The Small Computer Magazine

kilobaud

T.M.

Understandable for beginners . . . interesting for experts

July 1978 / Issue #19 / $2.00 / DM 7,50 / Sfr 8,10 / Ffr 16,0 / UK £2

SwTPC MULTI-USER SYSTEM

OPERATES – Up to 4 terminals running INDEPENDENT programs

HARDWARE TIME SHARE – Requires no modifications to computer

IDEAL FOR – All multi-terminal applications

The SwTPC multi-user system converts our standard 6800 single user computer into a multi-user time share system that may be operated with up to four terminals. The four terminals operate independently and may be running four different programs.

No modifications to the computer are necessary, you simply plug in the multi-user board and add an interface for each additional terminal.

The multi-user system is ideal for program training, multistation business applications and for computer aided instruction (CAI). Speed reduction from a single user system is negligible because all switching is done in hardware.

Multi-user BASIC, suitable for program instruction and simple business applications, is included with the multi-user board. An 8K disc BASIC is also available for systems in which disc drives are used. This software has a complete nine digit floating point math package, full string features and data files.

For computer aided instruction applications, a full feature version of PILOT is available. It includes math operators, misspelling match features and all other proposed for the ANSII standard version. The 6800 multi-user system is just as economical, but far more flexible and powerful than multiple small machines for CAI applications.

MUB-68 Multi-User Board and BASIC Software

Assembled and tested. $150.00

Kit $129.95

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
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Available for immediate delivery from Contemporary Marketing
The Original, "Industry Awakening Advance in Personal Computers"

THE PET

PERSONAL COMPUTE

Just Released
HIGH SPEED PRINT
ACCESSORY

Featuring
IEEE-488 B

The Commodore PET -- Its technology is so advanced; its concept, remarkable; its ease of operation, so utterly simple, and its cost so incredibly low, that ov night it has given rise to a brand new era -- The Age of the Personal Computer.

THE PET has become the standard for the emerging personal computer industry. Computer magazines, trade journals, consumer and business publications have lauded its discovery. POPULAR SCIENCE put THE PET on its October, 1977 cover, in full color, and devoted a feature news story to the coming revolution in personal and office computing. PLAYBOY, February, 1978, gave full color coverage to the "mind-boggling" PET.

IN A LEAGUE WITH IBM, HP AND WANG MINICOMPUTERS

THE PET should not be confused with game products that hook up to household T.V.'s. It is a minicomputer. What sets THE PET light years apart from other computers is its price. While the others cost from $11,000 to $20,000 and more, THE PET, with similar capabilities and power, costs only $795.00.

One extremely important capability shared with HP's minicomputer, and full size computers, is its IEEE-488 Bus. This standard data/control channel means your PET can be directly connected to a variety of peripherals and laboratory measuring equipment. Over 120 pieces of compatible equipment such as counters, timers, spectrum analyzers, digital voltmeters and printer plotters from manufacturers such as HP, Phillips, Fluke, and Textronix are currently available.

ROM Magazine, January 1978, writes, "THE PET comes out of the box, plugs into the wall, and is ready to use." It is equipped with a CRT video display with reverse and blink features, an alpha-numeric keyboard with complete graphics and a built-in standard cassette tape deck.

THE PET is an exceptionally powerful think tank with 8K bytes of RAM (User Memory). Optional equipment, permits expansion to 32K. The system contains 14K bytes of ROM (Program Memory).

THE PET COMMUNICATES IN THE EASIEST COMPUTER LANGUAGE

Computers talk in many languages. The easiest is BASIC or English-like words. If THE PET wants you to press a key, it will flash, "Press such and such", right on the display. You speak back to THE PET through its full size 73-key keyboard.

EXTENSIVE CHARACTER ORIENTED GRAPHICS

The unit features a 9-inch, high resolut
1000 character CRT. Characters are
ranged 40 columns by 25 lines on an 8
matrix for superb graphics.

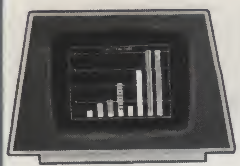
WHAT IS THE PET REALLY FOR?

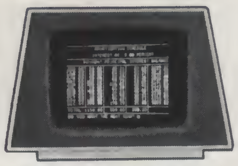
It is the single most important teach
device for any computer related subjec
can help a youngster learn number facts
help a med student do tissue analyses
will entertain the most sophisticated d
application, or the simplest inqu
response assignment.

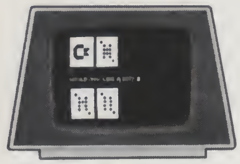
IN THE LAB it handles instrumentati
process monitoring, computer aided
structions, and more. A number of Fortu
500 companies have already made PETS
integral part of their lab and gene
office system.

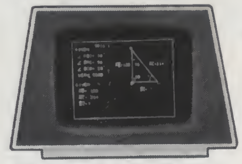
As a **BUSINESS TOOL** it will; Maint
ledgers. Illustrate cash flow charts. K
payroll records. Create P & L's. Control
ventory. Store and analyze sales data. Dr
bar graphs. Issue invoices. Do statisti
work. Hook up to on-line computer syste

THE PET is the only totally integrated, self-contained, personal computing system. It measures a compact 16½" wide; 18½" deep; 14" high, and weighs just 44 pounds.


Bar Graphs


Amortization Chart


Blackjack


Teaching Trigonometry

As an **AT-HOME TOOL** it will; Compute state and federal tax returns. Make heat and insulation analyses. Keep Christmas lists. Keep checkbook and finances up to date. Programs are even being developed to store recipes and to compute larger or smaller portion requirements.

WHO IS THE PET FOR?

Engineers, scientists, doctors, educators, students of computer science, attorneys, stock brokers, realtors, insurance people, list brokers, home economists, churches, grocery store owners, automobile dealers, sales people, organizations.

JUST FOR FUN

There is hardly a game, from Blackjack to Master Chess, that cannot be programmed into the unit. A variety of game programs is currently available.

ANNOUNCING THE PET PRINTER

This powerful word processing accessory lets you print hardcopies, invoices, and computer correspondence. Faster than an IBM Selectric, THE PET Printer delivers 60 characters per second at a sustained rate -- or 3,600 characters every minute -- with upper and lower case capability. Characters are 1/8" tall and printed in a 7 x 8 dot matrix. The printer uses a standard 8½" wide paper roll. And, most unbelievable -- it is only $599.95.

