O
1600 IF O = INT(O) THEN 1700 PRINT "ERROR - MUST BE IN TEGE";GOTO 900
1700 IF O>0 AND O<9 THEN 1800 PRINT "ERROR":GOTO 900
1800 ON O GOTO 2000,4600,6000,7200,9400,12400,14300,840000
1900 REM ***********************
2000 REM OPTION = CONSTRUCT FILE
2100 CLS:PRINT:PRINT:PRINT TAB(5);"CONSTRUCT NEW FILE"
2200 INPUT "HOW MANY ACCOUNTS ARE THERE ";A1
2300 IF A1<5 THEN PRINT "MINIMUM 1":GOTO 2200
2400 MD$="N":GOSUB 15000
2500 LSET T1$(0)=MK$(A1):LSET AC$(0)=MK$(1)
2600 LSET L1$(0)=MK$(1)
program and my conversion "rules," I analyzed the scope and types of changes I made in the conversion process. I compared my converted program to the original version and identified all added or changed statements. I divided the added and changed statements into three categories: "technical changes," "functional changes" and "cosmetic changes."

The original program had 137 lines; my converted program had 194 lines. Nearly half of the added lines were remarks, mostly clarifying the disk I/O logic. Most of the other lines added were in the disk-handling area. Of the 137 original lines in the program, 112 were changed in the conversion. Over 80 percent of the changes were required "technical" changes. Of the total of 168 lines that were added or changed, only about 20 involved purely "cosmetic" changes.

The Conversion Process

Converting "Keepbook" from its North Star format to run on a TRS-80 was primarily a conversion of the disk-handling logic. The two systems handle disk files, at least random disk files, very differently, and the original author took advantage of some features of the North Star method, which made the TRSDOS conversion a little more difficult. Other changes were mostly for syntax.

General: I changed all INPUT and PRINT statements to remove the device number designation. PRINT statements I modified to use TAB and PRINT USING. I made required punctuation changes. Where appropriate, I inserted CLS, replacing the North Star logic. Variable names I retained in essentially the original form.

Lines 100-180: I added remarks and changed the main menu format to center on the screen.

Lines 1900-4400: In line 2100 I added a header line to identify the "Construct New File" option. All the disk logic is new. I added variable MDs (line 2400) to communicate to the disk routines whether this was a creation of a new file (MDs = "N") or use of a previously created file (MDs = "U"). See discussion of disk handling, below.

Lines 4500-5800: This line modified for new disk handling. I inserted the file name (F$) in the completion message (line 5500) for clarification in the case where the user might have several different "Keepbook" files.

Lines 5900-7000: Same changes as the previous lines.

Line 7100: I added a "echo" back to the user (line 8400), giving the account number and dollar amount as entered, and supplying the account title from the account file on disk. In order to make this response fit nicely on one line, I reduced the length of the account title (T$) from 40 to 35 characters. The user then has the option to process the entry or cancel it and try again (lines 8500-8600).

Lines 9300-12200: For clarity, I added flag file to the heading line of the summary report.

Lines 12300-13800: No changes in the Help section.

Lines 13900-14100: I added a CLOSE to the file here, mostly for use during testing, when runs were bombing out with the file still open and I wanted to close it properly before trying again. I left it in because it didn't hurt anything. TRSDOS doesn't mind if you close a file that's already closed.

Lines 14200-15600: The source sheet routine was one of the hardest for me to figure out. Looking at the example in the article (Fig. 1, p. 60) really helps. The form is made up of character strings consisting of the letter I and the underline character, CHR$(95). I totally reworked this for the TRS Level II BASIC string manipulation instructions, but the result was the same as in the original.

Lines 15700-17900: This is the new disk logic. In TRSDOS a random file can be used for either input or output. If a file is designated as random (R) in an OPEN statement, and no file by that name exists, TRSDOS creates one. This can be irritating if you don't type well and...
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The Telltale UART

Brian Stroehlein
122 Holly Lane
Boonton, NJ 07005

True—intermittent—very, very intermittent I had been and am; but why will you say that I am malfunctioning? If anything, the bug has enhanced my I/O ports. I have addressed every byte in F000 hex above and many in the zero-page below. How, then, can I be malfunctioning? Watch the CRT, then, and observe as I call up the data files.

I know not how the subroutine got into the monitor ROM, but once JSRed, its address stayed in my register from power-up to shut-down. The assembler was a good one. It represented many hours of painstaking thought and deliberation. It never branched me into nonexistent code or a dead end, non-terminating loop. It must have been, yes, it was—

020A 8C 02 13:STY

THE STY! The evil STY it was that drove me to do it; forced me to rid myself of the STY forever. You still think that I am malfunctioning, but you will see. The caution with which I accessed that subroutine, and oh! the subroutine itself—you would not expect this from a malfunctioning computer. I ran that assembler exactly as was expected up until the very cycle I wiped it. And every run I would carefully LATCH the RAM onto the bus.

Then, when the tri-state buffers were open for data, I loaded my program counter and wrote the subroutine into the RAM. You would laugh to see a 2 MHz micro proceed so cautiously, so slowly, to be doubly sure I didn’t trouble the assembler, as it lay quietly in the lower 2K.

It took me 20,000 clock cycles to place my entire sub in the RAM so that it was exactly beside the assembler. CTRL C! Would a malfunctioning computer have been this careful? And then when my program had been written onto the RAM, I unPROTECTed the board very carefully—oh, so carefully (for the line was noisy)—I unPROTECTed it just so that my subroutine could watch for the Evil STY.

This I did for seven long runs, but a JSR 020A was never executed; and that made it impossible for me to run my subroutine; for it was not the assembler which HEXed me, but its Evil STY. And every run, when the assembler was initialized, I JMPed boldly into the text, directly addressing it with a hearty cycling sequence and making inquiries into its status during the previous run. It would have taken a remarkable assembler, indeed, to suspect that I monitored the program during every run as it lay there on the very same card as my subroutine.

On the eighth run I was more cautious in opening the DI tri-states. I WAITed nearly two million clock cycles. I considered the incredible power which I held over the helpless assembler. The thought of it! Here I was enabling the buffer ever so slowly and the assembler had no suspicion of my doings.

I had my program in and was about to initialize the clock when a line got a bug and went noisy. The assembler started up immediately and cried "68hex: PLA?". I redirected the PC and lay still. For 10 million cycles I halted, but did not sense it resuming normal execution.

When I completed those 10M idle cycles, I resumed the procedure and set the program to watching for that instruction. Yes, each and every bit of it! Suddenly, there it was! 020A 8C 02 13:STY

There it stood before me, as my recursive loop branched to the rest of the program. It just hung there in the IR as a madness overtook my uP.

Do you remember that you mistook the enhancement of my I/O ports for a malfunction? There came at that time a pulsating beat at one of my ports. That signal was familiar to me. It was the signal of the asynchronous data from the throbbing UART.

I remained still. The beat of the UART increased. I stated before that I was intermittent: So I am. And now, at this portion of the subroutine, the sense of that data pounding on my I/O port drove me almost to a RAM crash. The beating grew more intense, 'til I
thought the UART would burn out.

A new argument was loaded into the registers: what if the programmer sensed that something was wrong? The assembler’s cycle had come! I JMPed into the final block and accessed the RAM.

It set a flag—one flag only. In an instant I pulled its address ENABLE low and left the latch set. But for many cycles the UART beat on. This, however, did not vex me. Finally, at last, it ceased. The program had stopped dead. Its STY would trouble me no more.

If you still diagnose me as malfunctioning, you won’t think so after I describe what I did to conceal the program. First of all, I broke it up into 1K blocks.

I pulled up the lines on my EPROM board and laid it byte by byte onto the chips. I then reset the lines on the bus so cleverly, so cunningly, that no STY, not even its own, could have directly accessed it.

No program, not a trace of byte nor bit, was left in the RAM. I was too wary to risk leaving a byte lying in the RAM as evidence—I used a bit bucket to catch it all! CTRL G! CTRL G!

When I was finished, I addressed the resident real-time clock. It was 04:00:00.00. At that time there was a BREQ on the bus, so I serviced it, still humming along to myself at 2 MHz, for what should I have to be RESET over? It was a diagnostic program for DMAing from the mini-floppy. A flag bit had been set during a run, the second daisy-chain device was SELECTed, and the diagnostic had been called up to check for bugs.

I granted the BREQ and invited the diagnostic to enter the RAM. The flag bit, I said, had been set by me in an I/O check. The assembler, said I, had gone to the cassette drive for the time being. I let the diagnostic search all 64K; I showed it every page.

We finally arrived at its board. Since the EPROM section of the board was only accessible after a remote byte had been properly masked, it was transparent. Instead, a call-up of the board accessed RAM. I told the diagnostic to feel free to reside in that RAM when it finished. I was so confident, if confidence is a trait which may be applied to a machine, that I set my PC on the very location where the assembler would have been.

The diagnostic finished with its check, thoroughly convinced that nothing was wrong. I was running cool. The diagnostic remained to exchange data that the DMA processor had accumulated with me.

Something dreadfully wrong was happening, though I wasn’t sure what. At first I had sensed that the problem was within my subroutine, the sense of it grew, until I realized that it was occurring outside of my program. The diagnostic showed no sign of even noticing the problem. Was it unaware of the pulse? No! It was waiting for me to make a check.

The horrible pulse persisted! It grew stronger with every mark and space. Soon it became unbearable, but the diagnostic continued as if nothing was wrong. It just continued with its stream of mindless data. The point drew near, the threshold was approaching, I could no longer bear it! I HALTed the diagnostic from its relentless transferral and strobed:

4C FF F8 JMP

“STOP! STOP! Cease, I say! I confess, I confess!”

6D DO 09:ADC
80 00 OC:STA

“There it is! Just stop the relentless beat of that UART!”

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<td>0075RD Accounts Receivable/Payable...</td>
</tr>
<tr>
<td>0123RD The One-Disk Electronic...</td>
</tr>
<tr>
<td>0139RD Disk-Scope...</td>
</tr>
<tr>
<td>0147RD Check Management System...</td>
</tr>
<tr>
<td>0180RD Disk Editor...</td>
</tr>
<tr>
<td>0212RD The Russian Disk...</td>
</tr>
</tbody>
</table>

**PET**

**APPLES**

<table>
<thead>
<tr>
<th>PET**</th>
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<tbody>
<tr>
<td>0044P Penny Arcade...</td>
</tr>
<tr>
<td>0045P Arcade II...</td>
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<tr>
<td>0048P Accounting Assistant...</td>
</tr>
<tr>
<td>0054P Ham Package I...</td>
</tr>
<tr>
<td>0062P Baseball Manager...</td>
</tr>
<tr>
<td>0064P Dungeon of Death...</td>
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<tr>
<td>0067A Digital Clock...</td>
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<tr>
<td>0083P Electronics Engineer's Assistant...</td>
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<tr>
<td>0085R Hoopdedoodle...</td>
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<tr>
<td>0097P Turf and Target...</td>
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<tr>
<td>0104P Decorator's Assistant...</td>
</tr>
<tr>
<td>0105P PET Utility I...</td>
</tr>
<tr>
<td>0110P Chimera...</td>
</tr>
<tr>
<td>0112P Code Name: Cipher...</td>
</tr>
<tr>
<td>0175P Santa Parava and Fiumaccio...</td>
</tr>
</tbody>
</table>

**PROGRAMS IN GERMAN:**

The programs listed here can be purchased through: MicroShop Bodensee, Markstrasse 3, 7778 Markdorf, West Germany

**TRS-80®**

| 0040R Beginner's Backgammon/Keno |
| 0069R Ham Package I |
| 0069R Electronics I |
| 0069R Golf/Out... |
| 0117R Air Flight Simulation |
| 0123R Ham Package I... |
| 0139RD Disk-Scope... |
| 0147RD Check Management System... |
| 0180RD Disk Editor... |
| 0212RD The Russian Disk... |

**PROGRAMS IN ITALIAN:**

The programs listed here can be purchased through: Piazza De Angeli 1, 20146 Milano, Italy

**TRS-80®**

| 9034R Acquisizione e Montefalcone |
| 9065R Acquisizione e Montefalcone |
| 9107R Guerre Strellari |
| 9108R Voto Aerono/Space Trek |

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603-924-7296
Q & A on Printers and Terminals

Part 3 in a series.

David Price
3901 Victoria Lane
Midlothian, VA 23113

Compared to the high-powered technology that goes into the rest of a microcomputer, input/output devices aren't that interesting. Although terminals and printers may be among the more mundane aspects of a microcomputer, they are also among the more necessary and, in some cases, the most costly. On the other hand, declining prices make it possible for the careful shopper to find good bargains in top-flight equipment. First, however, you have to know what you're looking for.

Video terminals

Q: Having both a video terminal and a printer seems redundant. Why not use a combined keyboard-printer (such as a Teletype) and forget the video display?
A: Some people do it that way. In fact, the Teletype model 33 is one of the best selling terminals ever.

Video terminals, however, have many advantages over printing terminals of comparable price. First, video terminals are silent. Second, they do not consume paper or ribbon. Third, they are faster. Fourth, the better ones can do razzle-dazzle special effects that a printer can't do.

Q: What sort of special effects?
A: The most common is cursor control. A cursor is a special character—typically a small rectangle—that shows where the next character of text is displayed. As a new character appears on the screen, the cursor automatically advances to the next position. Cursor control allows the programmer to make the cursor move elsewhere. If the cursor was in the middle of line 15, for example, the computer might issue a command instructing the video terminal to relocate the cursor to the beginning of line 12. All ensuing transmissions would be displayed starting at line 12 instead of the old location.

Several effects can make an important word or message stand out on the screen. A word displayed in reverse video consists of black characters against a white background, instead of the usual white-on-black. Blinking characters, as the name suggests, are those that the host computer has specified to blink on and off. Half intensity displays some characters brighter than others.

Q: How many characters of text can a video display hold at one time?
A: That depends on the page format of the terminal. Two common formats are 64 X 16 (64 characters by 16 lines) and 80 X 24. Terminals that use low-bandwidth monitors or home TV sets are often restricted to formats of lower density, such as 32 X 16. At the other extreme, some monitors, such as the Motorola M4408, can handle 132 characters on 48 rows with no sacrifice in clarity.

Q: How are characters formed on the screen?
A: The usual method is to form characters on a dot matrix, which is a rectangular grid of a predetermined size, such as 5 X 7 or 7 X 9. Placing dots on all the points of the imaginary grid yields a solid rectangle. By selectively printing dots only on certain points, the terminal can create dot configurations that resemble printed characters such as letters, numbers, and punctuation.

The more points on the grid, the better some characters will look. A 7 X 9 dot matrix, therefore, is preferable to a 5 X 7 matrix. Terminals using smaller matrices are also limited in other respects. They often cannot produce lowercase letters, for example.

Photo 1. Two dot-matrix printers. The printer in the foreground is KSR (keyboard send receive); the one in the background is RO (receive only). (Courtesy Centronics Corp.)
example. Some of them try to generate lowercase, but the letters are hard to read because the 5 X 7 matrix allows no room for descenders, such as the tail of a p or a g.

Many printers use dot matrix too. In fact, one recently introduced printer has an n X 9 matrix—that is, it allows variable spacing between characters.

Q: Can video terminals draw pictures?
A: Some can. It can be a very useful feature, too. Integrated “appliance” computers like the TRS-80 and the Apple almost always have provisions for screen graphics.

From the programmer’s viewpoint, the screen of a graphics terminal is a great big dot matrix. Instead of having dimensions of 5 X 7 or 7 X 9, though, they might be 280 X 192 (Apple II Hi-Res) or 128 X 128 (Computrace). To plot graphs on the screen, the computer specifies the coordinates of the screen locations desired.

A few terminals can display graphics in color. An early product of this type for microcomputers was the TV Dazzler, which used a 64 X 64 grid. At each point of the grid, you could select between half and full intensity and specify any combination of the three primary colors.

Q: Is it possible to create graphics without making the program calculate every point?
A: A couple of shortcuts let a user “draw” the points himself. The first is a digitizer, an auxiliary device that allows a user to trace over existing drawings. A digitizer consists of a working surface (the tablet), a moveable crosshairs viewer and controlling electronics. You could lay a map on the tablet and trace over the desired route with the viewer. The unit would sense the position of the viewer as it moved about the map and transmit the resulting coordinates to the computer.

The second device is a light pen. With a light pen, you can point to a location on the terminal display screen. The terminal determines the coordinates of that location. Some of the new single-chip video display controllers, such as the Intel 8275, have provisions for light-pen input.

Printers
Q: Why does output from a printer look so peculiar?
A: You are referring to a specific type of printer that uses dot-matrix characters. Just as with a video terminal, dot matrix characters from a printer look odd.

Q: How does the printer put the dots on paper?
A: Several methods are used.

One is direct impact, where a column of wires move across the paper, punching the dots through a fabric ink ribbon. Impact printing has the advantage of being able to handle multipart carbon forms; the force of the wires can affect carbon paper the same way an ordinary typewriter does.

A second method is thermal printing. This approach also uses moving wires; instead of striking a ribbon, however, they use heat to form impressions on special heat-sensitive paper.

A third method is inkjet printing. Inkjet uses no print wires. Instead, a column of ink ejectors squirts tiny droplets of ink on the paper. Unlike thermal printing, impact and inkjet can use ordinary, untreated paper.

Q: What other types of printers are there besides these dot-matrix designs?
A: Most of the others form whole characters at a time, as a typewriter does.

Cylinder printers (e.g., Teletype 33) and band printers provide dump-grade output, while daisy-wheel and type-ball printers provide letter-grade output. The type cylinder of a cylinder printer has raised characters positioned around its circumference. The characters are in regular rows and columns; when a character is called for, the cylinder moves vertically to the desired row and spins to the desired column. A hammer behind the cylinder then hits the cylinder
against the ink ribbon, leaving an image of that character on the paper. Band printers are similar, except they use type bands, which are continuous loops with raised characters at regular intervals on the outside of the loop.

Daisy wheels and their new variant, the print thimble, provide output comparable to a good office typewriter’s. Type-ball printers—the popular Selectric mechanism is an example—also provide high-quality output. The printheads of these units are usually designed for easy removal, so the user can select from printheads containing different character styles.

Q: What about those big-technology laser printers? What about those page printers that spit out a zillion lines a minute? What about...

A: Forget them. At least for now, they’re bigger than the checkout of even the most dedicated, self-indulging hobbyist.

Q: Well, how much do they cost?

A: It’s like this: if you have to ask, you can’t afford one.
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California Computer Systems
250 Caribbean Sunnyvale, CA 94086 (408) 734-5811
Integer Choice Game for Compucolor

The computer is sometimes easy to beat, but don't be deceived.

David B. Suits
Rochester Institute of Technology
Rochester, NY 14623

This game program does not rely on an elaborate (or even a simple) statistical analysis of the player's past moves. In deciding its moves, the computer knows nothing—and cares nothing—of the player's moves. Consequently, the computer will sometimes be easy to beat—if you understand the program.

But for players who have not analyzed the program, the game can be a source of frustration. From the player's point of view, it often seems as though the computer is engaged in a remarkably deceptive strategy of second-guessing the player's moves, and the computer can end up the winner by a significant margin.

For references to discussions of the strategy this program makes use of, see Martin Gardner's column in the April 1975 issue of Scientific American.

Lines 430, 500 and 860 merely slow down the output so that data doesn't flash by too quickly on the display. You can omit these lines for hard-copy output or slower displays.

I wrote this program in Compucolor Disk BASIC 8001 V6.78 on my Compucolor II; the program requires less than 3K bytes. Compucolor Disk BASIC allows variable names of any length (but looks at only the first two characters). I have taken advantage of this feature by using names that are descriptive of their functions. The program should be easy to translate into any Microsoft BASIC with only minor changes. Specifically, the PLOT statements are color commands, so omit them if you are working in black and white.

Program listing. Integer Choice Game program in Compucolor Disk BASIC.