PERIPHERAL SECOND CASSETTE

This optional component expands storage and increases flexibility. Only $99.95.

MILES OF SOFTWARE

Listed below is a sampling of currently available PET programs. "BASIC BASIC" shows you how to write a program for the unit. You can actually develop your own programs to meet personal requirements.

GAME PROGRAMS ARE $9.95 EACH:
☐ **Black Jack** ☐ **Draw Poker** ☐ **Galaxy Games**
☐ **Space Flight** ☐ **Target Bong, Off-The-Wall**
☐ **Lunar Lander, Wumpus, Rotate, Tic-Tac-Toe**
☐ **Osero, Reverse** ☐ **Spacetrek** ☐ **Kingdom**

PROGRAMS AT $14.95 EACH:
☐ **Mortgage Analysis** ☐ **Diet Planner and Biorhythm**
☐ **Basic Basic**-by Lodewyck and James

PROGRAMS AT $24.95 EACH:
☐ Basic Investment Analysis-loans, annuities, return on regular and irregular sequences of payments, calendar calculations ☐ **Stock Portfolio Recordkeeping and Analysis**-keeps track of buys, sells, and dividends. Calculates current value, rates of return ☐**Checkbook Recordkeeping and Analysis**-keeps track of checks and deposits. Analyzes expenses by date and type

PROGRAMS AT $29.95 EACH:
☐ **Basic Math Package**-matrix addition, multiplication, determinants and inverses to 16 x 16, solution of simultaneous linear equations, vector and plane geometry calculations, integration by trapezoidal, Simpson's rule or Gaussian quadrature, differentiation
☐ **Basic Statistics Package**-mean, median, variance, standard deviation, skewness, kurtosis, frequency distribution, linear regression, T-tests, correlation analyses

FREE ORIENTATION PACKAGE

Your PET comes complete with two programs and an easy-to-follow instruction manual. By working through the routines you will quickly discover how easy it is to gain command of your personal computer.

SERVICE WORLDWIDE

THE PET is made in the United States by Commodore International, a worldwide, vertically-integrated manufacturer of electronic products for home and industry. Because your PET is self-contained and compact, professional factory service is never far away. If ever major service is required, the unit can simply be returned by UPS to an authorized factory PET clinic.

You can order your PET by sending a check or money order for $795.00 plus $20.00 for shipping and insurance. To order the PET Printer, add $599.95 plus $12.00 for shipping and insurance. The Second Cassette is $99.95. No shipping and insurance charges are required when ordering a second cassette or programs with your PET. Credit card orders are invited to call our toll free number below. Orders will be accepted on our TELEX, No. 25-5268.

CONTEMPORARY MARKETING

Contemporary Marketing is a major source for advanced electronic products. Our commitment to this exciting industry is the reason why Contemporary was selected to bring THE PET to you. In comparison with other full-fledged computers, it is an incredible value. Nevertheless, we recognize that it is a substantial investment for any company or individual. Please be assured that we are pledged to protect your investment. As a Contemporary PET owner, we will see to it that you are kept abreast of all new peripherals and software, as they are developed. We want you to use THE PET with complete confidence. If, for any reason, you are not satisfied with your PET, simply return it within 30 days for a prompt and courteous refund.

THE PET is perhaps the most exciting discovery in many years, and demand is enthusiastic. If our lines are busy, please call again.

TECHNICAL SPECIFICATIONS

MEMORY
Random Access Memory (user memory); 8K internal, expandable to 32K bytes
Read Only Memory (operating system resident in the computer); 14K bytes
8K-BASIC interpreter program
4K-Operating system
1K-Diagnostic routine
1K-Machine language monitor

VIDEO DISPLAY UNIT
9" enclosed, black & white, high resolution CRT
1000 character display, arranged 40 columns by 25 lines
8 x 8 dot matrix for characters and continuous graphics
Automatic scrolling from bottom of screen
Winking cursor with full motion control
Reverse field on all characters (white on black black on white)
64 standard ASCII characters; 64 graphic characters

KEYBOARD
9½" wide x 3" deep; 73 keys
All 64 ASCII characters available without shift. Calculator style numeric key pad
All 64 graphic and reverse field characters accessible from keyboard (with shift)
Screen Control: Clear and erase
Editing: Character insertion and deletion

CASSETTE STORAGE
Fast Commodore designed redundant-recording scheme, assuring reliable data recovery
Cassette drive modified by Commodore for much higher reliability of recording and record retention
High noise immunity, error detection, and correction
Uses standard audio cassette tapes
Tape files, named

OPERATING SYSTEM
Supports multiple languages (BASIC resident)
Machine language accessibility
File management in operating system
Cursor control, reverse field, and graphics under simple BASIC control
Cassette file management from BASIC
True random number generation or pseudo random sequence

INPUT/OUTPUT
All other I/O supported through IEEE-488 instrument interface for peripherals
I/O automatically managed by operating system software
Single character I/O with GET command
Easy screen line-edit capability
Flexible I/O structure for BASIC expansion with peripherals

BASIC INTERPRETER
8K BASIC; 20% faster than most other 8K BASICS
Upward expansion from BASIC language
Strings, integers, multiple dimension arrays
10 significant digits; floating point
Direct memory access: PEEK and POKE commands

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Contemporary
Marketing Inc.

PUBLISHER'S REMARKS

Wayne Green

Micros for Farmers

The National Weather Service is getting up something of interest to microcomputer fanatics . . . a microcomputer-based terminal that would sell to farmers for around $100. It would consist of a modem and use the home TV set to get weather reports, predictions, weather maps, agricultural information, insect and disease control data, etc. The reports would come from the county agent's office by phone line. They are working on setting up a pilot test of their "Green Thumb Box."

The idea of the service sounds fine, but I'd rather see it cooked up by industry than the government. Sure, it would be of great value to farmers, but do we really need an even larger U.S. Department of Agriculture? Remember that there are no cases where a government agency has been able to do things as reasonably as a private concern. I can only think of one government agency that has even been able to make a profit . . . and that was the New York City Triborough Bridge Authority, which controlled the tolls from the tunnels and bridges around New York. Other than that, the government record has been virtually unblemished as a giant loser.

On the other hand, considering the ability of many firms in the microcomputer business to lose money, perhaps we should welcome our government to familiar territory.

Honesty Is the Best Policy

It must be awfully difficult for computer hobbyists who are working for computer firms or stores to resist slipping some chips or a small part into their pockets. With mountains of temptation like that around, I'm not sure how much *I* would be able to resist.

Two employees of Datapoint got arrested recently . . . reported in the local paper as the biggest-ever computer-theft-ring raid. These chaps had slipped parts home over a period of time, ending up with five complete computer systems. There was no mention of their intending to sell the systems.

An eariler bust in Phoenix caught some enterprising chaps who had been brown-bagging Motorola chips for quite some time. They were a bit more mercenary about it, complete with full-page ads in *73* offering the stolen chips for sale.

This should be a warning to hobbyists. Keep your hands off the goodies. And it can also serve as a warning to manufacturers . . . if you are making it simple for employees to swipe things, it would at least be prudent to offer hobbyists a discount (a substantial discount) on parts they might otherwise swipe. The more you remove the temptation to steal, the less you'll have stolen . . . and the fewer good employees you'll lose. Wouldn't you hate to lose a good technician over a handful of chips?

A Need for Standards

Are there any good reasons for our having so many different bus systems? And why do we have a dozen different cassette recording systems? Can anything be done to bring some standardization to the field? Is there any good reason for pushing for some standards?

One of the major reasons for the wide variety of bus systems being used in microcomputers is that manufacturers have the idea that if they make their system incompatible with others, customers will have to buy their add-on boards and peripherals. This, in turn, means that the prices on these accessories can be higher than if they were in competition with a lot of other firms. More money.

Since money is fairly well accepted in this country as a desirable item, with many of us spending a good deal of our lives trying to get enough of it, any edge a firm can get that will increase profits (or decrease losses, which is more often the case in the microcomputing field) will be popular.

Yes, I'm aware of the technical arguments that can be cited to put down the SS-100 bus (SS = semi-standard). I'm also aware of the large number of reasons why this bus isn't so bad. People like George Morrow have done a lot to tame it. But isn't the wide variety of bus systems splintering the pioneering efforts of the microcomputer field just as the proliferation of video recording standards has slowed down the sale of VTR systems by several years?

I can see why a major bus restructuring could excuse firms from going a different bus route, but where the reasons are to prevent other equipment from being used, I wonder at the long-term benefits. One of these days the engineers may come along with an optical bus using a modulated laser and separate radio channels for each signal. That would be a breakthrough that would warrant a new bus structure. Of course one way to fight this whole miserable situation is for some firm to get hot and put out a series of bus transfer boards that will allow us to go from a 44-pin bus to a 48 or to a 100 . . . etc. How about it, hardware fanatics?

The cassette standard and disk standard mess may be a little easier to clean up. Let me warn everyone that I am intent on putting out programs on cassettes so our little computers will able to do all of those nice things we thought they could when we bought them. I intend to make computer programmers into a wealthy class along with recording artists and the better authors of books . . . perhaps even in a league with some sports stars. At first we will be putting out our cassettes in each of the more popular recording systems . . . for the TRS-80, the PET, Altair. What do you think will be the end result if we issue programs by the thousands for one or two machines and none for the others?

We are checking out programs on the equipment we have and will be selling programs we will advertise as being tested and working on that equipment. We have the Radio Shack TRS-80, the Commodore PET, the Altair, the Heath H8, the ISC Compucolor. Note that this means we are presently limited to Z-80, 8080 and 6502 based systems. We have a couple of possible 6800 systems in the works.

One of the problems with cassettes standards is that few, if any, of us know which system is best. I've been trying for almost three years, ever since I started *Byte*, to get someone to write an article or even a series of articles describing the many cassette techniques in use and evaluating them. We have the Altair, Apple, Digital Group, Commodore, Radio Shack, Tarbell, Kansas City, National Multiplex, and probably others. Whew! Is there anyone out there who knows enough about this situation to enlighten all of us with an article?

When I conceived and organized the Kansas City meeting in 1975, it was with the goal of preventing this insane situation from happening. I won't go into the details as yet on how *Byte* and I became separated . . . there are a couple of very expensive lawsuits going on that topic . . . but the end result was that the new management had no interest in providing any leadership for the field and they dropped the whole thing

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Reader Responsibility

One of your responsibilities, as a reader of *Kilobaud*, is to aid and abet the increasing of circulation and advertising, both of which will bring you the same benefit: a larger and even better magazine. You can help by encouraging your friends to subscribe to *Kilobaud*. Remember that subscriptions are guaranteed—money back if not delighted, so no one can lose. You can also help by tearing out one of the cards just inside the back cover and circling the replies you'd like to see: catalogs, spec sheets, etc. Advertisers put a lot of trust in these reader requests for information. To make it even more worth your while to send in the card, a drawing will be held each month and the winner will get a lifetime subscription to *Kilobaud*!

We've held our second lifetime-subscription drawing; and the reader-service card of Gary Martin of Kansas City MO came out of the barrel. Congratulations, Gary.

EDITOR'S REMARKS

John Craig

Where Have All the Forums Gone?

Do you remember the KIM Forum? How about the Heathkit and TRS-80 Forums? Sure you remember them . . . and a lot of people have been asking whatever became of them. They're also asking when we're going to be starting a PET Forum . . . and an 1802 Forum . . . and a 6800 Forum. Well, we've come up with a solution . . . and decided to concentrate on articles for the variety of systems and do away with columns for certain ones. The original objective in having these columns in *Kilobaud* was to provide you with a substitute for having to shell out for newsletters on these systems (there is a limit to how much most of us can afford to spend on subscriptions).

But in spite of the costs, we've reached the conclusion that the newsletters might be the answer. A newsletter for any system is going to be able to cover a multitude of interesting and useful tidbits (hardware and software) that really aren't appropriate for the *Kilobaud* forums. Therefore, if you have one of the systems we've been addressing with a forum . . . then give some thought to subscribing to such a newsletter. I've mentioned many of them in previous editorials and I've recently run across a new one for you PET owners: It's being put together by Rick Simpson (your friendly ex-KIM Forum type) and Terry Landereau. Subscription rate for 10 issues is $15 . . . and it looks good! PO Box 43, Audubon PA 19407.