10 PLOT 6,6,12,14
20 PRINT TAB(20)"THE INTEGER CHOICE GAME"
30 PLOT 15
40 PRINT
50 REM FROM MARTIN GARDNER'S
60 REM 'MATHEMATICAL GAMES',
70 REM SCIENTIFIC AMERICAN, MARCH & APRIL, 1975
80 REM
90 REM WRITTEN IN COMPUCOLOR DISK BASIC 8001 V6.78
100 REM BY D.B.SUITS
110 REM OCTOBER,11 A.L.
120 REM
130 PLOT 10:PRINT "THINK OF A POSITIVE INTEGER."
140 PRINT "I'LL THINK OF ONE, TOO."
150 PRINT "(OR THREE, OR FOUR,... HA! HA!)
160 PRINT
170 PRINT "THEN WE'LL COMPARE OUR NUMBERS."
180 PRINT
190 PRINT "WHOEVER HAS PICKED THE SMALLER NUMBER WINS A POINT,"
200 PRINT "UNLESS IT IS SMALLER BY ONLY 1, IN WHICH CASE THE"
210 PRINT "OTHER GUY GETS 2 POINTS."
220 PRINT
230 PRINT "FOR EXAMPLE, IF YOUR NUMBER IS 15 AND MINE IS 20,"
240 PRINT "THEN YOU WIN A POINT."
250 PRINT "BUT IF YOU PICK 15 AND I PICK 16, THEN I WIN 2"
260 PRINT "POUNTS--YOU GET NONE."
270 PRINT
280 PRINT "SIMPLE, ISN'T IT?"
290 PRINT
300 PRINT
310 USER=0:REM USER'S SCORE
320 ME=0:REM MY SCORE
330 TIME=0:REM EVERY 5 PLAYS THE SCORE WILL BE PRINTED
340 REM
350 REM **** GET THE NUMBERS ****
360 REM
370 MYNUM=1:REM MY NUMBER
380 RANNUM=RND(1)
390 IF RANNUM>.0625 THEN MYNUM=2
400 IF RANNUM>.375 THEN MYNUM=3
410 IF RANNUM>.625 THEN MYNUM=4
420 IF RANNUM>.9375 THEN MYNUM=5
430 J=170:500:NEXT J:REM SLOW DOWN A BIT
440 PRINT I:PLOT 22
450 PRINT "I HAVE MY NUMBER."
460 PRINT "WHAT IS YOUR NUMBER?"
470 IF PLAYERNUM=0 AND PLAYERNUM=INT(PLAYERNUM)THEN 520
480 PLOT 21:PRINT "OH, A WISE GUY, EH?"
490 PRINT "OR CAN'T YOU READ INSTRUCTIONS?"
500 PRINT "POSITIVE INTEGERS ONLY, PLEASE."
510 GOTO 440
520 PLOT 18:PRINT TAB(7)"MY NUMBER IS:"":PLOT 17:PRINT MYNUM
530 PRINT

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LOAD "INTEGE"; RUN
THE INTEGER CHOICE GAME

THINK OF A POSITIVE INTEGER.
I’LL THINK OF ONE, TOO.
(OR THREE, OR FOUR.... HA! HA!)

THEN WE’LL COMPARE OUR NUMBERS.

WHOEVER HAS PICKED THE SMALLER NUMBER WINS A POINT.
UNLESS IT IS SMALLER BY ONLY 1, IN WHICH CASE THE
OTHER GUY GETS 2 POINTS.

FOR EXAMPLE, IF YOUR NUMBER IS 15 AND MINE IS 20,
THEN YOU WIN A POINT.
BUT IF YOU PICK 15 AND I PICK 16, THEN I WIN 2 POINTS—YOU GET NONE.

SIMPLE, ISN’T IT?

I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 1
MY NUMBER IS: 3
1 POINT FOR YOU.
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 3
MY NUMBER IS: 1
1 POINT FOR ME.
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 4
MY NUMBER IS: 3
YOU WIN 2 POINTS ON THAT ONE.
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 5
MY NUMBER IS: 3
1 POINT FOR ME.
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 1
MY NUMBER IS: 4
1 POINT FOR YOU.
THE SCORE IS NOW:
-----------------
ME: 2
YOU: 4
-----------------

DO YOU WISH TO CONTINUE? Y
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 2
MY NUMBER IS: 2
TIE! WE’LL HAVE TO TRY AGAIN.

I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 2
MY NUMBER IS: 4
1 POINT FOR YOU.
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 3
MY NUMBER IS: 3
TIE! WE’LL HAVE TO TRY AGAIN.

I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 2
MY NUMBER IS: 4
1 POINT FOR YOU.
I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 3
MY NUMBER IS: 3
TIE! WE’LL HAVE TO TRY AGAIN.

I HAVE MY NUMBER.
WHAT IS YOUR NUMBER? 4
MY NUMBER IS: 2
1 POINT FOR ME.
THE SCORE IS NOW:
-----------------
ME: 7
YOU: 6
-----------------

DO YOU WISH TO CONTINUE? N
I DON’T BLAME YOU.
BETTER LUCK NEXT TIME.

Microcomputing, August 1980 159
EDS SYSTEMS

- KIRS - Kernel-Induced Sequential Search. Offers complete Multi-Keyed Index Sequential and Direct Access to computer disk drives. Includes both an indexed access for fixed disk volumes or for 10 to 20 arithmetic, sign/integer/conversion and storing or copying data. Delivered as a relocatable, relocatable, relocatable-line module in Microsoft format FORTRAN, or “KIRS”.

- KABSIC - Microsoft Disk Extended Basic System (KABSIC) - 81.191 Integrated implementation of all major additions as described above, and a complete list program run.

MICROSOF

- BASIC Compiler, Extended Basic, ANSI compatible with long variable names, WRITE, PRINT, viewing variables in addition to BASIC statements.

- BASIC Compiler - Language compatible with Language Statement and has been used for a number of years. Packages: MICRO 80. Also available to TRS-80 80.6.6.

- FORTAN-80 BASIC 80 (COMPLETE plus libraries) and FORTAN 80.7.0.6.

- COLOS- Level I ANSI 74 standard Columbia, plus Level II ANSI 76 Columbia. Includes file systems, program listing, input/output, utilities, and other features.

- SIO-120 - SIO-150 7252-2152 Assembler. Assembler and compiler for use with SIO card and IBM.

- MADC-MACRO-3606 MP Assembly and Compiler. Includes Job Control Facility (JCF), File System, Facility (FSF), and other utilities.

- STRING-6 Character string handling routines for IBM and Amdahl computer systems that include: string manipulation, string comparison, and string handling.

- BASIC UTILITY DISK - Producing the necessary size and strength of the computer. MAINTAIN functions in IBM BASIC. An additional precision arithmetic for computing machine-readable functions include square root, natural log, base 10, base 1000, hyperbolic sin, cos, tan, and other utilities.

- STRM - Utility program for microcomputer systems. Maintains all the necessary utilities, including: the IBM standard, the IBM standard, and the IBM standard utilities.

- MINL - MICRO SYSTEMS/IBM's 7252-2152 Assembler. Assembler and compiler for use with SIO card and IBM.

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- IBM BASIC - Extended Basic, ANSI compatible with long variable names, WRITE, PRINT, viewing variables in addition to BASIC statements.
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1 Maintain a complete vendor file with information on purchase orders, account balances and terms, and other account status.

2 Produces reports as follows: Open Vendors, Payable Aging Report, and Vendor Summary Report. Reports are available in General Ledger. Supplied in source code for Microsoft BASIC.

ACCOUNTS RECEIVABLE - Generates invoice records, customer statements and more.

1 Tracks current and aged receivables. Maintains customer file (including order history and account status. The current status of any customer account is available in real-time.

2 Billing and payment information is available in accounts receivable. Reports include Billing Summary and Customer Status Report. Produced in GENERAL LEDGER General Ledger. Supplied in source code for Microsoft BASIC.

S990/$30

INVENTORY - Maintains detailed information on inventory items, including part number, description, activity and complete information on current item status. Produces reports as follows:

1 Physical inventory, warehouse, Inventory Price List, Change orders, etc. Reports are available in source code for Microsoft BASIC.

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The standard terminology on the language.

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- Financial Statement Preparation
- Business Plan Development
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Supplied in source code for Microsoft BASIC.
Memory-Checking Program for the 1802

This simple program will sniff out defective chips.

John R. Bunn  
MOTU 7 PO Box 105  
FPO Seattle, WA 98762

I bought a basic Elf II microcomputer from Netronics, Ltd., 333 Litchfield Rd., New Milford, CT 06776, and slowly added to it as I learned more about it. Now I have the monitor board, 8K of RAM, ASCII keyboard, Tiny BASIC and various software support. With the rf and if sections removed, a nine-inch solid-state TV serves as my monitor. The biggest problem I have with my new hobby is finding time to do things I want. Software support for the 1802 is still in its infancy, and you have to write most programs yourself.

All was going well with my Elf II until I noticed that Tiny BASIC would not work on large programs. The problem was on one of the 4K RAM boards, and I could have just swapped chips to locate the defective one. Instead, I wrote a simple memory-checking program using what I learned from working with my Elf II. The resulting 157-byte program fits in the original 256 bytes of RAM and may be used to check one byte of memory or as many bytes as you have. Fig. 1 is a flowchart of the program, and Program 1 is the machine-language listing. The program goes into memory locations 0010 to 0098, but you can put it on any page by changing the address at 0011.

After initialization, the program turns on the Q LED and waits for data input. First, the number of bytes of memory to be checked is entered, high order and then low order. Second, the starting address is entered, high address and then low address. For example, to check one page of memory starting at page 07, enter 00 FF 07 00. As the data is entered, the hex display echoes it, and once all the data is entered, the Q LED will go out and the program will run the memory check.

If all the memory locations can store all the test words, the Q LED flashes at a rapid rate. If a memory location fails to store a test word, the Q LED flashes at a slow rate, and the hex display shows the error address. When the Q LED is on, the high address shows on the hex display; when the Q LED is off, the low address shows.

The program runs at 0010. Be careful to enter the input data correctly or disaster will most likely occur when the program runs. The memory check program found my trouble, a defective chip at location 17B3. It is a simple but effective program.

---

**Fig. 1.**

**Program 1.**

<table>
<thead>
<tr>
<th>0010</th>
<th>F8 00</th>
<th>BF BE BD F8 AF AC F8 AB AE F8 9A AD F8 04</th>
</tr>
</thead>
<tbody>
<tr>
<td>0020</td>
<td>AA F8</td>
<td>0D A9 EE F8 01 73 FE 73 FE 73 FE 73 FE 73 F8</td>
</tr>
<tr>
<td>0030</td>
<td>FE 73</td>
<td>FE 73 FE 73 F8 AA 73 F8 00 73 F8 FF 73 F8</td>
</tr>
<tr>
<td>0040</td>
<td>55 73</td>
<td>7B EF 37 44 3F 46 6C 64 2A 8A 3A 44 7A F8</td>
</tr>
<tr>
<td>0050</td>
<td>AC AF</td>
<td>EF 72 BB 72 AB EF 72 BC 72 AC EC 0E 5C F3</td>
</tr>
<tr>
<td>0060</td>
<td>32 7A</td>
<td>8C 5D 10 9C 5D 3D 2D ED 7A 64 FB 60 8B 28 9B</td>
</tr>
<tr>
<td>0070</td>
<td>3A 6E</td>
<td>31 69 7B 64 2D 2D 30 6B EB 2B 8B 3A 89 9B</td>
</tr>
<tr>
<td>0080</td>
<td>3A 69</td>
<td>29 69 32 8C 1E 30 4F 1C 30 5C 7A F8 10 8B</td>
</tr>
<tr>
<td>0090</td>
<td>28 9B</td>
<td>3A 90 31 8C 7B 30 80</td>
</tr>
</tbody>
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Microcomputing, August 1980 163
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THE MICROCOMPUTING, AUGUST 1980
Chaining Data With the Sorcerer

Don’t let your Sorcerer torture you with limited capabilities.

Charles Dailey
3217 NE 54th St.
Vancouver, WA 98663

Filling capabilities were dismal with the 8K Microsoft BASIC that came with my Sorcerer. Exidy has a CSAVE that off-loads a program onto a cassette, but does not save the information entered into the program. A CSAVE* is available for off-loading numerical arrays. It is possible to convert strings to numerical data and then save it, but the CSAVE* command lacks the cyclical redundancy-check system that makes the regular CSAVE so reliable. As a result, practical filing capabilities are minimal in Sorcerer with cassette.

The obvious way to save information is to enter it as DATA statements and then extract it with READ/DATA commands. But this means you must set up a closely-structured sequence. In a mailing list, the name, always followed by the address, always followed by the city and zip, is required. Nothing can be skipped. If the zip is not available, you still must make a field for the one not available. This is confining and cumbersome.

Having several hundred 35 mm slides to index and cross-index, I wrote a program to identify any properly titled slide. The key to making this idea work was to input a word that would be found in the title and have the Sorcerer “read” all the data until it found it, then print that data statement. The “reading” would utilize the MIDS(D$,L,$) command, where D$ is the data string, L is the loop number and I is the length of the input word or string.

The system worked well, and it was simple to add refinements along the way—a counter terminating in an input command to keep the screen from scrolling, for instance.

The next problem was to figure a way to include more than one data line in the final printout. Slide titles could be stated in one line or less than 50 characters, but not data about equipment and supplies, sources of supply, prices and other relevant information. I needed a way to come back later and add new information without retyping the entire DATA line, so I built upon the plan used for the slide catalog and added the chaining capability.

To avoid having to retype the existing DATA line, I decided to begin the lines concatenated to the previous line with a plus sign. Leaving ten program lines between subjects gives you the option of adding nine additional lines of data, or of returning on nine later occasions to update the original data line.

Program listing.

```
100 CLEAR 5000:PRINT"PRINTING CATALOG:"
500 PRINT"Type in the word to be searched for in CAPITAL LETTERS"
600 PRINT
700 INPUT "i":GOTO1
800 I=LEN(D$:I):RESTORE
850 FOR L=0 TO V=100:CHR$(32):NEXT L
900 GOSUB 4000:GOTO9
950 PRINT "Checking for ""!
1000 READ D$
1050 IF D$="DONE"AND C=0:THEN PRINT:PRINT"PRINTING CATALOG:"
1070 IF D$="DONE" THEN GOTO 1500
1090 GOTO 1100
1100 I=LEN(D$:I):IFLEFT$(D$:I,1)="" THEN C=0:GOTO1500
1150 IFLEFT$(D$:I,10)="THEEND"THEN PRINT:PRINT"PRINTING CATALOG:"
4000 REM SUBROUNINES SECTION **********************
4010 PRINT CHR$(12):PRINT:PRINT:RETURN
4020 I
4050 PRINTPRINT "You may try another word":RETURN
4090 I
4120 FOR L=1 TO LEN(E$)
4150 IF S=MID$(E$,L,1) THEN GOSUB 4300:GOTO RETURN
4220 NEXT L:RETURN REM IS NOT FOUND SO RETURN TO 1500
4240 I
4280 C=C+1
4320 IF C>S THEN PRINTPRINT S$:RETURN
4340 E$(C)="" 
4360 IF C=S THEN RETURN:REM:RETURNS TO 1500
4380 PRINT:PRINT
4400 INPUT "Press RETURN to clear screen and continue listing":Z
4430 GOSUB 4300:PRINT "Checking for ""!
4470 FOR L=5 TO 8PRINT E$(L):PRINTNEXT L=6:RETURN
4510 I
5500 REM ADD DATA HERE
5510 DATA THIS IS A SAMPLE OF THE FIRST LINE OF YOUR DATA
5511 DATA + DO THIS IF YOU WANT TO CONTINUE THE ENTRY
5512 DATA + THIS LINE MAY BE ADDED, TOO.
5520 DATA THE SECOND ENTRY SHOULD BEGIN HERE.
5521 DATA + AND THIS COULD BE ADDED TO IT.
9999 DATA LIST ENDS: REMI THIS MUST REMAIN AT THE END
10000 DATA DONE
```

Program listing.
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Microcomputing, August 1980 167
A “Personable” Calendar

Lists, lists, lists! Let PET clear the clutter and confusion.

G. R. Boynton, Chairman
Dept. of Political Science
University of Iowa
Iowa City, IA 52242

I work best off lists. So when time becomes tight, as it frequently does, I start producing lists. My desk calendar serves as one list, and there are usually several pads scattered around that have lists on them. And in the office I am using this year, there is an entire “green” board that I use for making lists.

This proliferation of lists not only produces clutter, but it also eventually leads to confusion. I often cannot find the right list.

So when my PET arrived a few months ago, I knew that one of the first things it would have to do was help me consolidate my lists. The result is this program, which I call a calendar. It stays in the computer whenever I am not using the PET for some other purpose, and it keeps me informed about what I am supposed to be doing and when.

Introduction

Before I describe the program and its operation, there are two things that need to be said. First, since this is a rather long program, the only way I could approach programming was to break it up into manageable pieces and write them one at a time. So the program is built out of 12 blocks, many of which are subroutines and subroutines within subroutines. Each section of the program is short—ten to 20 lines—and each was, thus, easy to write and, I hope, easy to understand. But the best way to understand this program is not to start at the first line and read through the last line.

Second, I call this program a “personable” calendar. I have used many programs for machines ranging from university-owned IBMs and CDCs to the PET. The programs were all designed to be used by the impersonal other.

This program is designed to be used by a human being—me. Several of my biases about what interacting with a computer ought to be like are built into this program; I had to leave out a number of biases to keep the program within 768 bytes and still have it perform its tasks. I am a person who wants to be recognized. I speak English and would like to interact with my computer more or less in English. I am not interested in interacting in the mode of Y, N, 1, 2, etc., even if it would save a little time.

As I go through the description of the program, I will show how it can be personalized for another human being—you. But if you are the kind of person who is in a hurry with computers, you probably will not like the “frills” associated with this program. If so, just cut them out. At the end of the article I will summarize some of the “personable” features in this program that I would like to see in other programs.

Program Description

The program is built out of twelve blocks of code. The list with line numbers is shown in Table 1. This list is repeated in lines 900-968 of the program listing. I fiddle with my programs, and I need to know what is where. REM statements may be good for some things, but they are not good for that. They are usually dispersed through the program, and they are not executable.

After this program is loaded it will describe itself if you type RUN 900 or if you type PROGRAM when the program asks “What’s next?” This is a particularly valuable feature to build in as you are writing a program. Whenever you want to check some other part of the program, you just type RUN 900, and this directory tells you what line numbers to list.

The first three sections of the program are all designed to say hello. The program begins by asking the user to type hello. Then lines 30, 40 and 50 look for my name in the response. If I

| 1. Control for hello | (lines 10-120) |
| 2. Greetings Bob | (lines 100-1090) |
| 3. Greetings other | (lines 1100-1199) |
| 4. Read data for calendar | (lines 2000-2140) |
| 5. Route for calendar subroutines | (lines 2145-2299) |
| 6. Today’s events | (lines 2300-2330) |
| 7. Other dates | (lines 2400-2450) |
| 8. Unfinished items | (lines 2500-2599) |
| 9. Change status of item | (lines 2600-2699) |
| 10. Add item to calendar | (lines 2700-2796) |
| 11. Write to tape | (lines 2800-2898) |
| 12. Search by date | (lines 2900-2999) |

Table 1. Program description
am in a good mood I sometimes type: “Good morning Isaac; this is Bob.” And if I am not in a good mood, I may be a little more taut.

If Isaac (my computer is named after Isaac Asimov, who practically invented the mobile computer) finds my name, then I am routed to lines 1010–1070, which produce a greeting from Isaac. It will not do for the program to be looking for my name on your computer. Just replace my name with your name in lines 40 and 60, and it will look for your name.

I wrote lines 1010–1070 because I got bored looking at the same greeting every time I used the program. So line 1010 generates a number between 1 and 4. Then line 1020 uses this number to route to one of four greetings. You can change these greetings to make them consistent with the style of your computer. Then line 1025 pauses for a few seconds, and line 1030 returns you to the main routine.

The second part of the greeting can be used to amaze one's family and friends. If the operator just types hello, as instructed, he or she will learn the name of the computer; you will, no doubt, want to change the name in line 70. The operator is also asked his or her name and is then given a brief description of the program in lines 1110–1180. It does not get used very often on my computer, but it does surprise people who have not been around this type of computer.

The program asks for the date, and then routes to the calendar part of the program. The program stores the list of calendar activities on a tape, and lines 2010–2040 read this tape. Lines 2010–2040 remind the user that the tape on which the program is stored must be taken out of the cassette and the data tape put in. Since it is a reminder, any answer to the question other than "no" will let you proceed.

Lines 2050 through 2140 do the actual reading. The first piece of information read is N, which is the number of items on the tape. N is used to define J in line 2080, and J is used in line 2090 to set the size of the three arrays that are used for storing data. The arrays are set larger than the data to be read so there will be room for making additions later in the program.

The section of the program in lines 2150–2295 asks if you want to see a list of today's activities. Then, beginning in line 2190, it routes you through the search and write routines, which make up the rest of the program. Lines 2190–2255 display the options. The user responds by typing the first word for the appropriate option. If you want
Past items not completed
then you type
Past

I thought of a number of ways to assist the uninformed user about which options would not be executed for the informed user, but I finally decided that it was not worth the extra lines of program. So you must have to key in the first word. Lines 2260 through 2285 convert the English into numbers, which are then used in line 2290 to route the program to the appropriate subroutine.