Series Problems

As a general rule, I prefer to discuss our successes rather than failures (if they can even be called that); but we have had some problems with multi-part articles in the past. Actually, the "problem" is very easily defined. In my enthusiasm to get timely or interesting material out to you as soon as possible, I go ahead and run the first part, or parts, of a series (which may be as short as two parts or go for months and months) . . . and then, for some reason or another, something happens and it doesn't get finished. This has happened more times than I care for in the pages of *Kilobaud*, and I've decided to adopt a new policy of holding off on such articles until they're all in hand. For a long-running series (such as Kilobaud Klassroom) this won't be practical, but for 2, 3 and 4 part articles it will become standard operating procedure. (Speaking of the Klassroom . . . it has had more than its share of problems. Be patient—it'll be finished up on a regular basis starting next month.)

It was a recent "failure" in the system which brought about this decision. In the February and March 1978 issues we ran "Small Business Software" (Parts 1 and 2) by Laurence McCaig. Larry started the series with good intentions, as every author does, and I went ahead and ran the material . . . as it came in. The last portion of the package never came in . . . because Larry changed jobs and was no longer working for the company the software was being developed for (Microtec Computers).

Another unfortunate aspect of running this series has resulted from people's having problems implementing the software (for one reason or another). These people have contacted Microtec for help and received a letter stating that the programs published in *Kilobaud* were strictly demo programs . . . and Microtec would be happy to sell them the entire package. This is not so. I would *never* do such a thing! I discussed the situation with Larry and he assured me the published programs are complete. However, it does appear doubtful that we'll ever see the final portion of the series. (In the future we're going to have the capability to check out most programs prior to publication.)

The Swap Meet . . . Still in a "GO" Status!

As I mentioned last month, be sure to mark July 1st on your calendar as the day for driving to beautiful Santa Barbara CA for the *Southern California Swap Meet*. Everybody loves a swap meet . . . and this good-time gathering should be no exception. Besides, it's the perfect occasion

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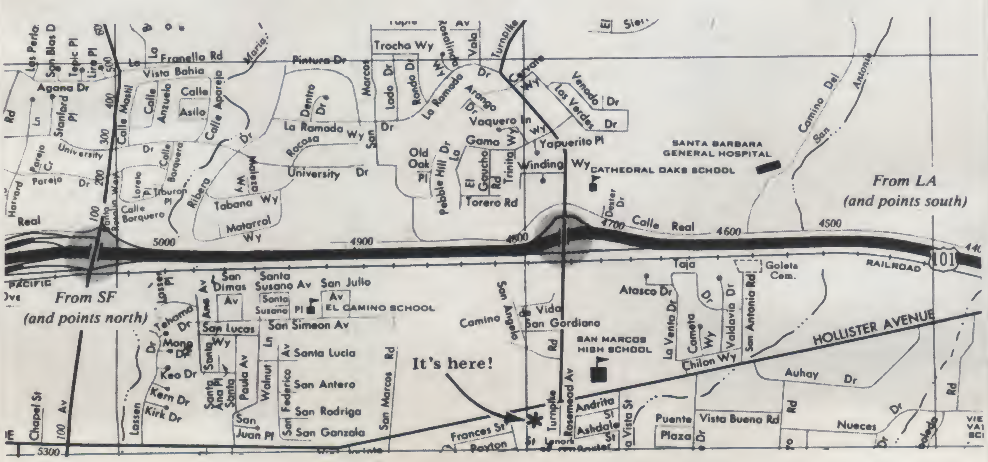

Fig. 1. Take the Turnpike exit off 101 (north or southbound) to Hollister Ave.

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INCLUDE OLD ADDRESS AND ZIP CODE WITH ADDRESS CHANGE NOTIFICATION.

AROUND THE INDUSTRY

Edited by John Craig

Two members of Knott's Berry Farm's Construction and Maintenance Division check operations via one of their three Mits/Altair microcomputers. To the left of the CRT terminal are printers; at the far left are systems processing units.

Personal Computer Pulls off Polls for New York Pols

Shortly before Edward Koch was elected Mayor of New York City, he received daily poll results. What was not known at the time by many other political pros was that these poll results were obtained almost instantaneously on the same day they were taken. This breakthrough in political polling was devised by the firm of Penn & Schoen with the assistance of a personal computer system puchased at a local computer store.

Mark Penn, a partner of Penn & Schoen Associates of New York City, and a law student at Columbia University, knew there had to be a better way to analyze political polls. "It's ridiculous to wait a week while raw data is being keypunched and fed into a large computer to be analyzed," he said. "If there is a flaw in a question, or a poll-taker doesn't understand what to do, you might not see the problem until a week of mistakes has occurred. All the results that follow have to be suspect until the problem has finally passed."

Penn felt that an interactive computer system could be used to monitor the poll and find problems in advance. Since political campaigns are notoriously strapped for cash, and the labor costs of poll taking are so high, the cost of the computer system was a major consideration. The solution, according to Penn, was a personal computer system.

After a trip to The Computer Corner, a computer store in White Plains NY, Penn decided to buy a SOL 20 Computer with a North Star minidisk drive. "We chose the SOL 20 because it's a complete computer with a keyboard and printer output built in. The North Star disk, although low in storage capacity, had the lowest price for any disk system. It also had a good extended disk BASIC interpreter," said Penn.

"Later, we purchased a used Centronics 102A character printer, North Star floating-point arithmetic board, and additional memory. The entire package cost under $6000."

The programs to analyze the poll were written by Mr. Penn using the North Star BASIC and the computer was ready for its debut, which was postponed by the blackout of '77. Polling was halted for a few days.

On Primary Day, no candidate received a majority vote so a runoff election was scheduled a week later. "We used our personal computer to run the whole show that week and continued to use it as the major data-processing element for the rest of the campaign. The day before the election, using the SOL/North Star, we called the election within a half percent of the actual vote," Penn reported.

The computer was busy, even on election night, tabulating results from sample precincts. "Instant poll results are almost unheard of in our profession," said Penn, "but with our personal computer we achieved it.

"Had we not purchased our computer from a computer store, especially one as reliable as The Computer Corner, we would have been in real trouble," said Penn. "We had two hardware failures, one of which happened on a Sunday. They opened the store Sunday night just to repair a defective memory board. They also replaced the disk drive, in minutes, the week before the general election."

Near the end of the campaign, the computer system not only analyzed the data; it helped gather it. A Mullen Opto-relay board was installed in the S-100 bus of the SOL, interfaced to eight phone lines and used to automatically dial the phones used by the poll-takers. The dialing system was devised by Greg Paret, a consultant to The Computer Corner. "All a poll-taker had to do was push a button. The next randomly generated number was then dialed by the computer," said Penn.