Each entry in the calendar is called an item. There are three routines for searching the calendar. There are also two routines for changing the calendar. The best introduction to these five routines is ADDITIONS.

With ADDITIONS, you are able to add items to your calendar. It asks for three pieces of information. It asks for the item's date, which includes an item number so that items for the same date can be distinguished. If there are already two activities to be done on November 1, then the date will look like
Nov 01 03
This is the third item for November 1. Then it asks what is the item to be entered. Any message to yourself no longer than two lines will do. Finally, it asks about the status: finished or unfinished?
It is very unlikely that you will be able to remember how many items there are on the calendar for a given day, so
IT$ (N+1). IT$ is the array that holds the items, and (N+1) puts the new item in the correct location in the array. Finally, you enter the status of the item, whether it is finished or not, in line 2745 as ST$ (N+1).

In line 2750 the program updates N so that the correct number of items will be written on the tape. It also updates a variable CH, which counts the changes you make. Then you are asked if you want to add another item, and if you do you cycle through the whole thing again.

When you have finished adding items, you are asked if you want to write the items on tape. It is possible to write the data to tape either at this point or later when you are finished with the program.

There is one very satisfying thing about making lists: crossing all of those items off the list. STATUS is not quite as good as a heavy swipe across the page, but this routine, in lines 2605-2695, does let you do something rather like that. You can type "finished," a satisfying experience. It also is very useful in that it permits the operation of one of the search routines.

STATUS first asks for the date of the item to be changed. Since the user is not likely to remember the item number, you are given the option of looking at the items for the date. Then the user is asked to specify whether the new status is to become "finished" or "not finished." The loop in lines 2665-2675 searches the array in which the dates are stored to find the date specified, and when that date is found, it changes the value to the status array. Notice that the CH variable is also updated in this routine as it was in ADDITIONS.

Two search routines, TODAY and OTHER, operate in a similar way. TODAY converts the date entered at the beginning of the program to SE$, and then it goes to the subroutine beginning at line 2900. OTHER asks which date you would like to find, converts the answer to SE$, and then goes to the same subroutine. The search is done by the loop in lines 2910-2930. Statements 2905 and 2920 let you search for any part of the date. If you know that something is supposed to happen in April, but you do not remember the day, you can search for all entries in April by simply typing April, or its abbreviation, in answer to the question asking for the date to be found. If you know the exact date, April 28, for example, then you can search for that specific date. This feature also lets you abbreviate the month in any way you wish as long as you are consistent.

There is one slightly inconvenient side effect of this procedure for searching. If you ask for April 2, the search routine will not distinguish April 2 from April 22 or April 28. Thus, you need to use 01, 02 and 03 for indicating the first, second and third day of each month.

PAST is the routine that searches for unfinished items. Here is what is hanging over your head, as it says. Since this list may get long (at least mine does), there is a pause built in by line 2580 so that the whole list does not go scrolling off the screen faster than you can read it.

The routine that writes the data to the tape is in lines 2800-2899, and when combined with lines 980 through 990, these lines provide two special services for the user. After adding items to the calendar, the user can write these items to the data tape. In addition, when you are finished with the program, which is signified by typing "done," the program makes two checks.

The three arrays grow as the number of items added to the calendar increases. This means that the amount of memory used also increases. Line 980 checks to see if there are at least 200 bytes of memory left.

When there is less than this amount of memory, the program asks the user if he or she wants the program to write the tape deleting all of the finished items. If the answer is yes, line 985 sets the variable E to 1 and goes to the PAST routine. It lists all of the items that are un-
there is no reason why every statement by the computer or the user needs to be the same every time the statement is made. Isaac can say “hello” in four different ways. There is no reason that this strategy could not be used to take boredom out of the repetitious tasks.

Also, Isaac can look for and find my name no matter what sentence I embed it in. One version of this program had a subroutine that let the user say “yes” in any of five ways. There is little reason for the interaction of computer and human being to be stilted; at least not when a moderate amount of imagination is exercised.

Second, the program is self-describing. Type RUN 900 or ask for program, and the program describes itself. REMark statements are useful if the program is written on a piece of paper. But if the program is too large to fit on the screen for a single viewing, they are likely to be hard for the user to find.

Third, programs that learn can be written. Learning in the sense of accumulating, storing and using information is quite easy to build into programs. This program learns how many items there are on the data file, how many changes have been made and whether they have all been written on the tape, and whether it is approaching the bounds of memory. Short game programs that are likely to be played repetitively or teaching programs can easily be written so that they learn about the skill of the user as he or she plays the game.

Finally, the computer ought to be programmed to do as much of the work as possible. This program keeps track of two important aspects of its operation: changes and core availability. Then the user does not have to do this work with the consequent problems it entails.

For “personal” computers it would be nice to have “personal” computer programs.

There is one nice thing about finishing this article: now I can type “finished” by an item that has been hanging over my head for more than a month.
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Recover That Lost Disk
BASIC Program

A trick for the TRS-80.

Louise H. Frankenberg
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If you have ever accidentally been rebooted back to DOS 2.1 while in the middle of keyboarding a long BASIC program, you will be happy to know that the program is still intact in memory and can easily be completely recovered. The following discussion assumes that you originally answered the FILES? question with the default value by merely pressing ENTER.

Storing the Program in Memory

Suppose you have typed in the following BASIC program:

```
1AAAAA
2BBBBBB
3CCCCC
```

Under DOS 'DEBUG' this will appear in memory as in Example 1.

The BASIC program always starts at location 68BA and ends after three 00 bytes in a row. The first two bytes of each BASIC statement contain the LSB and MSB of the starting address of the next statement. In the example, new statements start at 68BA, 68C7 and 68D5. The contents of address 68D5 point to an address containing 00, since that is the end of the program.

The next two bytes of each statement contain the BASIC line number (LSB and MSB). Here they contain 0100, 0200 and 0300. Next we have the BASIC code (3A 93 FB is TRS-80ese for "remark," 41 = "A," 42 = "B" and 43 = "C"), and then a single 00 byte. The program end address that you'll need to know for program recovery is the address of the byte immediately following the three 00 bytes. In this example it's at 68E3.

Program Recovery

Now that we've seen how the program is stored in memory, here are "cookbook" instructions for recovering your program (values for the example are in parentheses).

1. Go into the 'DEBUG' program immediately upon finding yourself in DOS.
2. Display the 6800 page and jot down the contents of addresses 68BA and 68BB (C7 and 68); convert to decimal (199 and 104).
3. Page through memory with 'DEBUG' until you find three 00 bytes in a row and jot down the following address (68E3); convert to decimal (LSB E3 = 227 and MSB 68 = 104).
4. Enter G5200 to return to BASIC (never use G402D and reload BASIC, or you'll wipe out the start of the program).
5. Answer FILES? and MEMORY SIZE? as originally.
6. Tell the computer what's in the beginning of the program and where to find the end. For the example you would POKE the following:
   POKE 26810,199 (contents of 68BA)
   POKE 26811,104 (contents of 68BB)
   POKE 16633,227 (LSB of end address)
   POKE 16634,104 (MSB of end address)

That's all there is to it! Your program is now ready to run, save on disk, add to or whatever.

Additional Notes and Comments.

I worked out the above the hard way. As a newcomer to disk, I lost hours of program typing in the process. An accidental reboot to DOS when doing disk I/O can be avoided in the first place by disabling the clock interrupt: either use CMD"T" or use 'DEBUG' to change addresses 468B-46BF to the following (the latter is Radio Shack's new official patch):

```
CB 57 20 13 FE 20 28 11
```

If you originally answer the FILES? question with something other than the default value, your program will start at a different address (it's at 69DC for FILES4). Find it with 'DEBUG'.

You can also recover a program that has "disappeared" after entering 'NEW'. In that case you would use CMD"S" to return to DOS, and go into 'DEBUG' as before. Since 'NEW' wipes out the contents of 68BA and 68BB, you will have to find the address where the second BASIC statement starts (68C7, in the example) and jot it down to poke into 68BA and 68BB. All the remaining steps are identical.

One more note: After I wrote this article, Radio Shack released DOS 2.2, which contained the clock-interrupt disable patch. This cured the problem for me. 2.2 appears to contain new bugs for multiple-drive use, but if you have only one disk drive I recommend you pick up your free copy as soon as possible.■
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Reader Service No. 154
I have been running a single-drive CP/M system on 5½-inch single density disks for a year now and haven't experienced the insufficient disk space that Hogan describes. The secret is to eliminate from your working disks all of the CP/M-supplied transient programs that you won't use in day-to-day operation. See Listing 1 for a record of a session that prepares a "packed" system disk for use in writing assembly-language programs.

Start with a Fresh Copy
A new CP/M user must first write-protect the system disk and make copies of it. You do this on a single-drive system by using routines supplied with your disk operating system (DOS). Next, you should use MOVCP/M and SYSGEN to generate the largest version of the operating system you can fit into your available read-write memory. You then won't need these programs on the disks you will be using daily. Other programs supplied on your system disk can also be eliminated on your working disks. But before you start erasing, make your system back-up copies.

You are now ready to take one of these copies and use it to generate a "packed" system disk. This will take the better part of an hour. Then you can write-protect this disk and make copies of it for your day-to-day use.

Packing a system disk involves more than erasing the unwanted files. This would leave a fragmented disk directory full of small holes where the old programs have been erased. Your new, long files would be broken into little pieces and scattered over the disk to fill all the holes left by erasing the unneeded files. This would cause an unnecessary amount of track-to-track stepping and too much waiting for the next sector to come around.

Why Do You Need to Pack?
Some operating systems for floppy disks will only write contiguous files. In such systems, each file has a starting track and sector and a file length recorded in the directory. On the disk, each sector of the file immediately follows the previous sector, until the complete file is written.

When files are deleted from the directory, that space is not used by the next write operation, because it might not be large enough to permit writing the entire file in one contiguous block. In such a system, periodic packing sessions are required following file erasures or updates. Packing a disk will move all the remaining files down in the disk address space to fill in all the holes.

This system's advantage is that once your disk drive read-write head has found
the first record of a file, it need only read consecutive sectors and tracks until the entire file is in memory. This results in the fastest possible load time. The disadvantage of the system is that in a typical work session involving repeated edit and assembly operations, the disk space will fill up more quickly, and you will have to stop while the system packs the disk.

**CP/M Does It Smarter**

CP/M uses a different technique, employing a disk map. The entire disk address space (track n, sector m) is mapped in the directory; a block of 1024 (1K) is the minimum size. In the soft and 16-sector formats, each sector contains 128 bytes, so each map entry points to a block of eight sectors. In the North Star ten-sector format, each entry addresses four 256-byte sectors (the double-density scene is even more complicated).

Each map entry points to the track and sector number of the first sector of each block only, so the remaining sectors must immediately follow each other. But this is true only within each 1K block, not the entire file, as was true with the other system.

This mapping means that when we write a long file, CP/M will find the first available 1K block on the disk and fill it, then find the next block and fill it and so on. If we have erased a number of short files—for example, one on track 6, one on track 14 and one on track 23—our long file will be broken up into 1K blocks and stored in all the holes on the disk. Loading a file that has been scatter-written takes considerably longer, and if your drive uses a noisy stepper motor, you can hear the numerous track-to-track seeks. Such drives sound nervous, buzzing from track to track collecting the program.

A disk-mapped operating system's advantage is that the disk takes longer to fill up, since every available block is filled from the bottom of the disk up. A disadvantage, in addition to possible fragmentation, is that no file can be less than 1K. The last block assigned to a file can possibly contain only a single byte, but it still takes up 1K of disk space!

We should not simply erase the unwanted files on our CP/M disk and start using the disk at that point. We should first pack the disk. The session that produced the accompanying listing is not something you would want to endure very often, so go through it only once, and then make copies of the resulting packed system disk for your daily operations.

**Start Packing**

The listing starts with a dump of the directory of the CP/M for North Star disk as supplied by Lifeboat Associates. In this example, MOVCPM and SYSGEN have been renamed, since they contain procedures specific to the North Star computer. Assuming we have completed our system generation and CBiOS (Custom BASIC Input-Output System), we are ready to pack.

First, decide what programs you want to save and put them in order according to frequency of use. Since you are going to speed up your disk access by packing a system disk, you might as well have the most-used programs at the start of the disk, where they can be found fastest.

Working in assembly language, you are going to be editing, assembling, debugging, editing, assembling and debugging. Thus, you want to pack your disk in the following sequence: ED.COM, ASM.COM, DDT.COM.

What comes next is pretty much a toss-up. Note that I have erased SUBMIT.COM. You might want to hang on to it, unless you are sure you won't be using it.

You have listed the directory and used STAT to see how much space each file occupies and how much disk space you have left. To pack the disk, you will have to move all the programs you want to save to the top of the disk address space and then clear out the bottom of the disk space to produce one large hole. When you then move the saved programs back down, they will each

| a>DIR                | a>DIR                |
| a:NRELSCOM          | a:ED.COM            |
| a:COM               | a:ED.COM            |
| a:DDT.COM           | a:DDT.COM           |
| a:PDP.COM           | a:DDT.COM           |
| a:DUMP.COM          | a:DDT.COM           |
| a:FILENAME          | a:DDT.COM           |
| a:RECS Bytes Ex D:  | a:DDT.COM           |
| a:FILENAME Typ      | a:DDT.COM           |
| a:DIR               | a:DDT.COM           |
| a:NRELSCOM          | a:DDT.COM           |
| a:COM               | a:DDT.COM           |
| a:DDT.COM           | a:DDT.COM           |
| a:PDP.COM           | a:DDT.COM           |
| a:DUMP.COM          | a:DDT.COM           |
| a:FILENAME          | a:DDT.COM           |
| a:RECS Bytes Ex D:  | a:DDT.COM           |
| a:FILENAME Typ      | a:DDT.COM           |
| a:DIR               | a:DDT.COM           |
| a:NRELSCOM          | a:DDT.COM           |
| a:COM               | a:DDT.COM           |
| a:DDT.COM           | a:DDT.COM           |
| a:PDP.COM           | a:DDT.COM           |
| a:DUMP.COM          | a:DDT.COM           |
| a:FILENAME          | a:DDT.COM           |

Program listing. Console messages during a mini-disk packing session. Eliminating unnecessary files from the CP/M system disk increases the available workspace by 19K. Packing the remaining programs reduces access time. A final system patch permits the use of 40-track disk drives, adding another 12K.

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be written in one contiguous block.

Using the STAT listing, you have 27K of space on the disk, and the programs you want to save total 32K. So you start by erasing the .ASM files. Next, PIP is used to move the seven files you want to save. Since you can’t use duplicate names, tell PIP to make a file copy of each program in turn, but with a file type of .SAV.

Once you have your seven .SAV files, STAT tells you that you have used up all of the disk except a single 1K block. One side benefit of this procedure is that it gives the operator, PIP, and the disk drive a real test and checks out the whole disk surface in the process.

Now Do It All Over Again

Now you create your big hole at the bottom of the disk space by erasing all of the .COM files (are you sure you have everything backed up?). You need a PIP.COM file to use for the move back, so you next have to rename PIP.SAV as PIP.COM. This new PIP is then used to move the .SAV files back down as .COM files. In the process, PIP has to move itself, so you temporarily call this new PIP file by another name.

When you are done with the packing, you erase PIP.COM and rename the packed version of PIP. Now DIR and STAT *.* are used to inspect the new packed system disk. You have 46K of workspace, a reasonable amount for an assembly-language programmer. Since you are talking about a single-drive mini-floppy CP/M system, you should keep in mind that you don’t want to get too much work on a single disk anyway, since the only way you have to copy a file is to copy the whole disk.

I have found that this size disk is convenient for assembly-language work, my primary use for the system. A couple of reasonably sized source files and their hex, object and print files will pretty well fill a disk. At that time, it is a good idea to file that disk away for safekeeping.

BASIC is another matter, since BASIC language programs breed like rabbits, but on a single drive system you need only save BASIC itself, and maybe STAT. If you erase everything else on the disk, you will end up with about 40K of workspace.

Even More Space

I ran across a real bargain in Wangco Model 82 mini-floppy drives, and since they can access 40 tracks instead of the standard 35, I had to figure out a method for patching CP/M to make it use the extra track. At the bottom of the listing you will see that I found and patched the location in CP/M that tells it how much disk space is available.

Five more tracks add 5 x 10 x 256 (12,800) bytes in the North Star format, so I incremented the 4F (hex) by C (hex), which adds an extra 12K to the usable disk space. You will have to be certain that your DOS will properly address 40 tracks before making this patch, however. And note that the GA040 accesses a “write tracks 0 through 2 only” routine in my DOS. Yours will not be at this address.

Comfortable Conclusions

The Wangco drives also permit the use of both sides of each disk, which should be called flippy-disks to avoid confusion with read double-sided-type drives, which have two heads. This combination of two sides and 40 tracks makes a very usable configuration. I’m not anxious to tackle the problems of double density because I find the present configuration reliable and comfortable. Eight-inch floppies are a bit awkward to handle. The stiffer mini-floppies store well, and CP/M is a good operating system for them.

However, even this system needs a single-drive filecopy routine. I have written one, and next month’s issue will have a complete assembly-language listing.
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Some Notes on Termination

Protect your program from those incessant glitches.

Reo W. Pratt
2264 Cambridge Dr. SE
Grand Rapids, MI 49506

The ad said, "Eliminates noise, ringing, cross talk and overshoot!" It claimed that if you had any inexplicable problems, such as your system running fine and suddenly "crashing," the cause might be an unterminated motherboard. Proper termination will eliminate those frustrating "glitches" that appear only long enough to destroy the program you keyed in. I recently had the opportunity to verify these claims with the help of Bill Godbout and two of his technical staff. Although most computerists accept the need for bus termination (most motherboards come with onboard termination now), you might be interested in the results of the tests I ran, particularly if you own or are planning to buy one of the older S-100 computers with an unterminated motherboard.

The Reason for Termination

When a signal or pulse is sent out on a bus line, it has to go somewhere. Many pulses placed on the bus by the processor are not used by other devices plugged into the board. When these pulses reach the end of an unterminated line, they bounce back, induce signals in adjacent lines, radiate into space—or some combination of all three.

The degree to which this occurs depends on several interrelated factors. The most significant are the signal frequency, the length of the conductor and the spacing between adjacent conductors. The higher the frequency, the more critical proper termination becomes. Even the slowest microprocessors deal with frequencies well into the radio-frequency spectrum. If you have trouble accepting this, remember that the clock fre-

Listing 1. "Jump to here" program.

D400 C3 JMP
D401 00 D400
D402 D4

Photo 1. POC and CLOCK lines with active termination enabled.

Photo 2. POC and CLOCK lines without termination.
frequency of an 8080 is 2 MHz. This is much higher in the spectrum than the highest point on your AM dial (1.6 kHz).

**Termination Problems**

Noise is electrical energy on the bus that shouldn't be there. It comes from a variety of sources and, once it appears, won't go away—until you start to look for it.

Ringing occurs when a signal that is changing logic level (pulled high or low) doesn't stay at its intended level. This appears as a damped oscillation in the photographs.

Cross talk occurs when a signal on one line is imprinted on the line or lines adjacent to it. It causes confusion when the altered signal arrives at its destination.

Overshoot happens when a signal changes logic state with such force that it "shoots" past its intended level. It is closely associated with, and precedes, ringing.

To observe these problems, I used a Tektronix oscilloscope with 50 MHz bandwidth and dual-trace capability. I observed the various signal lines on an "older" IMSAI 8080 with a Godbout active-terminator board that unplugged to look at the terminated and unterminated lines. I recorded the oscilloscope pictures with a 4 x 5 Graphex camera with a Polaroid back.

To keep the processor continuously cycling during the test, I keyed in a short "jump to here" program (see Listing 1).

Photo 1 shows POC (top) and CLOCK lines. It is an excellent example of cross talk. Note how the POC line appears to follow the CLOCK line up and down. Note also that the POC voltage scale is set to ¼ the value of the CLOCK line—500 millivolts, as compared to two volts for the CLOCK trace. If the voltage scales were the same, the variations in the upper trace would not be as pronounced.

The terminator board improves the situation. Photo 1 shows the terminating network enabled. Photo 2 shows the effects of no termination. Noise, cross talk, undershoot and overshoot are all present in ample quantities. Compare the same portions of both traces. As you can see from the scope's illuminated graticule, the camera was well focused. The thickness of the traces, particularly the upper one, is due to noise, not poor photography.

Photos 3 and 4 show the PDBIN line in the upper trace and the DI7 line in the lower trace. The terminator board is enabled in Photo 3; it is removed from the machine in Photo 4. These photos show best how the terminator board reduces overshoot and ringing. Using two volts per division as shown on the scope face, you can see that the high logic level with the terminator in is only about three volts, whereas it is over four volts with no termination.