A SOL 20 personal computer enabled Mark Penn to analyze poll data for Mayor Edward Koch's victorious campaign.

Small Computers Help Run Big Operation

Behind the scenes at Knott's Berry Farm in Buena Park CA, three small desk-top microcomputers are helping to operate the nation's oldest and third-largest theme amusement park (after Disney World and Disneyland).

They're integral to the construction and maintenance division's activities in scheduling and expediting the many maintenance and construction jobs continually in progress; lighting control; and air-conditioning control to promote energy conservation.

Knott's Berry Farm, which hosts four million visitors a year on its 150 acres—featuring more than 100 rides and attractions, eating places and unique shops—boasts some of the world's most advanced electronics systems.

Mike Reafsnyder, director of construction and maintenance, long had recognized a growing need for computer support to his division in maintaining the Farm's attractions and, when desired, adding new features. The situation became critical after attendance zoomed by 52 percent in 1975.

Given the availability of the division's strong internal electronics department, Reafsnyder felt confident that his staff could build the needed computerized control systems themselves, starting with computer kits. The three Mits/Altair 8800 microcomputers were purchased from an Altair Computer Center.

While each of the three Mits/Altair central processors is dedicated to a specific application (i.e., work order scheduling, lighting and air conditioning), all of the terminals and printers can be switched as needed to any of the three applications. Computer system hardware includes three

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TROUBLE-SHOOTERS' CORNER

Ralph Wells

If you're having trouble with bugs, this could be for *you*. Jim Fox once concluded a letter to *Kilobaud* with the following queries.

"How about when you get your new board assembled and nothing happens? I haven't seen a good memory test yet. I just built a scope—how do I use it? Did I get the right one? How do you troubleshoot a dead or intermittent system? What other diagnostic routine can be used for various systems? How much can you do with a VOM (volt-Ohm-milliammeter)? Where should a logic probe probe? What do all those lights on the front panel tell you? What are typical (besides solder joints) or interesting problems? How about a statistical study of problem areas—what does go (or come) bad? Must 5 volts be 5 volts—or is 4.5 V OK?"

Some Background—and Foreground

John Craig had been toying with the idea that some sort of "'Dear Abby' for the Microcomputerist" could become an informative feature in *Kilobaud*. I agreed . . . with the exception of my super-simple SC/MP, every one of the microcomputers I've built or bought and modified —these include: three 8080-based systems, five 6800-based systems and three 6502 systems—has had bugs in it. (For more details on my problems, see "PET's First Report Card," *Kilobaud* No. 17, and *Interface Age* Vol. 1, 9, August 1976.)

Of course, a lot of the bugs were of my own making, but even if I had been *perfect* in my assembly, testing, etc., *all* of these systems would have malfunctioned due to defective engineering, defective hardware or defective software. Most of them suffered from all three. So if you've been having problems—*you are not alone!*

With the first installment of the projected "Troubleshooters' Corner" series, *Kilobaud* plans to do something about problems. Obviously, we're going to need *your* help. Debugging microprocessors comprises a large field, and trying to solve everyone's specific problems would not only be impossible, but also downright boring. What percentage of you readers would be interested in troubleshooting a Sphere's reset circuitry when Sphere "went under" a year ago? On the other hand, the memory tests and techniques for using them would probably answer most of Jim Fox's questions in that area, since they were developed to solve a memory expansion problem involving seven Spheres and more than 500 currently popular 4K dynamic memory chips. They just might give you a different slant on your memory problems, too.

In other electronics fields, such as television, where perhaps 100,000 sets of a particular model may all have a common bug, a very useful purpose is served by specific answers to specific problems for a particular device. However, we won't attempt to solve such specific problems in this column. Besides, the input/output time delay would be at least two months, and who wants to wait that long?

I hope to use your questions as a guide to explore the areas that the most people are having trouble with, using specific questions as a "springboard" into that subject. Although several books and articles have been written on the topic of troubleshooting electronic equipment in general, they are obsolete and of very little use regarding microprocessors or other large-scale integrated circuits.

The basic principles of problem solving still apply, and these will be stated, restated and restated again and again, using your problems as examples. Our aim is not to solve your problems, but rather to give you the techniques and approaches that will let you solve them yourself!

To this end, we'd like to hear of your solutions to problems, particularly if they pertain to a common condition. This especially applies to the newer mass-produced micros, such as the TRS-80 and PET. I assume that by now most owners of the older Altair 8080s, etc., have cured their problems, and very few people have even heard of a Data Works micro . . . much less be interested in solving its power-supply problems.

Getting Underway

Now to get back to Jim Fox's questions. There are a couple of subjects that can be better handled by some technical paperbacks from your local supply store or the *Kilobaud* bookshelf. I don't intend to reinvent the wheel, so to speak, by rewriting basic dissertations on how to use an oscilloscope or VOM. However, it is very likely that my experiences with the Paratronics logic tester will find their way into this column . . . if it's an appropriate solution to somebody's problem. The practical use of logic probes could probably supply enough material for a full feature article.

A couple of years ago it would have been a good idea to split up a column such as this into two columns: hardware and software. Today, however, the two are becoming inseparable. In fact, electrical engineering as I learned it in college is rapidly becoming extinct in the use of microcomputers! A very high level of engineering expertise *is* required from the designers of the microprocessor chips, memories, USARTs, etc.; but for the level upon which you and I need to work, it is primarily required for analog inputs and outputs.

Take a look at a KIM, TRS-80 or PET. Most of the capacitors are used for filtering, and a change in value of 10 to 1 (or often even total elimination of any one component) wouldn't materially affect the overall practical operation. Resistors are much the same—they are usually "pull-ups" for wired-OR logic or "build-outs" to limit the current to an LED readout . . . both chosen by rule of thumb.

You don't even need to know Ohm's law to work with perhaps 90 percent of these circuits and do as good a job (for practical purposes) as a so-called expert. The engineering was done when the integrated circuit was designed.

Today's logic designer puts ICs together like the elements of an erector set. True, he has a lot of constraints and considerations, but these are (in my personal opinion) closer to the domain of pure logical thought than to the *old* world of the electrical engineer. This means that a lawyer who "thinks logically" would probably learn to debug a micro as fast as an electrical engineer who graduated more than five years ago, before the advent of microprocessors.