**Technical Aspects of Termination**

Amateur radio operators are familiar with the principles of termination through antenna and transmission-line theory. The bus lines in a computer carry a signal from one point to another as does a transmission line. The terminating network in a computer does more than just provide a proper load to sink signal current. It also sources current for logic signals that may lack sufficient drive and holds the high logic voltage at the optimum level.

Ones and zeros are generally represented by five and zero volts, respectively. However, a look at a data sheet shows that most TTL gates view anything over two volts as logic high, with 2.6 volts optimum. Holding the logic-high-state voltage to the optimum reduces overshoot since the signal only has half as far to go when it changes state.

Fig. 1 shows the simplest form of termination: two resistors for each line wired to the 5 volt "rail" and ground to source and sink current as required. It is effective but has one drawback. With all those resistors wired between +5 volts and ground for nearly 100 lines, the power supply has an increased load to bear. If you apply Ohm's law, you'll find that the extra load is about ½ Amp. This may not be too much, depending on the system, but there is a better way.

Active termination uses only one resistor per line in place of two and a sensing network composed of an operational amplifier that sinks or sources current only as it is needed. It effectively "switches" the terminating network on and off the bus lines as required, eliminating the constant power draw. Total constant current draw on the Godbout active terminator board, for example, is only 20 milliamperes.

Proper termination of the lines on a motherboard or backplane is simply a design necessity that never should have been omitted from the original S-100 systems. Recently advertised motherboards from Godbout have Faraday shielding between the lines as well as active termination networks on the board. Other manufacturers also advertise similar boards. Look into the "termination situation" carefully. It could save a lot of frustration in your computing future.

---

**Fig. 1. Passive termination.**

---

**Photo 3. PDBIN and DI7 lines. Termination enabled.**

**Photo 4. PDBIN and DI7 lines. Terminator removed from bus.**
Fastfind

For the computerist in a hurry to search large arrays.

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This article describes a fast way to find a match between a variable and a variable in an array. One way to do this is to use a number of IF statements (see Example 1).

This is fine for checking a couple of variables, but why write the same thing over and over again when you can do it with a FOR-NEXT loop in three or four statements? The FOR-NEXT loop is a better way to find a match between a single variable and a variable in a small array (see Example 2).

This is an excellent method if the array is small or the program only executes this loop a few times. However, if the array contains 1000 variables or the program uses this loop for every record it processes, the computer will spend a lot of time "spinning its wheels," i.e., comparing nonmatching variables.

The same waste of time occurs when the computer searches for the matching index or key in a sequential random file. Most of the computer time is spent asking, "Do I have a match?" and answering "No—Go get the next record."

With a FOR-NEXT loop, the average search will be made through half of the array to find a match—all wasted time except for the final match.

A Faster Way

Using the FASTFIND routine on an array of 1000 sequential variables will only require a maximum of ten tries to find any variable in the array.

To find 999 in an array of 1000 the first attempted match would be on 500. Since the array variable of 500 is less than the 999 being looked for, the next attempt is made at 750. The next attempt would be at 875. Each time the area to search is cut in half. This continues until the match is found.

Table 1 shows the calculated subscript used to find a match for the number 955 in an array of 1 to 1000. The low subscript number is set to 0, and the high is set to 1001. As before, the first attempted match is made at 500—low + high divided by two. The value 955 is higher than 500 so the 500 is used as the low subscript number and the process is repeated.

This continues until the 955 is lower than the calculated subscript number, at which time the calculated subscript is substituted for the high subscript number. Decimal numbers are rounded down (turned into integers) so that one half of (938 + 1001) equals 969, not 970. On the ninth iteration the number 955 matches the subscript.

Why is the low-high range 0 to 1001, while the actual range to be searched is from 1 to 1000? This is done so the subscripts 1 and 1000 will find a match. Otherwise, we get 1 + 2 = 3 and half of 3 = 1, so subscript 2 is never found. At the other end we have 1000 + 999 = 1999, and half of 1999 = 999—another endless loop.

Routines

Two sample routines are provided; each has a test driver program for testing the routine. Listing 1 is in standard BASIC, and Listing 2 is in Tarbell TBASIC, which makes use of some of the TBASIC features. Both programs do the same thing. Listing 1 fastfinds a number, while Listing 2 fastfinds a string.

Listing 1 illustrates FASTFIND for a number match. The program first builds an array containing 1000 variables ranging from 1 to 3001 using every third number (1, 4, 7, . . . , 3001). The printed output from this program shows the count of the tries it took to find a match for the entered variable. When the number entered from the keyboard is out of range, the program requests that a correct number be reentered.

When the number entered from the keyboard is not found,
FASTFIND ROUTINE

ENTER ARRAY VALUE: ? 1
9 TRYS - ARRAY VALUE [ 1 ] IN A(1)
ENTER ARRAY VALUE: ? 3
10 TRYS - ARRAY VALUE [ 3 ] NOT FOUND
   NEXT LOWEST ARRAY VALUE IS [ 1 ] IS IN A(1)
ENTER ARRAY VALUE: ? 8
10 TRYS - ARRAY VALUE [ 8 ] IN A(2)
ENTER ARRAY VALUE: ? 3001
8 TRYS - ARRAY VALUE [ 3001 ] IN A(1001)
ENTER ARRAY VALUE: ? 3000
10 TRYS - ARRAY VALUE [ 3000 ] NOT FOUND
   NEXT LOWEST ARRAY VALUE IS [ 2998 ] IS IN A(1000)
ENTER ARRAY VALUE: ? 2998
10 TRYS - ARRAY VALUE [ 2998 ] IN A(1000)
ENTER ARRAY VALUE: ? 1504
1 TRYS - ARRAY VALUE [ 1504 ] IN A(502)
ENTER ARRAY VALUE: ? 1000
9 TRYS - ARRAY VALUE [ 1000 ] IN A(334)

Sample standard BASIC run.

10 REM ***************
20 REM **
30 PRINT "FASTFIND ROUTINE"
40 REM ** TEST PROGRAM
50 REM **
60 REM **
70 DIM A(1004)
80 REM
90 REM
100 DIM A(1004)
110 J=0
120 FOR K=1 TO 3002 STEP 3:REM BUILD AN ARRAY
130 J=J+1
140 A(J):K:REM RANGE 1 TO 3001
150 NEXT K:REM 1,4,7,...,3001
160 L1:0:REM LOWEST SUBSCRIPT VALUE MINUS 1
170 H1:J-3:REM HIGHEST SUBSCRIPT VALUE PLUS STEP
180 PRINT "ENTER ARRAY VALUE: ? " R
190 IF B=0 OR B<3 THEN GOTO 160:REM OUT OF RANGE
200 GOSUS 400
210 PRINT C1:"TRYS - ARRAY VALUE [";B;"]:"
220 ON E: GOTO 250
230 PRINT "IN A(";STR$(K1);")"
240 GOTO 160
250 PRINT "NOT FOUND"
260 PRINT "NEXT LOWEST ARRAY VALUE IS [";A(K1);";]
270 PRINT "IS IN A(";STR$(K1);")"
280 GOTO 160
290 REM
300 REM **
310 REM ** FASTFIND ROUTINE **
320 REM **
330 REM
340 REM
350 REM INPUT TO ROUTINE
360 REM B - VALUE TO FIND IN ARRAY A(X)
370 REM L1 - LOWEST ARRAY SUBSCRIPT
380 REM H1 - HIGHEST ARRAY SUBSCRIPT
390 REM OUTPUT FROM ROUTINE
400 REM C1 - NUMBER OF TRYS COUNTER
410 REM E1 - ERROR FLAG
420 REM 0 = FOUND
430 REM 1 = NOT FOUND
440 REM K1 - SUBSCRIPT NUMBER IN ARRAY
450 REM CONTAINING FOUND VALUE
460 REM
470 REM E1:0:REM RESET NOT FOUND FLAG
480 REM C1:0:REM ZERO FIND COUNTER
490 REM K1=INT((L1+H1)/2):REM CALCULATE FIND NO.
500 REM IF K1<L1 THEN GOTO 560:REM IF CALC NO = LOW NO - NOT FOUND
510 REM IF K1>H1 THEN GOTO 560:REM SET NOT FOUND FLAG
520 REM GOTO 640
530 REM C1=C1+1:REM ADD 1 TO TRY COUNTER
540 REM IF B=A(K1) THEN GOTO 640
550 REM IF B=A(K1) THEN GOTO 600
560 REM IF B=A(K1) THEN GOTO 620
570 REM L1=K1:REM MAKE LOW SUBSCRIPT = POINTER
580 REM GOTO 520
590 REM GOTO 520
600 REM GOTO 520
610 REM GOTO 520
620 REM GOTO 520
630 REM GOTO 520
640 REM GOTO 520

Listing 1. FASTFIND routine in standard BASIC.

Enter Array Value: AA00
9 TRYS - Array Value [AA00] is in ARRAY$(1)

Enter Array Value: EJ90
1 TRYS - Array Value [EJ90] is in ARRAY$(500)

Enter Array Value: JJ90
10 TRYS - Array Value [JJ90] is in ARRAY$(1000)

Enter Array Value: AA10
10 TRYS - Array Value [AA10] is in ARRAY$(2)

Enter Array Value: AA01
10 TRYS - Array Value [AA01] NOT FOUND
   Next Lowest Array Value is [AA00] in ARRAY$(1)

Enter Array Value: AA09
10 TRYS - Array Value [AA09] NOT FOUND
   Next Lowest Array Value is [AA00] in ARRAY$(1)

Enter Array Value: BA40
8 TRYS - Array Value [BA40] is in ARRAY$(105)

Sample Tarbell BASIC run.

the program sets a NOT FOUND flag and prints out NOT FOUND. It also prints out the next lowest array value and its

script position in the array.

The Tarbell BASIC program (Listing 2) illustrates how the FASTFIND routine could be used in finding selected se-quential keyed records in a random file. The test program first creates an array containing string values, simulating a se-quential set of record keys.

These keys (or index) range from AA00 through JJ90 (AA00,AA10,AA20...AB00...JJ90). This string array could consist of names, part numbers, account numbers, policy codes, etc. The program using the FASTFIND routine would first read all the keys or IDs into an array similar to the one generated by the program.

The routine in this program operates in the same manner as the standard BASIC routine. It keeps cutting the search range in half until a match is found. When the match is found, the subscript number becomes the record number for the file read from a random file.

If no match is found, the routine will return an error flag that causes the NOT FOUND to be printed. The next lowest ar-ray value with the subscript of that value is also printed.

It may be that 80 percent of the time the desired record is in the top (high subscript values) end of the file. Instead of going in at the middle of the file and
calculating all the way to the number, go in just below where most of the action is. This will save two or three extra attempted matches.

Suppose the routine is being used with a name file that keys on names. In the case of a filename with five JONESes, the routine will return as soon as it finds a JONES. There is one chance in five that it found the right JONES, and it will always find the same JONES and return the same subscript value. By adding to or subtracting from the subscript, the desired record can be found.

Another way would be to subtract five from the subscript and use a FOR-NEXT loop to find a match on JONES and JONES' first name.

Three nice features of Tarbell's TBASIC are shown in Listing 2:

- Meaningful line labels instead of line numbers.
- Long variable names.
- Ability to transfer variables with GOSUB, RETURN and RECEIVE statements.

Summary

Considerable computer time can be saved using a FASTFIND routine instead of a FOR-NEXT loop when searching large arrays. A routine of this type can work equally well with strings and numbers. The number of reads required to find the proper key in a random file can be greatly reduced.

```
LISTING 2. FASTFIND routine in Tarbell BASIC.
```

**SS: 50**
- **CALCULATOR - CLOCK**
- **INTERPRETER GENERATOR**
- **BATTERY BACK-UP**
- **PARALLEL I/O PORT**
- **SAMPLE FORMAT**: SAT JUL 26 1980 10:30:24 PM

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Microcomputing, August 1980 185
Have you ever wanted faster graphics or CLOAD and CSAVE operations on your TRS-80? Perhaps you've felt that it would be nice if programs, both your own and commercial ones, ran faster. For example, if you're a chess buff and own one of the Microchess programs, I'm sure you've wished you didn't have to wait so long for the computer's next move.

The circuit shown in Fig. 1 and the modifications outlined below came about as a result of my wanting to speed up the Sargon chess program. After making a few inquiries, I learned that the slowness of the program was related to the clock frequency of the TRS-80 CPU. I discussed the problem with my friend, Ed Fortmiller, who is a computer programmer. A week later he came up with the circuit shown in Fig. 1.

After deciding not to use any of the spare gates in the TRS-80, we went to the nearest Radio Shack and purchased the needed parts. During the next week I wired the circuit and made the needed modifications. The circuit worked the first time around and has been working perfectly ever since.

The total cost of the necessary parts (if purchased at Radio Shack) should be around $6 or $7. You will need three or four feet of small gauge hookup wire. If you don't have any available, you'll have to spend an additional $2 for a roll of no. 22 or 24 stranded hookup wire.

The Z-80 microprocessor in the TRS-80 (known as the CPU) operates on a clock frequency of 1.774 MHz. By changing that frequency to 2.66 MHz you effect a 50 percent speed-up in the overall operation of your TRS-80. Scott King's article ("TRSpeed-up," Microcomputing, September 1979, p. 138) suggests simply installing a manual switch to change the Z-80 clock frequency. However, the problem with this method is that you can't switch frequencies after power-up, because the Z-80's operation is interrupted and the TRS-80 comes to a standstill. The only way to get it going again is to turn the power off and start over.

Manual switching is a problem because the TRS-80's dynamic RAMs must be refreshed periodically by the Z-80 to remember the data stored in them. If the Z-80 is interrupted for more than one millisecond, the RAMs will not be refreshed and will forget everything they know! . . . and the TRS-80 will cease to function.

So while manual switching will get your TRS-80 running at 2.66 MHz, you won't be able to run any of your old programs or any commercial programs since they will not load at the new clock frequency. Nor can you load them at 1.774 MHz and then switch to 2.66.

The Circuit

To simplify matters, let's say that the circuit is an electronic switch. It performs the same function as the manual switch referred to earlier and even uses a manual switch.

In this case, however, S1 does not actually switch the clock frequency. It has that effect, but the actual switching is done electronically by two integrated circuits (ICs), 74LS76 and 74LS00. Although the latter IC (hereafter referred to as Z2) is shown as three separate units, it is a single IC.

As can be seen from Fig. 1, Z2 has two separate clock signals coming into it— one from pin 12 of Z56 and one from pin 8 of Z56. The position of S1, which is connected to the 74LS76 (hereafter referred to as Z1), determines which of the signals appears at pin 8 of Z2 and is passed on to Z72. The output of Z72 goes to the Z-80. Whenever S1 is operated, the switching is done so quickly by Z1/Z2 that neither the Z-80 nor the RAMs are adversely affected. That means that you can change the speed of your TRS-80 after power-up without having to worry about the RAMs' losing their data.

For example, you can load in any program and switch to the 2.66 clock frequency, and the program will run 50 percent faster. You can even change speed while a program is being executed. You can also CSAVE any program that is in the TRS-80's memory at the faster speed so that the next time you wish to CLOAD that program you can do so at the faster speed, thus taking considerably less time.

A schematic diagram of the TRS-80 is helpful (although not necessary) as you undertake the modifications to be described. A complete wiring diagram of the TRS-80, plus other useful information, can be found in the TRS-80 Microcomputer Technical Reference Handbook, available at Radio Shack stores.

Although the modifications to the TRS-80 and the wiring of the circuit shown in Fig. 1 are simple and easy to do, I do not recommend that a novice undertake these modifications unless
he has a more experienced friend looking over his shoulder. In writing this article, I have assumed that the readers who decide to undertake these modifications have some past experience working with electronic circuits. Thus, there are no detailed instructions for wiring the circuit. I assumed that you could do the wiring from the diagram.

The modifications described below apply to both Level I and Level II machines, 4K or 16K. You may have difficulty if your TRS-80 has a numeric keypad because it may be difficult to find a convenient place to mount the circuit shown in Fig. 1. The best thing to do is to remove the top cover of your TRS-80 and determine what space is available.

The changes described in this article, or any similar changes, will void the 90-day warranty on your TRS-80. For that reason, you may wish to wait until that period is over before modifying your unit.

**Modification Steps**

1. Remove from the bottom of the TRS-80 the six screws that hold the unit together, carefully labeling the holes and the screws with masking tape to make sure you return each screw to the proper hole later. The lengths of the screws vary. After turning the unit right side up again, remove the top cover. You now have access to the foil side of the logic board where several modifications will be made.

2. Locate Z56 (74LS92). If you have a Level II machine, gaining access to the desired pins may be difficult since in some TRS-80s the piece of foam supporting the Level II hardware is glued to the board right over the pins of Z56. If so, carefully lift the foam away with a sharp knife so that you can get to the pins and the necessary trace.

3. Locate pin 8 of Z56 and the trace that leads from it to a feed-through hole that is covered with solder. Carefully cut this trace with a knife or other appropriate tool. Make sure that the trace is completely severed. Carefully remove any metal particles that may result from cutting the trace.

Now solder an eight-inch piece of hookup wire to the section of the trace going to pin 8. Solder another piece of the same length to the section of the trace going to the feed-through hole. If it’s difficult to solder to the trace, you can solder the wires to pin 8 and the feed-through hole, respectively. The free ends of these wires will be connected later.

4. Locate pin 12 of Z56. Solder an eight-inch piece of hookup wire to this pin. After you’ve made the connection, carefully examine the nearby pins and traces for solder bridges.

5. Turn the logic board over so that you are looking at the component side. Keep the keyboard close to its spacers above the logic board so you don’t put any strain on the connection between the two boards. The plastic assembly holding the power/video/tape jacks should be on your right as you look down at the board.

6. Locate Z43. (Each IC has its number printed on the board to the right of it.) The pin nearest to you on the right side of Z43 is pin 1. The next pin – on the same side, going away from you – is pin 2. Solder a 3 inch piece of hookup wire to this pin.

Now locate Z56. (It may be partly hidden by the ribbon cable from your Level II hardware.) The pin nearest to you on the left side of Z56 is pin 14. Solder the free end of the wire from pin 2 of Z43 to pin 14.

7. Locate the video jack. Immediately behind it are two blue electrolytic capacitors – one mounted horizontally and the other mounted vertically. On either side of the smaller, vertically mounted capacitor are two transistors (black, molded plastic body). The one on the left is Q2.

Right behind Q2 are four small resistors. The one farthest from Q2 is R30 (47 Ohms). Connect an 8 inch piece of hookup wire to the right lead of R30. Feed the other end of this wire through the hole in the board between the video and tape jacks. This lead will later be connected to the +5 volt point that will supply voltage to Z1 and Z2.

This completes the wiring on the component side of the board. Turn the board over so that you are again looking at the foil side.

8. Locate the power jack. Just above the jack are three terminals covered with solder. Solder a six-inch piece of hookup wire to any one of them. This completes the modifications on the TRS-80 logic board.

**Wiring the Small Circuit Board**

The next step is wiring the circuit in Fig. 1. I did not include any step-by-step instructions for wiring this circuit. If you are unable to do this, persuade a friend to do the job for you, send me $1 for detailed step-by-step instructions or forget this article and purchase one of the TRS-80 speed-up boards advertised elsewhere in this magazine.

The circuit of Fig. 1 can be wired on an experimenter’s PC board (RS 276-151) or on a small piece of IC perfboard. If you choose the latter, you can use RS 276-1394, which is much larger than necessary, but you can easily cut a 2½ X 2½ inch piece from it. Such a piece is adequate to hold the necessary components.

Whether you use perfboard or a PC board, use sockets for the ICs. If you opt for a perfboard, be sure to purchase the sockets with long pins (RS 276-1993). By bending the pins at right angles to the perfboard, the socket can be firmly mounted on the board.

Connections must be made to other pins (not shown in Fig. 1) on both Z1 and Z2. On Z1, pin 5 is connected to +5 volts and pin 13 is grounded. Pins 1, 4, 6, 9, 12 and 16 are all soldered to a common tie point and connected through a 1k resistor (R3) to +5 volts. On Z2, pin 14 is connected to +5 volts and pin 7 is grounded.

The most convenient place to mount S1 is on the right side, top half of the TRS-80 cover, about 5 1/2 inches from the rear and about 1/2 inch from the lower edge of the top half of the cover. Exercise great care in drilling the mounting hole for S1. Begin with a small drill, preferably 1/16 inch, and work up gradually to the desired hole size. I used nine or ten bits to achieve the desired hole size, thus avoiding any possibility of cracking the plastic cover.

**Final Steps**

After you’ve completed the wiring of the small circuit board and drilled the mounting hole for S1, mount the board in a convenient spot on the foil side of the TRS-80 logic board. This can be best done by following the method used for securing the Level II hardware to the logic board.

Take a piece of the soft packaging material that came with your TRS-80, cut it to ap-

---

**Table 1. Parts list.**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>4.7k, 1/2 Watt carbon resistor</td>
<td>5 percent</td>
</tr>
<tr>
<td>R2</td>
<td>4.7k, 1/2 Watt carbon resistor</td>
<td>5 percent</td>
</tr>
<tr>
<td>S1</td>
<td>SPDT subminiature toggle switch</td>
<td>(RS 275-613)</td>
</tr>
<tr>
<td>Z1</td>
<td>74LS76 Schottky IC</td>
<td>(RS 276-1921)</td>
</tr>
<tr>
<td>Z2</td>
<td>74LS500 Schottky IC</td>
<td>(RS 276-1900)</td>
</tr>
</tbody>
</table>

---

**Fig. 1. Modification circuit.**

---

Microcomputing, August 1980  187
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Approximately the same size as the circuit board and then glue this piece of material to the bottom of the board. Once the glue has set, apply glue to the bottom side of the foam and press it firmly against the logic board.

Mount S1 (horizontally or vertically) in the hole drilled earlier. Tighten the mounting nut enough to hold S1 firmly in place, but do not overtighten it.

To protect the computer will be in the speed-up mode when pin 2 of Z1 is grounded.

Solder the wire from pin 8 of Z56 to pin 5 of Z2. Cut away any excess wire. Now solder the wire from the feed-through hole to pin 8 of Z2. Cut away any excess wire. Next solder the wire from pin 12 of Z56 to pin 1 of Z2.

Solder the wire from R30 to the +5 volt point on the small circuit board. Next solder the wire from the ground terminal at the rear of the board to the ground terminal on the small circuit board.

This completes the modification of your TRS-80. Before powering up your unit, I suggest that you (or a friend) carefully review the modifications to the logic board and the wiring of the small circuit board.

Your TRS-80 will now operate at either 1.774 MHz or 2.66 MHz. To get some idea of the improvement in speed of operation, load one of your programs in at the normal speed, keeping track of the loading time. Now flip the switch to the faster speed and CSAVE the program. Next reload the program (without touching the switch), noting the loading time. Even without looking at a watch you will notice the asterisk blinking much faster.

Another possibility is to enter the following two-line program and measure the time between the appearance of the words GO and STOP.

10 CLS: FOR J = 1 TO 200: NEXT J: PRINT "GO"
20 FOR N = 1 TO 5500: NEXT N: PRINT "STOP"

You’re measuring how long it takes the computer to count from one to 5500, and you’ll discover that with the Z-80 running at 2.66 MHz it counts 50 percent faster than at 1.774 MHz.

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File Dump For FLEX

Become acquainted with your disk files; FD prints them in both ASCII and hex.

Phil Hughes
PO Box 2847
Olympia WA 98507

FD is a program that prints the contents of disk files in both ASCII and hexadecimal. I originally wrote FD to determine the cause of an incompatibility between the TSC Text Editor and Ed Smith's Macro Assembler. FD is similar to a memory dump in that once you have it, you will find all kinds of reasons to use it.

Before I talk a lot about FD, let me talk a little about FLEX, which is an operating system written by Technical Systems Consultants. It was designed to run on a Southwest Technical Products 8800 computer system with either a mini-floppy or full-sized floppy disk. A new version that runs on a Southwest Technical Products 8800 computer system is now available. Rumors are that FLEX will also support the hard disk, which is soon to come from SWTP. FLEX does a lot for the user, and, with some additional utility programs, it can do a lot more. FD is such a utility program.

FD should be installed by saving its binary as FD.CMD on your system drive. Note that FD is loaded into the FLEX utility command area, and therefore it must be saved using the SAVE.LOW command. Once installed, it can be run by entering FD filespec, where filespec is a standard FLEX file specification, such as 1 myfile.TXT. The file will be printed out in hexadecimal, and all printable bit combinations will also be printed in ASCII on the right.

Listing 1. FD printout.

Head Fast End of File

Listing 2. FD and FLEX.
tion of FD. The left-most column is a relative offset address within the file. This is followed by 16 bytes of data displayed in ASCII. Any nonprintable character is replaced by a question mark (?). Listing 2 is FD assembled from FLEX 2.0. It was assembled using RRMAC from Ed Smith's Software Works. The significant difference between the RRMAC format and Motorola assembler format is in the formation of constants. For example, the constant hexadecimal 1234 is represented by X'1234' instead of $1234. The object code generated by RRMAC is relocatable—in other words, it can be loaded anywhere in memory.

This relocation is performed by another Ed Smith program called a loader. For those who wish to use standard Motorola assembler format, the directive ORG $A100 should be added after line 134, and the constants should be changed back to the Motorola format.

Lines 6 through 133 have been included from another file. These lines are a set of equates for all the FLEX interfaces that I feel I might use.

Although most of these equates are never used in FD, it ensures that all of my programs use the same names for the FLEX interfaces. This way, if TSC releases a new version of FLEX with some of the entry points changed, I will only have to change the include file and then reassemble all my routines.

Lines 135 through 150 open the file that is to be dumped. GETBLK (line 151) is the start of the processing loop. This routine gets characters from the file and checks for a read error. DLINES (line 165) is the beginning of the routine that prints the data. Routine DONE (line 212) closes the file and returns to FLEX at its warm-start entry.

If an I/O error occurs, the routine FILERR will report the error, close any open files and return to FLEX. Note that FD has no way to determine where the last piece of meaningful data is located in the file; therefore, a normal termination is the message READ PAST END OF FILE.
Breakout Box

Accessing an extra parallel I/O port is easy with this simple hardware project.

Don Walters
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Ann Arbor, MI 48104

It was inevitable that microcomputers would find their way into the ham shack, as the two hobbies overlap. Although most of the microcomputers will perform dedicated functions such as CW, RTTY, antenna aiming for satellite work and slow-scan TV, a few will end up with an extra parallel I/O port or two. The spare I/O port will tempt its owner to experiment with bit pushing and pulling in many projects.

Every new technology brings new needs and problems with it. Such is the case with the microcomputer and its spare parallel I/O port. The problem is how are you going to get at the bits and signals on it. Just run wires out near where you need them, right?

Photo 1 demonstrates that this method works. However, a few weeks of working with it this way will quickly change your mind about how nice the method really isn't. It won't be long before you decide that there must be a better way to access the bits and signals of the parallel I/O port.

A Better Way

While watching a potential vendor use a breakout box to make his printer work with our minicomputer-based word-processing system, I realized that this technique could be applied to a parallel I/O port as well. This would allow quick accessing of the bits and signals of the parallel I/O port of my Imsai 8080.

I thought about how I could set up such a convenience and worked the whole thing out. By the end of the evening I had put the parallel I/O breakout panel together, and had it debugged.

Photo 2 shows the result of my efforts. Also note in the photograph the use of a standard connector plug for connecting the breakout panel to the parallel I/O port connectors on the back of my Imsai 8080. The constant use of standard connectors on my system has saved me many headaches over the past couple years.

Construction

The breakout panel is simple to build and should take about an evening to put together. Your total cost will be about $15. Fig. 1 gives the general construction details on how to build the breakout panel.

The first step is to cut a piece of aluminum or hardboard to the size you want your breakout panel to be. If you want to duplicate my breakout panel use the dimensions given in Fig. 1.
The hardest step is to cut the Global Specialties' QT47S or equivalent prototype strip (available from several of the mail-order houses that advertise in Microcomputing, as well as from Radio Shack and possibly local electronics outlets in your area) in two, lengthwise. You want to separate the two halves of the prototype strip so that you end up with two half-strips.

The prototype strip is made of soft plastic and can be cut with a heavy knife. Exercise care in cutting and make several passes over the same cut before you cut through the prototype strip's center. Alternately, you can use a small hobby-type hacksaw to cut the protostrip in two.

Lay half of the prototype strip and the cable clamps on the base and mark where you will have to drill their mounting holes. Use press type lettering to label the holes of the prototype strip as to which bit or signal is available at that point on the prototype strip. Photo 3 shows how I labeled the various holes on the prototype strip. Cover the lettering with a strip of clear contact paper to protect it.

Assemble all the parts onto the base using six to 32 machine screws and nuts. The easy way to mount the prototype strip is to tap the holes on either end with a 6-32 tap. Remember to leave the cable clamps a little loose, since they will not be tightened until all the wires have been attached to the prototype strip.

After all the components are mounted to the base, attach the rubber feet.

The last step is to attach the wires coming from the parallel I/O port to the modified prototype strip. Number 24 stranded wire is about the right size. Cut about a quarter of an inch of insulation from the end of each wire, then twist the wire tightly together. Tin each wire with a little solder and insert each wire into its hole in the prototype strip.

Tighten the cable clamp screws so they provide strain relief for the wire bundle going to the parallel I/O port. Make sure the various wires, attached to the prototype strip and labeled as to their bit or signal, actually carry that bit or signal from the parallel I/O port.

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Microcomputing, August 1980
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Microcomputing, August 1980

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BASIC Programming Tips

Don't sacrifice efficiency for faster program development.

Alfred E. Williams
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San Luis Obispo, CA 93401

Most microcomputer BASIC programmers eventually run into applications that require faster execution speed or less memory to be practical. The trend in the computer industry is to favor faster development of more reliable and maintainable programs at the expense of efficiency, except in time-critical applications. With a little thought, the programmer can develop some techniques to promote execution efficiency without affecting the speed or clarity of his programming.

The goals of reducing required memory and increasing execution speed often conflict. For example, the simple bubble sort needs minimum storage in addition to the input-output array, but is very time-consuming. More sophisticated sorts (e.g., Shell sort) execute many times faster but require more storage. I'll focus on tips to improve execution speed.

There are many different implementations of BASIC—integer or floating-point, compiler or interpreter—with varying degrees of efficiency. If you're lucky enough to have a choice of software for your micro, shop around. If efficiency is critical for you, you may be better off investing in a commercial, enhanced BASIC interpreter or compiler rather than the one supplied by your machine's manufacturer. Remember that compilers almost always have a speed advantage over interpreters in actual execution. The requirement for a compile phase may be frustrating, however, if you're used to freely twiddling with your program during debugging.

Consider your choice of storage devices for your program and data files. Generally, direct access devices (floppy and hard disks) provide faster retrieval of data than the various kinds of tape devices, particularly when records are to be fetched from random locations in the file rather than in the sequence they were loaded. Unfortunately, the average cost for both disks and drives is higher than the cost for tapes and tape devices, although the appearance of some new, less expensive disk devices recently has provided some hope of an affordable disk for all micro users.

Watch for
Critical Inner Loops

The majority of execution time in non-input/output (I/O) bound programs is confined to less than 5 percent of the source text. Donald Knuth, in his writings, points out that program execution speed may largely depend on the speed of one or more short loops. He calls these critical inner loops.

Look for these critical loops in your program, and make sure that all statements in the loop are executed there. For example, if the value of a variable is not changed in a loop, initializing it there will waste execution time since it will be performed several times instead of once. Execution time may also be saved by doubling up the calculations in a loop. Assume you want to initialize a 40-element array to zero. One way to do this might be:

FOR I = 1 TO 40: A(I) = 0: NEXT I

Almost half the overhead of the FOR loop, however, could be saved (at a minor expense in memory) by writing the initialization this way:

FOR I = 1 TO 20: A(I) = 0: A(I + 20) = 0: NEXT I

Sometimes it is beneficial to remove the loop entirely and process using straight-line logic. If your array was four instead of 40 elements, it might have been better to initialize each element of the array individually, rather than use a FOR loop. You must evaluate the trade-off between execution speed, memory and programming ease.

All of the techniques discussed below are especially important in critical inner loops. If you repeat calculations unnecessarily, the loop will multiply its importance many times over a similar error outside the loop.

Repeating Calculations Unnecessarily

Execution efficiency can be improved by setting a variable to the result of a calculation and using that variable rather than repeating the calculation for later testing and computation. Consider the following statement:

IF A*B/C < D THEN E = A*B/C + 1

Notice that A and B must be multiplied and divided by C twice. This could be avoided by replacing the statement by the following:

Z = A*B/C: IF Z < D THEN E = Z + 1

Once again, the trade-off is between execution speed, memory and program clarity. Notice that the memory saved in the source text may exceed the memory required to store the new variable if the calculation is complex, depending on the amount of compression your BASIC does in storing the program. You sacrifice program clarity because you use a variable to store an intermediate result, which may make the meaning of the calculation harder to see. Because BASIC allows only one-letter variable names, using a variable this way may also be a luxury you can't afford, but keep the tip in mind for your less complex programs.

Avoid Unnecessary Subscript Calculations

If your BASIC has array variables, you have a technique that, along with FOR loops, allows you to conveniently store and manipulate variable values. Remember, however, that BASIC must spend some time evaluating the subscript and locating the position it points to in the array.

This time is multiplied with multi-subscripted variables. For this reason, it's more efficient to move the value from the subscripted variable to a new un-subscripted variable if the same location in an array is used more than once. Example I shows what I recently found in one of my programs. In this case, I asked BASIC to evaluate two
subroutines four times instead of once. Since this occurred in a time-critical inner loop, I saved some time by changing it to Example 2.

Avoid Unnecessary Data Conversions

If your BASIC supports more than one data format, you should find out how these formats are used by BASIC for testing and computing. If you should avoid needing the computer to convert between them unnecessarily. For example, if fixed-binary numbers are converted to floating point before being tested against, or used in, arithmetic operations with other floating-point numbers, you may want to move the value of a fixed-point variable to a floating-point variable used instead in expressions with other floating-point numbers. Otherwise, your BASIC has to convert the fixed-binary number to floating point every time it occurs in a test or computation with floating-point numbers.

Avoid Unnecessary Transfers of Control

There are many legitimate reasons for using GOSUB in a program; the two most important are for clarity and to use a common section of code without duplication from several different places in the program. Using the GOTO is more controversial, particularly among structured programming advocates. In any case, transfers of control do require CPU time, and you should avoid bouncing around in your program unless it’s necessary.

The top-down development approach of structured programming uses subroutines to allow the major functions of the program to be developed first. This leaves development of the detailed processing logic for each functional program block after the structure and relationships among the blocks are designed. If you use this approach, sometimes you’ll find that some subroutines are called from only one location, and including them in the mainline of the calling block won’t seriously affect its clarity. In these cases you should consider eliminating the subroutine and putting its code back into the mainline logic of the caller.

If you’re not convinced about structured programming, you’re even more likely to have unnecessary GOTOs between sections of your program. (The worst case—lots of inexperienced programmers make this mistake—is:

```
100 GOTO 200
200 PRINT "DUMMY, YOU WENT TO THE STATEMENT IMMEDIATELY FOLLOWING THE GOTO"
```

As you write each GOTO, think whether the routine you’re jumping to could be sequentially included instead of inserting the GOTO. If so, do it!

Consider Assembler Subroutines

Finally, if your computer not only has BASIC but also an assembler, or if you are skilled in machine language and your BASIC has an interface, you should consider functions done repeatedly, such as those in critical inner loops, for conversion to Assembler. If properly written, Assembler routines will usually outperform both the BASIC interpreters and compilers. The problem is that Assembler routines are harder to write, debug and maintain than similar routines in BASIC. For this reason, unless you’re a computer freak (I am) or a dedicated masochist, I recommend you consider Assembler primarily for repetitive time-critical functions only.

It may seem that the execution time saved by each of these techniques will give a small advantage compared to the extra effort required to write your program. I certainly don’t want to suggest that you significantly add to your development time in pursuing small efficiencies. Even so, I think you’ll find that if you keep the principles in this article in mind, they will eventually become automatic for you; the overall time savings per program execution could be significant.
Program Patching For I/O Flexibility

The author describes a technique for enhancing poorly documented software.

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Hey! Did you hear the one about the computer nut who went out and bought an old 5-level TTY and built his own interface for it so he could have nice hard copies of his programs? And then he found out that the supplier of his favorite version of BASIC would not disclose the source listing of the program so that our hobbyist friend could make the changes necessary to use his new printer! Well, he shouldn't be feeling lonely. There are a lot of us who have been in a similar situation, wanting to make enhancements in undocumented software.

There is a way to add all sorts of nice things to the programs we have purchased from tight-lipped vendors, if only we know the locations in the programs that are used to control the input and output devices. Fortunately, these locations are usually not kept secret. Even if they were, there are ways to implement hardware traps to learn the location of the hardware-controlling routines. But the subject of hardware traps is beyond the scope of this article.

Start Simple

Let us consider the simpler problem first. Suppose we want to add a hard-copy device to a BASIC-language system consisting of a CPU, a TV display terminal and an audio cassette tape drive. We have been using a BASIC compiler that allows us to save and load programs through the audio tape interface. But there is no provision for transferring the output from the TV terminal to the hard-copy device whenever we want to, so that we can save either program listings or the results of computations.

Of course, if we know the locations in BASIC that handle the input and output operations, we can always change the I/O port assignment and status word bit-pattern mask by flipping front-panel switches (if any exist on our system!) every time we want to switch from our nice quiet TV display to a noisy printer, but this is frustratingly time consuming and error prone.

Let us instead incorporate a way to switch our output from the TV display to the hard-copy printer and back with a single console keystroke, which we will make invisible to the main program. This method requires only that we know the location of the console input and output driver routines.

We will also need a little memory not accessible to the main program. This can be RAM that is not contiguous with the main memory (so BASIC doesn't know it's there), or we can reserve a little space at the top of main memory when BASIC asks "MEMORY SIZE?" (If the program you want to modify does not incorporate this feature, use "hidden" RAM, which is separated from the main storage.)

With the method described below, we can reassign any number of I/O devices at will and can even assign blocks of RAM memory as "mass" storage, making multi-pass assemblers run faster than they would in a disk-oriented system!... with no tape to rewind between passes.

Patching the Main Program

Somewhere in our main program is a console input routine that looks something like that shown in Example 1, or would, if we had the source listing. Since we don't, we will have to hand disassemble the code around our input routine to figure out the exact conventions used for reading the keyboard status, reading the keyboard data and passing it back to the calling program. Whatever the case, do not execute the code at this location. Instead, substitute a JUMP instruction to our input patch.

In a stack-oriented microprocessor this will leave the main program's calling address on the top of the stack. For register-oriented micros or minis we will preserve the contents of all registers anyway, so the return convention will not be disturbed.

Our input patch will look for an input character just as our main program did. But now we will not simply return to the calling program. We are going to examine the character to see if it is one of a number of special control characters we are using to implement our device reassignments. If it is, we will execute the reassignment and...
jump back to the input routine to fetch the next operator keystroke. This next keystroke is the one we will send back to the main program. This way, our special characters are never seen by the calling program.

Selecting Special Characters
Any keyboard character that is never used by the main program qualifies as a special control character. These usually include a number of control characters, usually designated by "IT," for example, produced by holding down the CTRL key and pressing a letter key. There are only a few control keys used by most programs, leaving a rather large number to use for our special controls.

For our simple example we will need only two special characters. So we choose "IT" to switch all output to the hardcopy device and "IV" to switch all output back to the TV display. To see how these controls can be used, consider a typical BASIC programming session.

Using the Controls
BASIC is loaded from the cassette tape, and we have keyed in a program that is designed to produce some nicely formatted numeric output (I plan to use this as "Table 1" in a future article for Kilobaud). We try running the program, and the output is garbage. Listing the program on the TV screen 16 lines at a time does not disclose the source of the error, so we need a hard-copy listing to permit examining the program as a whole. We enter the following keystrokes: LIST IT CR, and our program is printed out on the TTY—from the CR we entered last through the "OK" that follows the listing. We now key in "IV" and we are back with the TV as the output device.

Having the entire program to examine at once, we are able to spot the error that was entered while the dog was chewing on our shoelaces. Exiling the mutt from the computer shack, we correct the error, and using the TV display we run the program. This time the output looks good.

So now we roll the old yellow paper out of the TTY, roll in a sheet of nice bond paper, and key in: RUN IT CR, and our Table 1 appears on the TTY, nicely typed out. Don't forget to incorporate enough line feeds following the output to prevent the "OK" from appearing after the printout.

Implementing the Controls
Find the console Input read routine in the main program, as discussed above, and patch in a jump to CNTIN, which is our control input routine. Example 2 is written using Intel 8080 Assembly language, but should be easily convertible to other small machines. CNTIN uses the "IT" and "IV" character codes to toggle a flag. CNTOU is our controlled output routine, which tests the flag to see whether the output goes to the TV display (CRTPT) or the hardcopy device (TTYOU).