At this point you could well wonder—if it's so simple, why doesn't my computer work? Recall that I said this applied to 90 percent of the circuitry. The other 10 percent usually applies to things involving time and analog interfaces, such as audio cassette I/O. You can change the value of an MOS pull-up resistor with relative impunity, but the timing resistors of a phased locked loop or a one-shot are usually very critical. Even the change of temperature caused by the touch of a soldering iron could cause a malfunction.

The timing of high-speed pulses traveling along bus lines can be very critical. The value of resistance and capacitance involved, as well as the shape, size and placement of the conductor, will affect the timing considerations.

Remember, too, that AM radio is centered around 1 megahertz (1 MHz) and most CPUs use clocks that are even faster. This means that energy doesn't need a solid copper connection to get from one wire to another in your computer. With appropriate programming you can "play" songs through the air into any AM pocket radio; in fact, this characteristic can be used as a crude form of signal tracing. More on that some other time.

The point to be made is that you don't need to be a graduate electrical engineer with years of experience to debug most of the troubles in your computer. In fact, the best troubleshooter for 8080s I ever met was only 19 years old!

Another point is that there are only a few experts in the field. No sooner do you begin to get comfortable with a family of devices than a whole new family is announced. Like today's doctors, computerists tend to become specialists. A lot of your problems will certainly exceed my knowledge, but some specialist somewhere probably has an answer. The chances are that he reads *Kilobaud*, just as you're doing.

In the future I'll expect to deal with nearly all of the general questions raised by Jim Fox. The amount of space allotted to each subject will be determined by the interest expressed in your postcards, "bingo" cards, or letters to John. Now, let's take a swing at Jim's last question.

TTL Questions and Answers

I, too, was intrigued by what constitutes the *practical* limits of the TTL 5 volt supply rating. The listed maximum handbook ratings are 4.5 V to 5.5 V for the wide temperature range "MIL SPEC" (expensive) devices, and 4.75 V to 5.25 V for the *garden* variety that we use. A few years ago, at my company (Inmarco) we were working with a battery-driven device in which regulation was a critical factor. We tested all of the device types we intended to use in order to find their mean and maximum failure points.

To start with, all TTLs with the same number are *not* alike. In most cases, the expensive (MIL SPEC) devices start life on the same production lines as the ordinary ones. Manufacturing variations will cause changes in performance, and before the chip is packaged it is tested to see if it can pass the military specifications.

Now comes the "gotcha." Depending upon the backlog of orders for the mil spec version, the parameters of the automatic testing machines can be set to sort out the required percentage, and the rest are molded into plastic. Supposedly, all mil spec devices will meet or exceed these high specifications. If the application is critical, the end user (such as the aerospace industry) will establish incoming inspection.

I won't risk a lawsuit by repeating the horror stories I've heard firsthand about the quality variations such incoming inspections reveal. Suffice it to say that a lot of devices in those gold-plated ceramic packages bearing mil spec numbers find their way to surplus houses where they're sold at a small fraction of the price listed by a factory authorized distributor.

Let me hasten to add that design changes can also result in these devices' becoming available at bargain prices. The chances are that the vendor you buy bargain TTLs from doesn't know (or want to know) why he can buy devices for less than the value of the gold they're plated with.

The hobbyist and garage-type small manufacturer of computer components are prime targets for the "dumping" of "out-of-spec" devices. Neither of them can afford the $100,000-and-up price tag for a good IC inspection machine. Bargain prices for out-of-spec TTLs aren't limited to the mil spec devices. The plastic molding process can change the characteristics of a normal chip. Often a whole batch may be rejected based on a few questionable spot checks . . . guess who gets them!

There's really no way of knowing, but my gut feeling is that perhaps three out of four of the bad devices supplied me with the kit and assembled microprocessors I've purchased were probably rejects. So how did all of this affect our voltage tests on TTL? We found that some 25¢ devices outperformed "prime" DIPs (mil specs from distributor) costing nearly $3, not only in voltage range, but also in high temperature tolerance.

The handbooks give the same maximum voltage for all the TTLs we tested, but our tests showed that the simple gates (7400 through 7412, etc.) would often operate down to as low as 3.85 V and as high as 6.6 V. The more complex circuits (counters in particular) would seldom get down to as low as 4.5 V or as high as 5.6 V before becoming erratic.

On the other hand, if the voltage was kept above 4.92 V and below 5.15 V, then all the counters (that would work at all) would function as well as the most expensive DIPs tested. Running on the high side of 5 V increased the case temperature of the package, as you might expect. A well-cooled final circuit made very little difference in the supply voltage limitations, but if it were to be used on closely packed boards (as is often the case with an S-100 bus) then the borderline cases of the plastic MSI TTLs would fail at nearly anything over 5.05 V. The metal-ceramic packages apparently dissipate the over-voltage heat more efficiently and could operate up to 5.12 V.

To sum it up—with the chips we're likely to be using, try to stay between 4.9 V and 5 V with your TTL supplies. Inmarco doesn't own a testing machine, so these tests were practical, and certainly not up to laboratory standards. If somebody out there has a better answer to Jim's question, we'll gladly pass it along. This goes for anything ever said in this column.

One other thing, in closing: My job at Inmarco takes up 60 to 80 hours a week. Add the time I spend working with my own stable of micros, and there is no time left to carry on correspondence or even answer telephone questions. Therefore, all of your contributions in the way of questions, answers and dissenting opinions should be sent to:

John Craig, Editor
Kilobaud Magazine, TC
Peterborough NH 03458

THE BASIC FORUM

John Arnold/Dick Whipple

This month's installment of The BASIC Forum begins, appropriately enough, with more discussion of BASIC-language standardization. We have kicked this subject around again and again since our first column without reaching any definite conclusions. Nonetheless, we think some additional kicking won't do any harm, so here it goes.

ANSI Standard BASIC

The first letter contains some very specific information about ANSI standard BASIC. Guy K. Haas, 2439 Jefferson #B, Berkeley CA 94703, serves on the BASIC Standards Committee and thus speaks with some authority on the subject. He writes: "I saw my first *Kilobaud* a week ago (October 1977 issue) and my second (November 1977) yesterday. Good mag! The remarks about standardizing BASIC caught my eye—I'm a charter member of ANSI X3J2 (the BASIC Standards Committee) and chairman of its strings subcommittee. The friend who lent me the two copies of *Kilobaud* tells me that you mentioned something about the Draft Proposed Standard for Minimal BASIC about six months ago. That was probably when it went out for public comment.