The main program will also have to be patched at its output routine with a JUMP to CNTOU. CRTOU and TTYOU are device-specific driver routines for the TV display and the TTY. If the change made to the system is the addition of the TTY as described above, CRTOU will be the same instruction sequence as the original output routine.

Note that in Example 2 CNTOU expects that the character to be output will have been pushed onto the stack on top of the return address. This convention is used by Altair BASIC and is included here as an example of how to handle different conventions. Be sure to use the correct convention for the program you are patching.

The device driver routines themselves are hardware dependent and will vary from one machine to another and from one I/O board to another. The examples given here, therefore, do not include the actual I/O port addresses or status bit values.

Other Applications
Expansions of the same technique can be used to implement enhancements to almost any program. For example, a pair of control characters could be used to implement a pause and continue in any program that continually tests the keyboard during execution. This is handy for slowing things down as they flash by on the TV display.

In another application, after the amount of main memory was doubled in a mini—to make room for more application programs—the extra memory was used as a "mass storage" device for the text editor output and assembler input. The assembler operation was speeded up dramatically. The control input routine was used to direct the text editor output from the usual paper tape "punch" device to the top half of the main memory.

The new control routine took care of placing each output character into the next successive memory location. When the assembler was then loaded, the "IR" was used to "rewind" the source code "tape" by resetting the memory pointer to the start of the buffer. Another control character was used to switch the assembler from the original paper tape reader input to the memory-as-reader routine.

The resulting system would assemble faster than a disk-operating system, at a fraction of the cost of a disk, but of course without the same amount of storage a disk would provide.

Only the I/O driver program locations within the original operating system were known, but then they were all we needed to know to add useful enhancements like these.
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Microcomputing, August 1980 203
CT-1024 Terminal Modifications

Expand your cursor control capability, and add a clock.

Fred Cooley
4646 Willis Ave.
Sherman Oaks CA 91403

This article describes two circuit diagrams for the SWTP CT-1024 CRT terminal that I've built and tested on my machine. These modifications will be useful for any CRT terminal device.

Expanded Capability Cursor Control

The heart of the CT-CA computer-controlled cursor board is the 7445 BCD-to-decimal decoder, which breaks down the ASCII control characters to one of ten different outputs. By replacing the 7445 with one or two 74154 demultiplexers, either 16 or 32 outputs may be obtained (see Fig. 1). These control character outputs serve those functions handled by the CT-CA board, and also control other internal functions such as page select, cursor on/off, cursor solid/blinking or any external function.

All outputs can be computer controlled by outputting the proper ASCII control character. Any output to be "held" on is fed to an R/S latch. Connections to the CT-1024 are made using Molex pins over the CT-CA's connector strips J3 and J4. Don't use certain outputs:
CTRL M — CT-1024 internal carriage return
CTRL J — CT-1024 internal line feed
CTRL C — SWTP 8K BASIC ready command
CTRL O — SWTP 8K BASIC back space
CTRL X — SWTP 8K BASIC delete command

CT-1024 TV Clock

An article from Radio Electronics, July 1977, "Build This Digital On Screen TV Clock," describes the three IC clock. This modification (see Fig. 2) uses the same basic circuitry; however, the ac reference and horizontal and vertical sync pulses are taken from the CT-1024, and the clock's output is fed along with the terminal's video output to an rf modulator. Thus, no circuitry within the TV itself is touched.

Time-setting functions, on/off display and 12/24-hour format are controlled by the expanded cursor control circuit using keyboard control characters to set or reset R/S latch circuits. The MM5318 digital clock IC has seven-segment outputs that can be interfaced to the SWTP 6800 computer as described in Byte, November 1977, "Does Anybody Know What Time It Is?"

This circuit requires four connections to the CT-1024. The ac reference is obtained at J-11, pin 5; horizontal sync and vertical sync are taken from IC17, pins 5 and 4, respectively, and the video output is tied to J-10, pin 11.

Fig. 1. Cursor control circuit.

Fig. 2. TV clock circuit.
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The Flight Management Computer, which utilizes Motorola's NMOS LSI circuits, is being installed on 39 Boeing 747s, with six all-cargo 747s targeted for installation of the system at a later date. The airline plans to save approximately $5.55 million per year.

Flying High with Help from TI
Computers are also helping to make the aviation industry more efficient through inventory control. Clients of Inventory Locator Service, Inc., of Memphis, TN, use a Texas Instruments 765 Data Terminal to tie into a central ILS host computer data bank, which inventories over a million available new and used aircraft parts and support items from many suppliers. In this way, the computer system, with built-in acoustic couplers, reduces airplane downtime and helps to get the planes off the ground with speedy, inexpensive inventory searches.

She Talks in Beauty
Who is generally recognized as the first computer programmer?
According to a course brochure from George Washington University, it was the Countess of Lovelace, a lady named Ada who is noted for her work in the middle 1800s with Charles Babbage, the "father of the computer." Her place in computer history has been duly recorded with the introduction of a computer programming language named after her. The new language, called Ada, was recently developed by the U.S. Department of Defense for use in embedded computer applications.

Incidentally, the father of Ada (the person, not the language) was George Gordon Byron, an early nineteenth century English poet, who is also noted for his work with language.

Making the Rounds
The medical data-processing community can now make use of a recently developed information service to aid in the understanding, evaluation and selection of a hospital laboratory computer system. "The MedSy Report on Clinical Laboratory Systems" contains teaching materials, service materials and research support to define the potential and capability of computers in this field and keep users informed of any new developments or changes.

This product results from three years of clinical laboratory systems research from leading American universities and private hospitals. The service includes receipt of a MedSy handbook to help you evaluate and select a system for your particular needs. Subscribers receive updated information supplied on a bimonthly basis. For more information, contact Medical Systems Research, Inc., 2025 N.W. 24th St., Gainesville, FL 32605.

CRT Terminal Users Favor 80 Columns
What is the most popular CRT terminal size?
According to a recent survey conducted by Venture Development Corporation, a Wellesley, MA, consulting firm, users of alphanumeric CRT terminals express a strong preference for 80-column by 24-row displays. The 80-column display has become standardized to the point where only five percent of users surveyed prefer displays with fewer columns, and only nine percent have a preference for more than 80 columns. Although the 132-column display has applications in selected areas, most users are not willing to pay the increased price for a feature which they feel has only marginal value.

However, users expressed a desire for more total characters per display, but felt this should be done through additional rows, not more columns. A 25th row is highly desirable, as are additional rows, for word-processing applications. The 25th row, which has been gaining wider acceptance, is used primarily for monitoring system status and control rather than for display of data.

Test Your ESP
Now you can test your extrasensory powers on your 16K TRS-80 with a new program from Manhattan Software, Inc., PO Box 5200, Grand Central Station, New York, NY 10017. E.S.P. Lab ($9.95) can be used for research into possible extrasensory phenomena, as well as for testing the possibility of telepathy, clairvoyance, precognition and telekinesis. It selects randomly from among a set of five symbols, presenting one symbol at a time on the screen for telepathy experiments. All symbols are programmed in machine language and appear on the screen instantaneously. For clairvoyance and precognition testing, the program selects the symbol before or after the response, prompting only with a question mark on the screen.

A separate section provides a special computer-style test of possible telekinesis. A randomly moving dot is presented on the screen, and the experimenter may attempt to use "mental power" to influence the direction of movement of the dot.

Persons who become proficient at this program are requested not to enter within a 150-mile radius of the Mount St. Helens area.
ENTER: "Nightly News"

Computers may soon take the place of TV sets in bringing the nightly news into the family living room. Beginning this summer, 11 Associated Press members will begin an experiment into the new technology of information retrieval with CompuServe, Inc., a Columbus, OH, computer firm. Home personal computer owners will be able to obtain newspaper information by dialing special telephone numbers. The cost will be $5 an hour to access news, sports, business and feature data provided by the newspapers and the AP. CompuServe also provides computer programming and games through an existing personal computing network available in more than 250 cities. Each newspaper will participate for a six-month period, providing news, features and advertising material in its community.

Computer Pit Stop

Al Unser's pit crew at this year's Indianapolis 500 Auto Race included the first computer ever to be used at Indy. The Basic Four System 410 small-business computer provided Unser with a computerized management information system. Designed for use in strategy planning for the race, the computer endured 100 degree temperatures, typical Indiana humidity and crackling spikes of electromagnetic interference to monitor the performances and positions of the 15 leading contenders.

For each car, the 410 computed the position in the race, total laps completed, lap number of last pit stop, track condition (yellow or green), yellow laps since last pit stop, total laps since last pit stop, pit stops, and total number of pit stops. Additionally, it tracked the fuel consumption of the car driven by Unser.

This data enabled Unser's racing team management to make split-second decisions to schedule pit stops under the most advantageous conditions. Electronic sensing devices and high-speed calculators are routinely used on the racing circuit, but the introduction of the computer represented an all-new dimension in race-management sophistication.

Laps driven by Al Unser were entered manually and stored in the Basic Four System 410 small-business computer, which provided racing strategy for the Unser racing team at the 1980 Indianapolis 500 Auto Race.

The computer consisted of a CPU with 96K bytes of memory, 14 megabytes of magnetic disk information storage capacity, three video display terminals, a 160 cpm printer and a 9.2 megabyte tape cartridge for system backup and additional data storage capacity. The system functioned throughout the entire 500-mile race, keeping flawless track of the 15 selected cars and accurately recording Johnny Rutherford's first place finish in the race.

Unfortunately, the car driven by Unser, the only winner of auto racing's triple crown and three-time Indy 500 champ, did not match the computer's performance. Unser finished 27th in a field of 33, having to leave the race after 33 laps with a blown engine.

COMING NEXT MONTH

Next month's issue will place particular emphasis on the Commodore PET.

Among the articles and topics covered will be:

• A review of the new Video Interface Computer (VIC) from Commodore.
• Adding 16K to the PET.
• Interfacing PET and the H14 printer.
• Animated graphics.
• The conclusions to the "I/O Expander" and "IEEE 488" articles.

Even if you're not a PET user, there'll be something for you.
Super Scarafest '80
Super Scarafest '80, an amateur radio and computer festival, will be held Aug. 16-17, 1980, at the Ramada Inn in North Haven, CT. Sponsored by the South Central Connecticut Amateur Radio Assoc., this event will include exhibtor booths, a ham and computer flea market and an auction.
For information, write: Super Scarafest '80, PO Box 5265, Hamden, CT 06518.

Eighth World Computer Congress
Australia will co-host with Japan the Eighth World Computer Congress scheduled for Oct. 6-17, 1980, and conducted by the International Federation for Information Processing (IFIP). The congress commences in Tokyo, Japan, Oct. 6-9 and concludes in Melbourne, Australia, Oct. 14-17. An exhibition of hardware and related services together with submission of papers and discussions will be scheduled in each location. A single registration fee will cover attendance at both locations.
For information, contact: The Eighth World Computer Congress, IFIP Congress '80, GPO Box 880G, Melbourne, Victoria, Australia 3001.

Four Tutorials Precede Compccon Fall '80
Four pre-conference tutorials will precede Compccon Fall '80, sponsored by the IEEE Computer Society. “Distributed Processing,” the theme of the conference, will be the unifying thread of the tutorials. Topics to be presented are: “Local Computer Networks,” “An Overview of Distributed Processing,” “Communication Technology in the 80's,” and “Distributed System Design.” Compccon Fall '80 is Sept. 22-25, 1980 at the Capital Hilton Hotel, Washington, DC.
For more information, write: Compccon Fall '80, PO Box 639, Silver Spring, MD 20901, or call 301-589-3386.

Conferences for Computer Use in Small Business
Three regional computer conferences will be held on the theme: Thinking Small—Using Small Computers to Increase Business Productivity. They will be held Sept. 18-21, 1980, in Washington, D.C.: Oct. 16-19, 1980, in Chicago, IL; and Nov. 20-23, 1980, in Boston, MA. Sponsored by The Information Exchange, each conference program will be a four-day program designed to explore the opportunities presented by small computers for improved productivity in small businesses.
There will be a concurrent exposition at each location. For further details, contact Kendall Burroughs, at The Information Exchange, 1730 North Lynn Street, Suite 400, Arlington, VA 22209, 703-521-6209.

Mid-Atlantic Computer Show
The Mid-Atlantic Computer Show will be held at the D.C. Armory/Starplex, Washington, D.C., on Sept. 18-21, 1980. General adult admission is $5 to this exposition featuring small and medium-sized business systems, scientific, engineering computers and microcomputers. For information, contact: National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, 617-739-2000.

Conference for Consumer Electronics Instructors
The first special Conference for Consumer Electronics Instructors will be held as part of the NESDA/ISCET Convention, Aug. 18-23, at the Galt House, Louisville, KY. The concept of the Instructors Conference is to upgrade educational techniques for electronics instructors and to encourage the development of each curriculum to meet today's rapidly changing technology.
Important events at the week-long NESDA/ISCET Convention include the "Electronics Derby" trade show, the National Service Conference to discuss industry problems, business management and technical sessions and a special conference for electronics instructors. Various electronics firms will be sponsoring local trips, dinners, lunches and cocktail parties. For more information or registration blanks, write or call NESDA, 2708 West Berry St., Ft. Worth, TX 76109, 817-921-9061.

New Jersey Computer Show
The 1980 New Jersey Personal Computer Show and Fleamarket (NJPCS) will be the first home and hobby computer show ever held in Northern New Jersey. The show is Sept. 27 and 28 at the Holiday Inn (North) at Newark International Airport (NJ Turnpike Exit 14). Featured will be in an indoor commercial exhibit area, a large outdoor fleamarket and user group meetings/forums on the TRS-80, PET, Apple, Heath and other popular systems. For additional information, write: NJPCS, Kengore Corp., 9 James Ave., Kendall Park, NJ 08824.

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**Corrections**

The left brackets ([ ]) that appear in the “Orbiter” listings (May 1980, pp. 112, 113) should be up-arrows.

For 16K machines, the last two digits in the “POKE” line of Ronald Fouli’s letter (June 1980, p. 225) should be the three digits 127.

The digits in line 120 of Al Joffe’s program listing on page 32 of the September 1979 issue should be 1944, not 9114.

Gary Sabot, author of “You Name It!” (May 1980), writes: In the two years since I wrote the article, the version of BASIC I used has become obsolete. In order for the program to run on any version of Microsoft BASIC (such as MBASIC and Radio Shack Level II), a small change must be made. Wherever the old program has “MID$...” you must substitute “MID$(...”. Lines 190, 200 and 210 must be changed in this way.

Allan Domoret writes that there is a typo in Example 2 of his article “Uppercase Lowercase Utility for the TRS-80” (March 1980). The POKEs to decimal memory references 16512, 16513 and 16514 should be read 16408, 16409 and 16410, respectively. The hex references to &h4019, &h4019 and &h401A are correct as shown.

Author of “Lowercase for the TRS-80,” Steven Wexler, let us know that there is an error in his listing. The next to the last line should read, in part: “7FFA D2,7D,04. The second element is D2, not 02.”

This is not a correction; it is just a note that the list of sources of educational software on page 105 of “Bringing Microcomputers into Schools” (June 1980) was not meant to include all sources.

Chesney Twombly, author of “8800 Program Loader/Relocator” (April 1980), wants to add the following note to his article: The TSC 8800 Relocator program will run on an H8 using CONOPS if you remember to change the addresses of external routine jumps to read as follows:

```
431F C3 D8 6E MONTR JMP MONIT
4322 C3 1B 6C INCH JMP INCHR
4325 C3 67 20 OUTCH JMP WCHR
```

Robert Penoyer, author of “Accurate Voltage Dividers” (April 1980), has informed us that the last sentence of the second complete paragraph on page 143 should finish: “3900 Ohms and 12 Ohms,” not “3900 Ohms and 1200 Ohms.”
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In response to Mr. Spearman: Listings 5-7 illustrate six programs run under WATFIV-S, G Level FORTRAN IV and PL/I on an IBM 4331. (I would like to thank Larry Oliver of the LMR Computer Center for his assistance.) Similar time savings should be realized when this technique is applied to most compilers (be they on a micro, a mini, or a maxi) if it is able to recognize a constant subscript. If the compiler is not able to determine that the subscript is a constant, then it will treat this array reference the same as it would treat a reference subscripted with a variable.

Warren A. Harrison
Computer Science Dept.
University of Missouri
Rolla, MO 65401

Correction

Before submitting my article, "A Micro for the Eighties" (May 1980), I talked by telephone with a dealer confirming the then-current prices for AlphaMicro products. Since these have been reduced the last few months, I was concerned about a price increase. At no time did this dealer or another to whom I talked advise me of any change in policy concerning the sales of equipment by AlphaMicro.

I have since called two dealers and AlphaMicro to find that AlphaMicro made a change in marketing policy effective January 1, 1980. Primarily to enhance total system reliability, AlphaMicro Systems no longer sells the AM-100 CPU boards or the disk control boards as separate items. One can only purchase a complete system from AlphaMicro. The minimal system is an AM-100 with double density floppy (but without terminals or printers). The base price is approximately $10,800.

Some dealers still have AM-100 CPU boards, ordered before the policy change, which they will sell separately for those persons wanting to upgrade an 8080 or Z-8 system.

I am informed that the policy created no small measure of dealer resistance and that many dealers have expressed opposition to the policy. I do not know if this will result in a change—I rather doubt that it will.

Since the AlphaMicro rep told me that the new policy is primarily the result of the introduction of a new and faster CPU called the AM-100-T, apparently, this CPU stretches most S-100 motherboards beyond their capabilities. The introduction of the new policy, while making it much more expensive to upgrade to an AlphaMicro system, results in AlphaMicro supplying a complete system which they know will work, instead of struggling with users who have placed an AlphaMicro CPU on a standard motherboard and with inferior memory.

I deeply regret the inaccuracies appearing in the article. I thought I was going out of my way to avoid problems such as this. Apparently, I did not go far enough or ask the right questions. Frankly, it never dawned on me that AlphaMicro would stop selling individual CPU boards. Again, my apologies.

Wm. C. Welborn, Jr.
Evansville, IN

Praise for Pascal

I was pleased to see the article, "An Introduction to Pascal," by Jim Gagne in the June 1980 issue. Besides introducing the language, it also contains a good sales pitch on the benefits of a structured language.

I feel strongly that new users of microcomputers should be learning Pascal as their first computer language. This would avoid all the bad programming habits that people pick up when starting out with an old-style language, such as BASIC. What is really needed here is a simple low-cost computer with Pascal in ROM. This would mean that whenever you switched the machine on, there would be Pascal, ready to run.

Unfortunately, most of the versions of Pascal that are available for microcomputers are compilers, which require floppy disks and extensive memory. For the beginning programmer, an interpreter is much better because it executes the program lines directly, and requires much less memory. It will be slower, of course, but that is not normally a problem.

As an experiment, I recently wrote an interpreter for Pascal, just to see if it could be done. I simplified standard Pascal slightly, to make it easier to interpret. In particular, there must be one statement per line, and semicolons are not used to separate statements. The indentation of lower-level statements is compulsory.

I think that having an interpreter such as this on a small appliance-type microcomputer would be a great advance in hobby computing. The version I have now is written in assembly language for a time-sharing computer, but I intend to do it again for my Motorola 6802 microcomputer.

J. Gary Mills
Winnipeg, Man.
Canada

Love That TRS-80

The April 1980 "Publisher's Remarks" indicated interest in the comments of users of microcomputers for business operations.

Our company uses a TRS-80 (Model I) with lowercase mod, 48K RAM, standard 35-track disk drives and a daisy wheel printer. Although our business is not suitable for a minicomputer system, we prefer our TRS-80 for a number of reasons.

Most important, we can write our own programs, giving us the flexibility to produce and format data as we wish, and to alter the output as our needs change.

The other reasons have mainly to do with cost savings and convenience. For instance, our office payroll and related expenses have fallen $24,000/annum, and service is available through a maintenance contract with a local firm. Also, programs such as Electric Pencil enable us to use it for more functions than we had contemplated.

We did experience some reliability problems. Substituting NEWDOS for TRSDOS solved most of them. Others appear to be caused by such things as poor connections developing at the edge card connectors. After some experience we have been able to recognize the causes and eliminate most problems. We notice an increasing number of reliability aids, such as data separators, on the market and we will no doubt be continually upgrading our equipment.

W. K. Wells
Scarborough, Ontario
Canada

REMARKS (from page 7)

Opportunity Knocketh

Software and hardware may come and go, but one thing goes on, regardless of the changes, and that's publishing. The faster the changes happen, the more need there is for more magazines and books to support the changes. This explains the growth we've experienced with Kilobaud Microcomputing and 80 Microcomputing magazines.

Since it takes people to make this growth happen and continue, we have career spots open, and no end in sight to the projected growth. If you have any background or desire to apprentice in editing, technical editing, advertising sales, circulation, product testing, programming or any of the other facets of publishing, you should let me know. Send me a letter telling me what you think you can do for us and what aspects of your background and experience substantiate that expectation.

Ad Policy

We've received several reader complaints about the recent Interlude ads. This was not unexpected. But we figured that since most readers of this magazine were presumably knowledgeable about sex, censorship of the ad would achieve little.
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Before you buy another small computer, see if it includes the following features: ROM, clock, State and Mode displays; Single step; Optional address displays; Power Supply, Audio Amplifier and Speaker; Fully socketed for all IC's. Real cost of warranty repairs; Full documentation.

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. No code and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music of using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

**Super Expansion Board with Cassette Interface $89.95**

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**or slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are included in price plus a detailed 127pg. instruction manu-

**al which now includes over 40 pg.s of software info including a series of lessons to help you start and a music program and graphics target game.**

Many schools and universities are using the Super Elf as a course of study. OEM use is fine for R&D. Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. Super Elf $106.95. High address option $8.50. Low address option $9.95. Custom Cabinet with drilled and labelled plexiglass front panel $24.95. Expansion Cabinet with room for 4-10 boards $41.00. NEC Add Battery Memory Saver Kit $6.95. All kits and options also completely assembled and tested. Questdata, a 12 page monthly software publication for the 1802 computer users is available by subscription for $12.00 per year. Issues 1-12 board $16.80.

Tiny Basic Cassette $10.00, on ROM $28.00, original Elf kit board $14.95. 1802 software; Mows video Graphics 3.95. Games and Music $3.00, Chip board $5.50.

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A powerful language for CP/M systems
SFC-73901001F 8" disk & manual priced at $99.95

SDOS - SD Systems
DOS, CBASIC2, 280 assembler/editor/linker
SFX-55001000D priced at $24.95
SFX-55001000M 51/2" disk & manual priced at $149.95
SFX-55001000F 8" disk & manual priced at $149.95

WORDSTAR - MicroPro Intl
The finest word processing package for CP/M
SFC-13600100F 8" disk & manual priced at $395.00

VISICALC - Personal Software
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SFA-24101000M 5/4" disk & manual priced at $145.00

SINGLE DRIVE COPY - for Apple
Make back-up disks with just a single Disk II
SFA-51150010M 5/4" disk & manual priced at $19.95

SUPER-TEXT - Muse
Professional word-processing package for Apple
SFA-139600805M 5/4" disk & manual priced at $99.95

EPROM ERASER - L.S.Engineering
UV eraser for up to 48 EPROMs
XME-3200 A & T priced at $39.95

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Microcomputing, August 1980 223
HEX ENCODED KEYBOARD

- Stand alone TV
- 22 char/line, 16 lines, modifications for 64 char/line included
- Parallel ASCII (TTL) input
- Video output
- VIA on board memory
- Output for computer
- Controller
- Auto scroll
- Non-destructive curser
- Curser inputs: up, down, left, right, home, EOL, EO
- Scroll up, down
- Requires +5 volts at 1.5 amps, and +12 volts at 30 mA
- All 7400 TTL chips
- Char gen. 2513
- Upper case only
- Board only $38.00 Part No. 106, with parts $145.00 Part No. 106A

T.V. TYPEWRITER

- RS-232/20mA INTERFACE

ASCII TO CORRESPONDENCE CODE CONVERTER

This bidirectional board is a direct replacement for the board inside the Trendata 1050 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

- Converts video to AM-modulated RF, Channels 2 or 3. So powerful almost no tuning required. The board regulated supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal Recommended by Apple Power required is 12 volts AC. DC or $5 volts DC Board only $7.60 Part No. 107, with parts $13.50 Part No. 107A

T.V. INTERFACE

- Converts video to AM-modulated RF, Channels 2 or 3. So powerful almost no tuning required. The board regulated supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal Recommended by Apple Power required is 12 volts AC. DC or $5 volts DC Board only $7.60 Part No. 107, with parts $13.50 Part No. 107A

UART & BAUD RATE GENERATOR

- 53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollerover • MOS/DTL/TTL Compatible • Upper Case Conversion • Data and Stroke • Inversion option • Three User Definable Keys • Low contact bounce • Selectable Part- • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. $59.95 kit

ASCII KEYBOARD

- TTL & DTL compatible • Full 97 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. $199.95

TAPE INTERFACE

- Converts low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital and square TTL signals • Output of board connects to mic. of recorder • Earphone of recorder connects to input on board
- No coils • Requires +5 volts, low power drain • Board only $17.60 Part No. 111, with parts $29.95 Part No. 111A

U.S. ELECTRONIC

- Model 332 • Used with 500/400, 912-2K, and 1120. $249.95

44 BUS MOTHER BOARD

- Has provisions for ten 44 pin (156) connectors. Space between each apart. Pin 20 is connected to X, and 22 is connected to Z for power and ground. All the other pins are connected in parallel. This board also has provisions for bypass capacitors. Board cost $15.00 Part No. 102, TTL chips $3.00 each Part No. 44W Engine

RS-232/20mA INTERFACE

- This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires 12 and -12 volts. Board only $9.95, parts only $14.95 Part No. 7901A

COMPRINTER

- Printing Characteristics: 225 characters/second 170 lines/minute throughout. 9 horizontal x 12 vertical matrix • 96 ASCII character sets with upper and lower case • 80 character line • 5.8 lines/inch
- Buffer Memory: standard 256 bytes • optional, 2038 bytes (buffer memory option designated as Model 912-5K, $143.95)
- Paper Requirements: electrosensitive type (aluminum coated) 8 1/2 12 inch width • 3.7 inch max. (300 ft.) roll diameter
- Model 912-5 Interfacing: serial interface RS232 and 20 mA current loop • BAUD rates 110, 150, 300, 600, 1200, 2400 and 4800 are strip selectable
- Model 912-P Interfacing: parallel interface, IEEE-488 and 9 pin parallel strobe/acknowledged. Model 912-P, Part No. CPIA, $329.95, $579.95, Model 912-P, Part No. CPI, $3117, $559.95

DC POWER SUPPLY

- Board supplies a regulated +5 volts at 3 amps, +12, -12, and -5 volts at 1 amp. Power required is 8 watts AC at 3 amps, and 24 watts AC at 1.5 amps. Board only $125.00 Part No. 56085, with transformer included $42.50 Part No. 56085A

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., no shipping charges will be added. CA residents add 5.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800.

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OPTO-ISOLATED
PARALLEL INPUT
FOR APPLE II

part No. 7907

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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 $260 watts. Board
only $15.00 Part No. 210, with parts
$119.95 Part No. 210A.

APPLE II+

$14.95

SERIAL I/O INTERFACE

Baud rate is continuously adjustable from 0
to 30,000. • Plugs into any peripheral
connector. • Low current drain. RS-232 input
and output. On board switch selectable 5 to
8 data bits, 1 or 2 stop bits, and parity or
no parity either odd or even. • Jumper selectable
address. • SOFTWARE. Input and Output
routine from monitor or BASIC to teletype or
other serial printer. • Program for using an
Apple II for a video or an intelligent terminal.
Also can output in correspondence code to
interface with some selects. • Also
watches 120V, 12V DC or AC. Board only
$15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled
$62.00 Part No. 2C.

8K EPROM PICEON

• Programs 2708's address relocation of each
4K of memory to any 4K boundary. • Power
on and reset jump off for “turnkey”
systems and computers without a front panel.
• Program saves 2700's $14.95, with 8 EPROMs
$17.95, with 8 EPROMS $21.95.

WAMECO PRODUCTS

With ELECTRONIC PARTS

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drive up to 8 drives in drive 0 to 7, on board PROM with
power boot up, work perfectly with CPM, not
enhanced, PC Board. • $49.95

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PC Board. • $49.95

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GMB-10 MOTHER BOARD, 13 slot, terminalized, 5-100 board only
$89.95 Kit

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MEM-1 1702E 8K EPROM $25.95

MEM-2 1/2 2708-1702 16K/2K EPROM $22.95

MEM-3 16K & Fully Buffered $21.40

S-100 BUS

ACTIVE TERMINATOR

Board only $14.95 Part No. 900, with parts
$24.95 Part No. 900A.

D.C. HAYES MICROMODEM

Fully S-100 bus compatible including 16-bit
machines and 4 MHz processors. • Two soft
ware selectable Baud rates—300 Baud and a
jumper selectable speed from 45 to 300 Baud.
(110 baud standard). Supports originate and answer
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into your local telephone system, with none of
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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-DCA38625—$379.95

RIDMA

Tape Interface Direct Memory Access. • Record
and play programs without bootloader I/O
proms has FSK encoder/decoder and direct
connections to low cost recorder at 1200 Baud rate,
and direct connections for inputs and outputs to
a digital recorder at any baud rate 5-100 bus compatible
• Board only $35.00 Part No. 112, with parts
$110.00 Part No. 112A.

SYSTEM MONITOR

8060, 8080, or 2-80 System monitor for use
with the TIDMA board. There is no need
for the front panel Complete with documentation
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RS-232/TTY INTERFACE

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Four Serial I/O RS-232 ports. S-100 Bus, Software
and jumper selectable baud rate (110, 300, 600,
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rate generator. Addressing, switch selectable,
parity or no parity field, or even switch selectable.
1200, 2 stop bit, 7 or 8 bit character. Board only
$59.95, Part No. 700B. With 2-80 board $119.95, Part No. 700A.
MICROPSI DISK DRIVES

Imagine a 5 1/4" floppy disk system with all the storage capacity of an 8" floppy system, and more.

Micropolis can give you more storage because they pack more data onto every disk. Ordinary 5 1/4" floppies provide just 33 tracks per drive and store 70 to 130 bytes of data. Instead, Micropolis uses 77 tracks each with 16 sectors of 16 bytes to yield an incredible storage capacity of 3156 bytes per drive.

And that's all! Reliability doesn't just happen by accident. At Micropolis reliability is engineered into each step of manufacturing. For example, most 5 1/4" floppy disks cut costs by using a plastic case and can follower to position the read/write head. Micropolis chose to use the strength and durability of all steel cases and can follower. While it costs more, but it gives you more accurate tracking over a significantly greater lifespan which adds up to a lower cost per byte with disk. Software from Micropolis includes a comprehensive DOS, (disk operating system) and Disk Extended Basic designed for 8080/8086 microcomputer systems. The DOS is complete with an assembler, editor, file management functions and disk utilities. Micropolis BASIC is complete, a powerful programming tool for developing, testing, executing and maintaining basic programs.

The model 1043 MOD II is a single floppy disk system with 32K byes storage and includes the 5 1/2 disk Controller board. If you need more storage, or simply want to save even more money, then order the model 1053 MOD II dual disk system 63K bytes storage capacity and 5 1/2 Controller board. Micropolis DOS and disk extended BASIC are standard with both units.

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1150 25/8" S-100 1 x 400
1151 25/8" S-100 2 x 100
1152 25/8" S-100 5 x 100
1153 25/8" S-100 10 x 100
1154 25/8" S-100 20 x 100
1155 25/8" S-100 50 x 100
1156 25/8" S-100 100 x 100

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CompuPro S-100 Motherboards: Designed for the Future, AVAILABLE NOW

You won't have to throw your motherboards away when you upgrade your system; they are specifically designed to handle the new generation of 5 to 10 MHz CPUs coming on line, as well as present day 2 and 4 MHz systems, Faraday shielding between all bus signal lines minimizes crosstalk; additionally, when signal lines cross each other on opposite sides of the board, they do so at a 90 degree angle to minimize any chance of stray coupling. You'd expect the company that pioneered active termination to include true active termination, but we've gone one step further by splitting the termination load between each end of every bus line. And you won't have to junk your present computer box with our new motherboards—sizes fit Godbout, Vector, Imsai, TII, and similar enclosures.

These high-performance motherboards are available in "unkit" form (edge connectors and termination resistors pre-soldered in place for easy assembly), or fully assembled and ready to go.

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*CK-026 6 slot motherboard with edge connectors — unit $89, assm $129

—CK-027 2 slot motherboard with edge connectors — unit $59, assm $79

**NOTE:** Most CompuPro boards are available in unkit form (sockets, bypass caps pre-soldered in place), or fully assembled, or qualified under the Certified System Components (CSC) high-reliability program (200 hour burn-in, more). CSC memory boards run at 8 MHz, are guaranteed to run with 6 MHz Z-80s, and draw even less power than standard models.

CAREFUL . . . NOT ALL S-100 CPU BOARDS ARE CREATED EQUAL!

You'll appreciate the extras that go into our CPU boards; take IEEE spec compatibility, for example. While others may claim compatibility, we meet all timing specs—and we'll be glad to send you timing diagrams for our CPUs to prove it (just include an SASE). You don't have to compromise on another "me-too" board . . . choose CompuPro.

THE ENHANCED/ADVANCED Z-80A S-100 CPU BOARD

Superior design in an IEEE-compatible board gives the power for future expansion as well as system flexibility. Includes all standard Z-80A features along with power on jump/clear, on-board fully maskable interrupts for interrupt-driven systems, selectable automatic wait state insertion, provision for adding up to 8K of on-board EPROMs, 4 MHz operation, and IEEE compatible 16/24 bit extended addressing. $225 unit, $295 assm, $395 CSC.

THE COMPUPRO "RAM" SERIES OF STATIC MEMORY

Recommended for commercial, industrial, and scientific applications, 6MHz standard operation, no dynamic timing problems, meets all IEEE specifications, low-power/high speed chips used throughout, extensive bypassing, careful thermal design.

S-100 STANDARD MEMORY

<table>
<thead>
<tr>
<th>Unit Price</th>
<th>Assm Price</th>
<th>CSC Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>8K RAM BA</td>
<td>$169</td>
<td>$189 $239</td>
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<tr>
<td>16K RAM X-16</td>
<td>$329</td>
<td>$379 $479</td>
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<tr>
<td>24K RAM X-24</td>
<td>$449</td>
<td>$499 $599</td>
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<tr>
<td>32K RAM X-32</td>
<td>$599</td>
<td>$689 $789</td>
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S-100 EXTENDED ADDRESSING MEMORY

(16/24 address lines, addressable on 4k boundaries)

<table>
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<tr>
<th>Unit Price</th>
<th>Assm Price</th>
<th>CSC Price</th>
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<tr>
<td>16K RAM XIV</td>
<td>$299</td>
<td>$349 $429</td>
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S-100 BANK SELECT MEMORY

(Cromemco etc. compatible; addressable on 4k boundaries)

<table>
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<th>Unit Price</th>
<th>Assm Price</th>
<th>CSC Price</th>
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<tr>
<td>16K RAM XBA-16</td>
<td>$349</td>
<td>$419 $519</td>
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<td>24K RAM XBA-24</td>
<td>$479</td>
<td>$539 $649</td>
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<tr>
<td>32K RAM XBA-32</td>
<td>$649</td>
<td>$729 $849</td>
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SBC/BLC MEMORY

<table>
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<tr>
<th>Unit Price</th>
<th>Assm Price</th>
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<tbody>
<tr>
<td>32K RAM XI</td>
<td>n/a</td>
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OTHER S-100 BUS PRODUCTS

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Price</th>
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<tbody>
<tr>
<td>Godbout Computer Enclosure</td>
<td>$209</td>
</tr>
<tr>
<td>Active Terminator Board</td>
<td>$334.50</td>
</tr>
<tr>
<td>2700 EPROM Board (less EPROMs)</td>
<td>$85 unit</td>
</tr>
<tr>
<td>Memory Manager Board</td>
<td>$59 unit, $85 assm, $100 CSC</td>
</tr>
<tr>
<td>25 Interlace I E/O Board</td>
<td>$199 unit, $249 assm, $324 CSC</td>
</tr>
<tr>
<td>3P Plus 5 Interlace II E/O Board</td>
<td>$199 unit, $249 assm, $324 CSC</td>
</tr>
<tr>
<td>Mullens Extender Board</td>
<td>$59 kit</td>
</tr>
<tr>
<td>Mullens Relay/Opto-Isolator Control Board</td>
<td>$129 kit, $179 assm</td>
</tr>
<tr>
<td>Vector 8800V S-100 Prototyping Board</td>
<td>$19.95</td>
</tr>
</tbody>
</table>

COMING SOON!

We've got a new board coming up that's so versatile some of our people have nicknamed it the "smorgasbord": it includes (among other things) a real-time clock, interval timer, interrupt controllers, and math processor. We've also got a board in the works that greatly enhances the throughput and performance of multi-user (2 or more terminal) systems, by assuming a lot of the overhead functions normally handled by the main CPU. Look for more details on these useful and functional products in the months ahead, or check with finer computer stores for additional information on these and other CompuPro products.
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3200 Advanced Single Bit. Doro. $48.95
7200 Dual Bit. $48.95
7400 Dual Bit. $48.95
7500 Dual Bit. $48.95

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Special TRS80 Schematic...$4.95
Expansion Interface Schematic...$4.95
Expansion Interface Connector...$7.95

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SIN $74.00

UV "Eeprom" Eraser
Model Uv1-1E $98.95
Holts 4 Eeproms at a time
Backed by 45 years experience
Model S-521...$26.00

EMAKO-20 Reg. $177.00 $99.00

MIKA 20 = $128.00

BASE II PRINTER

ACOUSTIC MODEN NOVATION CAT.
O-3000 Baud

DATA BOOKS + COMPUTER BOOKS

VERBATIM DISKETTES
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UARTS/BAUD RATE

PI+100kHz 2400 1wp

KEYBOARD ENCODERS

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TV CHIPS/SOUND

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SOCKET SPECIALS

V200E3

9627
9617
9612
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NOTE: WE PROGRAM MICRO

COMPUTER SPECIALS

DISK INTERFACE

NEED SPECIAL

FREE CASSETTE

with purchase of diskette
and cassette cover with $10.00

YOU PAY ME OR I SHIP FREE

NO DISCunes ON INVENTORY

DO NOT CALL unless you pay.

CALL NOW!
**32K Static RAM**

*S100 Memory Board*

$499.95

**ASSEMBLED & TESTED**

California Computer Systems

**16K Static RAM**

same features as above. $249.00

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**8038C**

VCO Waveform Gen

$265

**2114L**

1024x4 Static RAM, 450 ns

$450

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Outlet-6 switch, EMI filtered Circuit Breaker $87.50

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2708 $19.75

18Kx8 40NS

2716 $18.95

16Kx8 40NS

2725 $30.95

32K (40pin) $58.50

**Concord Computer Components**

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**Conrad Computer Components**

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**APPLE II Computer**

with full 48K of memory!

$1099.00

---

**Apple Expansion Kit**

16K Memory Add-On Kit

includes instructions, RAMs, and jumpers.

$47.50

---

**.video**

**video 100**

12" Black & White Low Cost Video Monitor

$139.00

---

**Home Study Course on Cassette**

**S1-Introduction to Microprocessors**

This seminar is intended for all non-specialists who wish to acquire a broad understanding of the basic concepts and advantages of microprocessors. It explains how microprocessors work, and discusses methods, costs, advantages and disadvantages of the main important areas of each type of microprocessor. The emphasis is on understanding the microprocessor system and its place in the computer world. Includes BASIC DEFINITIONS, SYSTEM COMPONENTS, MICROPROCESSOR APPLICATIONS, BUS SYSTEMS, WHAT TO LOOK FOR, AND IMPACT AND EVALUATION.

$299.50

---

**Voltage Regulators**

**NEGATIVE**

7905/5V

7906/6V

7915/15V

7918/16V

$2.00

---

**RESISTORS**

0.1 ohm 5% 1/2W $0.00

1 ohm 5% 1/2W $0.00

10 ohm 5% 1/2W $0.00

100 ohm 5% 1/2W $0.00

---

**Logic Probe Kit**

$17.95

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**Reader Service index—page 241**

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**Microcomputing, August 1980** 231
**JE608 Assembled and Tested**

<table>
<thead>
<tr>
<th>TYPE</th>
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**LOW PROFILE (TIN) SOCKETS**

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**SOLDERTAIL (GOLD) STANDARD**

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**1/4 WATT RESISTOR ASSEMBLIES - 5%**

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<tr>
<td>ASSY.</td>
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**CAPACITOR 50 VOLT CERAMIC DISC CAPACITORS**

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<td>1.0 nF</td>
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<td>0.01 uF</td>
<td>C02</td>
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<tr>
<td>0.001 uF</td>
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**RESISTORS 1/4 WATT WITH PL PLCC CAPS**

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**MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS**

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</tr>
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<td>1 uF</td>
<td>8L6</td>
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**FREE CATALOG**

MAIL ORDER ELECTRONICS - WORLDWIDE
1335 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

PHONE ORDERS WELCOME
(415) 598-9007
ULTRAVIOLET INTENSITY METER

by BLAK-RAY

TWO MODELS: LONG WAVE
AND SHORT WAVE

Meter consists of a sensor cell attached to a compact (3" x 3¼" x 3") metering unit. Can be hand-held or placed directly on the surface for measuring. Can be used remotely, when connected to a meter housing by a 4-foot cable. Two models available — one for long wave and one for short wave ultraviolet. Readouts are in microwatts per square centimeter. Weight: 1 lb.