"I'm pleased to report that it has been approved with slight modification and will be published within a very few months as ANSI Minimal BASIC. This represents the 'smallest' version of BASIC. It has no files, no MATs, hardly any strings, etc.

"The X3J2 Committee is continuing to standardize enhancements. There are several categories of enhancements: Nucleus (a little here, a little there, throughout the language), Arrays, Mathematical Functions, Files, Strings, Chaining, Subprograms, Formatting, Graphics, Error Control, Debugging, Real Time and Editing. Each enhancement is being handled by a subcommittee, and each enhancement is divided into levels. Thus, an implementation can be described as conforming to Nucleus 1, Strings 2, Files 1, Formatting 3, etc. The enhancements are progressing but will not be approved for a couple of years.

"X3J2 is working quite closely with the European Computer Manufacturers' Association committee on BASIC standard (TC21) and with the Purdue Real-Time BASIC standard. The X3J2 Committee holds three-day meetings in January, April, July and October. I could (1) do an article on Minimal BASIC, (2) serve as correspondent to *Kilobaud.* I await your enthusiastic response."

We have made a personal reply to Mr. Haas and look forward to future contributions.

Pro BASIC Standard

A second reader, C. E. Harland, PO Box 32, Ontario OR 97914, brings up several pertinent questions in his letter to the Forum: "After reading the November 1977 Forum entry by Mr. Jim Faliveno, I must write to tell you that I, and no doubt many others, must agree heartily with his argument for a BASIC Standard. My experiences almost exactly parallel his. I have found that the BASIC language is very frustrating.

"One of the most outstanding questions in my mind at this stage of the game is: Who are the manufacturers of computers and software attempting to attract? Do they wish to sell to rank amateurs and newcomers or only to experienced programmers? Unless something is done soon to relieve the confusion, the word will get out fast that the home computer is not for the inexperienced, and sales will slump to a screeching halt. In fact, in view of the closing of several computer stores recently, I believe this is already happening. Why can't they take time out of their hurried program of new developments to help some of us who have already invested in the equipment get it up and running, which, in turn, will help sell more?

"Another problem that leads me to believe that software is not made for the newcomer is that the documentation is written for only the experienced. I never will forget the anxiety I felt when I first read through the documentation of Maxi-BASIC. I didn't even know what some of the words meant, let alone what they were for. Since then, after many hours of try and try again, some of it is beginning to make sense, but it ain't easy.

"In the article in the October issue of *Kilobaud,* Mr. Howerton admits that Maxi-BASIC was not written for the newcomer. He says that in all the comments and questions they've received, very few, if any, were from experienced programmers. Here again, I wonder for whom the software was written? And, to whom would they like to sell it? Mr. Howerton would be praised and remembered forever by many of us if he would follow up with some sort of documentation describing how Maxi-BASIC can be converted to some of the other BASIC languages, and what it takes to use some of the many other oddball statements.

"Thanks for letting me bend your ear and add another vote for a standard."

Consumer Considerations

Marketing targets are undoubtedly a concern to microcomputer manufacturers. When the wheels of industry turn at the larger micro companies, we feel certain they turn in a predetermined direction. Hobbyists must not assume that these wheels turn solely for their benefit. Some companies, after an initial fling with hobbyists, have turned to more lucrative markets such as small business and industrial control. It is unlikely to find these companies bending over backward to help rank amateurs.

In purchasing a computer, you should consider more than just pretty boxes, flashing lights and low cost. You should consider carefully the attitude of the manufacturer, and especially the local dealer, toward hobbyists. After taking the plunge into deep water, it is too late to inquire whether the lifeguard will rescue all in trouble or just bikini-clad blondes!

Dartmouth BASIC

Do you ever get the feeling that maybe you missed something along the way? The next letter made us feel that way. It comes from Fran Taylor, RR1 Box 15, Charlestown NH 03603.

"You guys at *Kilobaud* are making a mockery of BASIC. Why don't you smarten up and start using the *real* Dartmouth BASIC? Good Dartmouth BASIC, used correctly, can set up elegant structure as good as, if not better than, COBOL. You can get a *real* Dartmouth BASIC manual if you send $4.50 plus $1.00 P&H to:

Documents Clerk
Kiewit Computation Center
Dartmouth College
Hanover NH 03755
(Specify document #TM075)

"I don't work for Kiewit, if that's what you're thinking . . . I just want to see BASIC written and used in the way John Kemeny wanted."

Gosh! Do you suppose that all this time the *real* BASIC has been hiding at Dartmouth? We should have thought to look there since that is where it got started in the first place. Our $5.50 is on its way to Hanover, and we'll let you know what we find.

Round-off Error

In February's BASIC Forum we published a letter from Robert Lurie which contained a few programs designed to test round-off error in BASIC. In looking over the letters received, we decided the results were too scattered and indecisive to be of any value to our readers. In that issue we expressed doubt about the validity of the test programs in any absolute, quantitative sense. Letters received so far seem to back our contention.

Ronald Anderson wrote to us on this subject and his comments are worth repeating.

Program 1.

```
SCORE=49 PERCENT
SCORE=61 PERCENT
0030  C=0
0040 FOR J=1 TO 100
0050  F=RND(0)
0060  L=RND(0)
     IF F=L THEN 70
0080  D=INT(2+9*RND(0))
0090 FOR I=F TO L STEP (L-F)/D
0100 IF I=L THEN C=C+1
0110 NEXT I
0120 NEXT J
0125 PORT= 7
0130 PRINT "SCORE=";C;" PERCENT"
0140 PRINT :PRINT:LIST
0150 PORT= 1
0999 END
```

Program 2.

```
0003 PORT= 7
0005 LIST
0006 PRINT :PRINT
0008 FOR D=1 TO 10
0009 PRINT "D=";D:PRINT
0010 FOR N=1 TO 2 STEP 1/D
0020 PRINT N
0030 NEXT N
0040 PRINT
0050 NEXT D
0055 PORT= 1
0060 END
```

Program 3.

```
SCORE=100 PERCENT
SCORE=100 PERCENT
0030  C=0
0040 FOR K=1 TO 100
0050  F=RND(0)
0060  L=RND(0)
0070 IF L=F THEN 60
0080  D=INT(2+8*RND(0))
0090 FOR J=0 TO D
0100  I=F+(L-F)*J/D
0110 IF I=L THEN C=C+1
0120 NEXT J
0130 NEXT K
0135 PORT= 7
0140 PRINT "SCORE=";C;" PERCENT"
0145 PRINT :LIST
0150 PORT= 1
0999 END
```