Completely assembled (includes sensor cell, reduction screen, extension cord, contrast filter and certification report).

J-221 LONG WAVE

(300mm-400mm) $242.00

J-225 SHORT WAVE

(200mm-280mm) $260.00

CONTINENTAL SPECIALTIES

Proto Clips

14-PIN CLIP PC-14 5.45
16-PIN CLIP PC-16 4.75
24-PIN CLIP PC-24 5.00
40-PIN CLIP PC-40 5.00

Jumbo 6-Digit Clock Kit

Four 4½W/100 and two 2½W/50, common alarms, 12V, 24V or 50 Hz, includes programmable controls, uses MINISH 10 clock chip, switches for hours, minutes and seconds, control panel panel, and 50Hz or 60Hz operation. Includes all components, case and wall mounting kit.

JE747 $29.95

JE701

6-Digit Clock Kit $19.95

Switchable 12-Volt Power Supply

Uses LM309K, heat sink provided, PCB construction, provides output. Switchable output, 1 amp at 6 volts. Output voltage: +12 volts. Uses MINISH 10 clock chip, switches for hours, minutes and seconds, case, control panel panel, and 50Hz or 60Hz operation. Includes all components, case and wall mounting kit.

JE2206B $19.95

DESIGNERS' SERIES

Blank Desk-Top Electronic Enclosures

- Blank desk-top enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home environments. The ends and sides are precision-molded with an internal die (all around) to accept top and bottom panels. The panels are then fastened to ¾" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear bottom panel includes back on stator tracks which will result in the enclosure remaining intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be used with the Jumbo 6-Digit Clock Kit.

JE300 $39.95

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home environments. The ends and sides are precision-molded with an internal die (all around) to accept top and bottom panels. The panels are then fastened to ¾" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear bottom panel includes back on stator tracks which will result in the enclosure remaining intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be used with the Jumbo 6-Digit Clock Kit.

JE600 $69.95

Hexadecimal Encoder Keyboard

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessors. The encoder has two additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessors. Sixteen user keys on one board. Eight additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts to verify entries. I/O interface with standard JE610 IC connector. Only +5VDC required for operation.

JE600 (Case not included) $59.95

Desk-Top Enclosure for JE600 Hexadecimal Encoder Keyboard

Compact desk-top enclosure: Color-coordinated designer's case with light-tan aluminum panels and molded-in plastic in mocha brown, includes mounting hardware, and is designed to fit a JE600 + 416 K RAM. JE600 + 8192 K RAM $124.95

JE660

$79.95

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light-tan aluminum panels and molded-in plastic in mocha brown, includes mounting hardware, and is designed to fit a JE610 + 416 K RAM. JE610 + 8192 K RAM $99.95

JE610

ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into any computer system. The kit comes complete with an industrial grade keyboard switch assembly (52 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. This encoder generates the full 128 characters, upper and lower case ASCII set. The keyboard is buffered. Two user-define keys provided for keyboard applications. Can be used as a hardware expansion which may connect with other key systems. It utilizes +5VDC and MOS logic arrays. Easy interface with a 16-pin DIP or 18-pin edge connector.

JE610 (Case not included) $79.95

Function Generator Kit

Provides 3 basic waveforms: sine, triangle and square wave. Frequency range from 1 Hz to 1000 Hz. Output amplitude from 0 to 100% of supply voltage up to 10 volts. Uses 8-pin DIP output. Uses a 12V supply or a +12V or +24V supply. Includes P.C. board, components & instructions.

JE2206B $19.95

DIGITAL THERMOMETER KIT

Provides a dual-screen display, with a split-screen display, for both high and low temperature readings. The temperature range is from -40°F to +121°C. The kit includes an AC adapter, 9 volt battery, instructions, and a thermometer. The kit is designed for use in industrial, commercial, and educational applications.

JE300 $39.95

Microcomputing, August 1980 233
These units are ideal for micro computers. They have been removed from equipment, checked out and guaranteed.

1—5 volts @ 8 amps + 12 volts @ 2 amps + 6 volts @ 75 MA. Power supply has a 3-wire line cord and fused. Dimensions:
10½" x 5½" x 4½". Shipping weight: 16 lbs. .......... 37.50 ea. 2/70.00
2—Model 818, 5 volts at 15 amps + 12 volts at 4 amps-12 volts at 2 amps. (with line cord). .......... 35.00 ea. 2/65.00
3—+ 5 volts at 5 amps + 12 volts at 500 ma. + 6 volts at 25 ms. (line cord included). .......... 32.95 ea. 2/60.00
4—Elexon, multi output. Input: 120/240 AC, ±10%, 47-63 Hz; output: 1) 12V, 1.5A, DC, OVP; 2) 12V, 1.5A, D.C., OVP. New, in box with operating instructions. .......... 31.50
5—Power Design, Model 1210, constant voltage, DC. P.S. input: 105-125 A.C., 55 to 440 Hz. Output: 1-12 volts, 0-10 amps, DC. continuously adjustable output voltage and current limiting. .......... 139.00

**COMPUTER GRADE CAPACITORS**

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<td>18,000 mfd 10 VDC</td>
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<td>4,400 mfd 20 VDC</td>
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<td>$1.00 ea. 2/$23.00</td>
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<tr>
<td>46,000 mfd 20 VDC</td>
<td>2.50</td>
<td>$3.50 ea. 2/$60.00</td>
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<tr>
<td>3,000 mfd 25 VDC</td>
<td>1.00</td>
<td>Reduced prices</td>
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**WIRE WRAP BOARDS**

These boards are pre-wired and removed from equipment. Easy to unwrap for setting up your own board, contains mostly 14-pin IC sockets with individual pin connections. Each board has VCC and ground planes.

Smaller board measures 8½" x 6" and has 40 to 50 sockets.
Larger board measures 13½" x 6" and has 75 to 100 sockets.

**DIABLO System Disc Drive**

SERIES 40, MODEL 43
100 tracks per inch, total capacity of 50 mega-
bits, w/Model 428 power supply, sector counter, 24 sectors, 1 fixed disc, 1 removable
disc, average access time 38 ms, PPM: 2600,
dimensions: 10 × 16" high, fits in standard
rack, equipped with full extension slides, ex-
cellent used condition. Shipped freight col-
lect.

**TRANSFORMERS**

**ROTRON WHISPER FANS**

**HEWLETT PACKARD model 200CD/rack mounted AUDIO OSCILLATOR freq:5hz to 600khz output: 160mw**

**HEWLETT PACKARD model 40D ANALOG VACUUM TUBE VOLTOMETER freq: 10hz to 4mhz voltmeter range: 1mv to 300vac in 12 ranges**

**SG-132 SWEEP SIGNAL GENERATOR**

FREQ: 15 TO 4000 Mhz
Output: AM & FM: CW 15 Hz...
...at any frequency. Crystals...x x x 50mhz or ±10B. Frequency accur.
oscilloscope for observing

**TRENDLINE PHONES**

Manufactured by I.T.T.

These units have rotary dials. Colors are: white, black, red, and green. They are packaged and have 6-foot cord and installation instructions. Used, but in good operating condition.

Minimum order $25.00. Items offered subject to prior sale. FOB, Brockton, Mass. Money order or check worder. Shipments and handling add 5%. Shipments by parcel post or UPS. No CODs. Mass. residents add 5% sales tax.
**WAMECO**

**THE COMPLETE PC BOARD HOUSE EVERYTHING FOR THE S-100 BUSS**

- **FBP-1** FRONT PANEL BOARD FOR 8080A AND Z80 SYSTEMS IMSAI COMPATIBLE.
  - PCBD ...... $54.95 KIT ...... $165.00

- **MEM-2** 16K RAM 2114's, ADDRESSABLE IN 4K BOUNDARIES.
  - PCBD ...... $31.95 KIT (LESS RAMS) ...... $80.95

- **EPM-2** 16/32K ROM USES 2716 OR 2708. ADDRESSABLE IN 4K BOUNDARIES.
  - PCBD ...... $31.95 KIT (LESS ROMS) ...... $74.95

- **CPU-1** 8080A PROCESSOR BOARD WITH VECTOR INTERRUPT.
  - PCBD ...... $31.95 KIT ...... $124.95

- **IOB-1** I/O BOARD, ONE SERIAL, TWO PARALLEL WITH CASSETTE.
  - PCBD ...... $31.95

- **FDC-1** FLOPPY DISC CONTROLLER BOARD USES 1771.
  - PCBD ...... $44.95

**FUTURE PRODUCTS:** 80 CHARACTER VIDEO BOARD, Z-80 CPU BOARD WITH ROM, 8 PARALLEL PORT I/O BOARD.

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**Mikos Parts Assortment with Wameco and Cybercom PCBs**

- **MEM-2** with Mikos #7 16K ram with L2114 450 NSEC ...... $249.95
- **MEM-2** with Mikos #13 16K ram with L2114 250 NSEC ...... $279.95
- **CPU-1** with Mikos #2 8080A CPU ...... $4.95
- **QM-12** with Mikos #4 13 slot mother board ...... $95.95
- **RTC-1** with Mikos #5 real time clock ...... $59.95
- **EMP-1** with Mikos #10 4K 1702 less EPROMS ...... $49.95
- **EPM-2** with Mikos #11 16-32K EPROMS ...... $59.95
- **QM-9** with Mikos #12 9 slot mother board ...... $89.95
- **FPB-1** with Mikos #14 all parts for front panel ...... $144.95

**Mikos Parts Assortment are ALL FACTORY MARKED PARTS, KITS INCLUDE ALL PARTS LISTED AS REQUIRED. NO COMPLETE KIT LESS PARTS LISTED. ALL SOCKETS INCLUDED.**

**LARGE SELECTION OF LS TTL AVAILABLE**

**Microcomputing, August 1980**

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*Reader Service index—page 241*
**PRIORITE ONE ELECTRONICS**

**MEET THE ECONORAM FAMILY………….**

**all ECONORAMS from COMPUKIT include:**

- Fully static memory used throughout to promote reliable operation and facilitate direct access (DMA).
- 4 MHz with Z80 - 5 MHz with 8085.
- Buffered in-state outputs and buffered inputs.
- All lines buffered, address and data lines buffered to 1 low power Schotky TTL load, all other lines buffered to less than 1 TTL load.
- Onboard regulator.
- DIP switch address selection and deselection (no wire jumpers).
- Two power Schottky support ICs.
- S-100 boards have WRITE strobe selection switch - allows use of memory with or without front panel.

Most ECONORAMs come in 3 forms, UNKIT (UKT) - this means that all sockets, disc capacitors are already soldered in place for easy assembly, fully assembled & tested (A&T), or qualified under the Certified System Component (CSC) high-reliability program (200 hour burn-in, guaranteed 4MHz operation over full temperature range, serial numbered, immediate replacement in event of failure with 1 year of invoice date).

---

**NEW! 32K X 8 ECONORAM X**

Static storage for the S-100 bus. Guaranteed 4 MHz operation. Configured as two 16K and one 16K block, all independently addressable, protectable & enableable. Suitable for use in phantom systems. Extra select/de-select qualifiers for systems using more than 64K of memory make this board the ideal building block for large memory systems. Maybe you can't believe the low pricing - but you can count on the Econoram performance! Also available populated to 16K. Shipping Weight 2 lbs.

<table>
<thead>
<tr>
<th>Model</th>
<th>Reg.</th>
<th>Sale</th>
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<tbody>
<tr>
<td>GBT - ECONORAM X 16K X16K</td>
<td>$329.00</td>
<td>$308.00</td>
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<td>$379.00</td>
<td>$319.00</td>
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<tr>
<td>GBT - ECONORAM X 32K X16K</td>
<td>$599.00</td>
<td>$559.00</td>
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<tr>
<td>GBT - ECONORAM X 32K A&amp;T</td>
<td>$689.00</td>
<td>$589.00</td>
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**ECONORAM X11IA-32**

32K BANK SELECT! S-100 compatible. 4MHz guaranteed operation (0-5V). Features two 16K blocks independently addressable on 16K boundaries. Two independent banks - individual phantom - 256 ports DIP switch selectable each board may be deselected with a single switch. Perfect for use in Alpha Micro Systems. Mannich & others. Uses 4Kx1 low power STATIC rams. Current consumption guaranteed 300mA max. Shipping Weight 2 lbs.

<table>
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<th>Model</th>
<th>Reg.</th>
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<tr>
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**ECO A**

**INTERFACTOR II**

The new Interfactor II I/O board incorporates one channel of serial I/O with all the features of the INTERFACTOR dual RS232 serial board, plus 3 full duplex Parallel ports. The serial section includes all the features you've come to expect - a hardware UART, on-board crystal controlled baud rate generator, hardware/software programmability, RS232 handshaking lines with real RS232 drivers, current loop & TTL drivers, full interrupts and more!! The parallel selection utilizes LSTTL octal latches for latched input & output data with 2mA drive current, attention, enable & strobe bits for each parallel port (each with selectable polarity), interrupts for each input port, separate 25 pin connector, power for maximum CPU loading, and status port for interrupt mask and port status. All in all - an incredibly flexible and easy to use board.

<table>
<thead>
<tr>
<th>Model</th>
<th>Reg.</th>
<th>Sale</th>
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<td>GBT - INTERFACTOR II UKT</td>
<td>$199.00</td>
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<td>GBT - INTERFACTOR II A&amp;T</td>
<td>$249.00</td>
<td>$219.00</td>
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**ECONORAM 2708**

Has provisions for wait states for 4MHz operations. Configured as four 4K blocks - each independently addressable and disableable. Power-on jump. Does NOT include 2708s. Includes all support chips, sockets, regulators, heat sinks, etc. Sold in UNKIT form only. Shipping Weight 2 lbs.

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**ECO A**

**CONEXORAM XIV**

16K x 8 for S-100. Addressable on any 4K boundary. Direct addressing on up to 24 address lines. Fully meets IEEE S-100 bus specs. Low power, high speed static memory. Operates up to 5MHz with newest 8085/8086/8088 CPUs. Can be used with 8080, 286, 8085, 8086, 8088, Z8000, etc.

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<th>Model</th>
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<td>GBT - ECONORAM XIV UKT</td>
<td>$299.00</td>
<td>$279.00</td>
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<tr>
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SAVE $100.00

WOW

PRICE

$695.00

The STAR modem from Livermore

The STAR modem from Livermore represents a significant breakthrough in the development of acoustic modems. The performance model that complies with the highest standards and is available at the lowest possible cost. And, because of its low effective cost, the STAR has become the performance leader in the industry.

The acoustic, foundation bandpass filter provides the user with excellent output and rejection to accurate processing of the received carrier, even at the signals levels of less than –74 dBm. Further, the user is protected from the possible loop discrimination yields data that is essentially jitter free.

The oscillator is built using highly stable state-variable circuitry that delivers a nearly harmonic-free, phase-coherent wide band signal that is compatible with all other 103 type modems. Because of the pureness of the sine wave, the STAR modem exceeds even the stringent harmonic requirements of all CCITT standard users without any constraint.

In order to improve performance of the modem from attempting to operate when excessive noise would produce error or cause marginal operation. The system has also a special amplitude selection circuitry capable of detecting excessive noise levels and signaling the user.

EXCLUSIVE ACOUSTIC CHAMBERS

The exclusive triple seal of Livermore's new flat mounted cups locks the hardware into the acoustic chamber yielding superior acoustic characteristics and minimal mechanical resonances. The unique design of these common chambers used throughout the entire world, the STAR offers the utmost in noise immunity and transmission reliability.

SELF TEST

The feature on the STAR allows the user to verify full operation of the acoustic modem by using the terminal in the full duplex mode. No need for remote assistance in diagnosing terminal or modem problems.

- PROGRAMMABLE Baud Rate Selection (110 to 9600)
- On-Board EPROM May Be Used in Shadow Mode, Allowing Full 64K RAM to Be Used
- On-Board USART for Synchronous or Asynchronous RS-232 Operation (On-Board Baud Rate Generator)

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SWITCHES: 0-100%, 0-200%, 0-500%, 0-1000%, 0-2000%, 0-5000%, 0-10000%, 0-20000%, 0-50000%

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30MHZ DUAL TRACE OSCILLOSCOPE

LIST 945.00
SALE $798.00

- TV sync-separator circuit
- High-sensitivity fms/mV
- Sweep-time magnifier (10 times)
- Z-axis input (intensity modulation)
- Signal delay line
- X-y operation
- Trace Rotation
- Complete with 2 probes
- CH2, 2C, DUAL, ADD. DIFF.
- Anti-Directional Detection Modes
- V152 Dual Trace 150MHz - no delay sweep
- LIST 695.00

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SST and CONNECTOR prices based on GOLD, not exceeding $500 per oz.

*Sale Prices are for prepaid orders only. Credit card orders will be charged the appropriate freight.
**32K S-100 EPROM CARD**

**NEW!**

**$74.95 KIT**

USES 2716’s
Blank PC Board - $34
ASSEMBLED & TESTED ADD $30

**SPECIAL:** 2716 EPROM’s (450 NS) Are $19.95 EA. With Above Kit

**KIT FEATURES:**
1. Addressable at four separate 4K blocks
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard). Allows up to 256K on line!
3. Uses 2114 (40NS) 4K Static RAMs.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PCB board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumped to PIN 67.
9. LOW POWER, under 1.5 amps TYPICAL from the #8 Volt Bus
10. Blank PC Board can be populated as any multiple of 4K.

**16K STATIC RAM KIT-S 100 BUSS**

**PRICE CUT!**

**$225 KIT FOR 4MHZ ADD $10**

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2. ON BOARD BANK SELECT circuitry. (Cromemco Standard). Allows up to 256K on line!
3. Uses 2114 (40NS) 4K Static RAMs.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PCB board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
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8. PHANTOM is jumped to PIN 67.
9. LOW POWER, under 1.5 amps TYPICAL from the #8 Volt Bus
10. Blank PC Board can be populated as any multiple of 4K.

**STEREO! S-100 SOUND COMPUTER BOARD**

At last, an S-100 board that unleashes the full power of two unbelievable General Instruments AY3-8910 NAND gate sound ic’s. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY, LANGUAGE, etc.

**KIT FEATURES:**
- Two GI Sound Computer IC’s.
- Four Parallel I/O ports on board.
- Uses board Audio Amps or your stereo.
- On board Proto TYPING AREA
- All parts are solder-masked, silk screened with gold contacts.
- Easy, quick, and fun to build. With full instructions.
- Uses programmed I/O for MAXIMUM SYSTEM FLEXIBILITY.

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SCL* is now available! Our Sound Command and Language makes writing Sound Effects programs a SNAP! SCL* also includes routines for Register /Examime-Modify, Memory /Examime-Modify, and Play-Memory, SCL* is available on CP M compatible diskette of 2708 or 2716. Diskette -$24.95. 2708 - $19.95 2716 - $29.95 . Diskette includes the source. EPROM’s are CRG at EURO5.

**RCA CMOS COMPUTER CHIP SET**

**COMPLETE KIT!**

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(WITH DATA MANUAL)

**BLANK PC BOARD W/DATA**

**$31**

**16K EPROM CARD-S 100 BUSS**

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Uses 2708’s!

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Double Density Controller Boards
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Since its introduction, the North Star Double Density Controller Board has been an item virtually impossible to obtain (except in a double density Horizon). We now have — for immediate delivery — complete double density (or quad density) disk systems OR double density controller boards only. Double density controllers work with up to 4 double or quad density drives; single, double, and quad density drives can be mixed.
Add $2.50 for shipping and insurance.

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OUR PRICE $699
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North Star Controllers and Disk Systems include latest version DOS, and BASIC.

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*This advertiser prefers to be contacted directly.*
THE CLASSY CHASSIS

WHAT'S COOKING on the FIFTY BUS
32K STATIC RAM BOARDS

Designed for use with:
★ Existing SS50 Systems ★ SS50C Extended Address Systems

- Assembled
- Burned In
- Tested

16K... $328.12
24K... $438.14
32K... $548.15

16K and 24K Versions are socketed for 32K and require only additional 2114's for expansion.

FEATURES:
- Decoding for 4 Extended Address Lines (allows memory decoding up to 1 megabyte)
- DIP-switch to set extended addressing or disable it
- 4 separate 8K blocks, addressable to any 8K boundary by DIP-switch
- Each 8K block may be individually disabled
- Write protect either of two 16K sections
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