Program 4.

```
0010 A=RND(0)
0011 PORT= 7
0012 PRINT "A=";A
0013 PRINT "(A*D)/D","(A/D)*D"
0014 PRINT
0020 FOR D=2 TO 9
0030 PRINT (A*D)/D,(A/D)*D
0040 NEXT D
0045 PORT= 1
0050 END
```

```
A=0.65407424
(A*D)/D       (A/D)*D
0.65407424    0.65407424
0.65407424    0.654074238
0.65407424    0.65407424
0.65407424    0.65407424
0.65407424    0.654074238
0.65407424    0.654074239
0.65407424    0.65407424
0.65407424    0.654074239
```

Program 5.

```
 .
 .
 .
 30 For D=1 to 8
 40 V=F+(L-F)/D
 50 REM USE V FOR THE CALCULATION
 .
 .
 .
 80 NEXT D
 90 PRINT "RESULT"
100 END
```

"Regarding Robert Lurie's letter and programs in the February BASIC Forum, enclosed (Program 1) are two runs of each program. The differences reflect only the difference in the use of the random function on my SWTP 8K BASIC.

"Programs 1 and 3 are really tests of 'number theory.' This can be more readily understood by using integer FOR N= and TO and using an integer for D in STEP 1/D (see Program 2). The fact is that some numbers (e.g., ⅓ when represented decimally, i.e., .333333, etc., are infinitely long. Any computer with less than an infinite number of digits must produce .999999 etc. for 3 times ⅓, since no matter how many nines are after the decimal point, the number never reaches the value of 1.0. No computer will meet the test of Program 1. Considering the numbers 2 through 10 as in Program 4, it is fairly obvious that even with integers the test will fail for $D=3$, 6, 7 and 9, for an interval of 1.0 (the computer scores 5/9 or 55.5555555 percent).

"Program 2 should, in my opinion, score 100 percent on almost any computer that uses BCD arithmetic. The loop is superfluous. It can only equal L (line *110*) when $J=D$. *When* $J=D$ (both are integers in Program 4), line 100 becomes:

$$I = F+(L-F)*D/D$$
$$I = F+(L-F)*1.0$$
$$I = F+L-F$$
$$I = L$$

(continued on page 24)

BOOKS

Illustrating BASIC (A Simple Programming Language)
Donald Alcock
Cambridge University Press
hardcover $10.95, softcover $3.95
134 pages

This is really a nice little book. In fact, for a specific class of readers, it's the best I've seen!

Like many other books on programming in BASIC, this one describes, and gives examples of the use of, the language features normally found in BASIC. The format, as well as the contents, of the book makes it stand out from the rest.

For example, the hand-lettered text and illustrations by the author produce some surprising advantages, at least in Alcock's steady hands. By drawing arrows to show where GOTOs are GOing TO and to show which FOR statement each NEXT refers to and by putting comments and explanatory notes in little clouds right on the program, the author provides surprisingly readable and understandable example programs in a language not noted for clarity of expression. In addition, the hand-done technique assures that the writer's attention stays focused in all phases of the writing process. It makes the book seem more alive.

This book stresses *program portability*—a concept that seems to have eluded the authors of many other currently available books on BASIC. The idea is simple: Wouldn't it be nice if your friend (or your friendly magazine) had a BASIC program that would run properly on your system? Unfortunately, there are so many different versions of BASIC around that this goal is difficult (in some cases, virtually impossible) to achieve—but the author has found a reasonable and realistic middle ground.

Like several other authors, Alcock had the manuals for 11 different versions of BASIC by his side as he wrote. However, instead of using that material to generate a huge appendix showing all the options of each version and instead of creating a conflicting maze of optional ways to write specific programs (". . . and on the NiteFlyer 8000 Super Exhaustive BASIC-Q, this entire program can be written as a single extended-range short-string matrix involution statement. What *power!*"), Alcock has abstracted those statements and usages *common* to a large number of BASICs. Thus, at the end of each section, he is able to suggest forms to avoid if you care about having a portable program. (I should note that Alcock isn't as rabid about this subject as I seem to be—if you really don't care about portability, his discussions of it won't slow you down.)

Another outstanding feature of the book is the practicality of the example programs. So often in programming texts, the examples are thoughtlessly jotted down just to demonstrate the form under consideration. How much more useful it is to see each statement type used in a meaningful program!

Example programs include calculating the amount of sag in a diving board produced by the diver, monthly payments on a mortgage, the volume of material in a pipe, solving simultaneous equations, printing "Old Glory," a game or two, sorting, using list structures to generate statistics on the employees of a store, converting Roman numerals to Arabic and finding the shortest path between two cities.

But it's not for eveyone . . . at least not as a first introduction to programming. Someone who is learning BASIC as a first programming language would do better to start with a slower-paced book, perhaps one of those produced by Dymax. The beginner just doesn't have the overview to absorb or appreciate the remarkable amount of information and ideas packed into *Illustrating BASIC.*

It's not a question of intelligence—there are just so many new concepts to be learned that jumping into the thick of it can be bewildering and frustrating. Start with a simpler book, then come here. For the person who wants to brush up on BASIC, or who has had some experience with other computer languages and wants to learn to use BASIC, this book is great.

Rich Didday
Santa Cruz CA

Basic BASIC Programming
Anthony Peluso, Charles Bauer
Dalward DeBruzzi
Addison-Wesley, Reading MA
$10.95

Learning BASIC is like learning a new language. Fortunately, most of the words are the same as in English; only the grammar is different. Teaching this new grammar is what BASIC programming texts are all about.

Although I have only been studying programming for nine months, I have already read six books on the subject in addition to numerous magazine articles. *basic BASIC programming* is by far the best of the bunch. I believe strongly in practical application, and that is what the authors give us in this self-instructional text.

It is the first BASIC book I have read that cried to be propped up next to the computer. A few pages of study and a few minutes of trying out your new skills at the keyboard do wonders for the learning process. In addition to chapter examinations, short quizzes are inserted after the discussion of each important item. This helps greatly to reinforce memory and understanding. Answers to exams are given in the appendices.

Forty BASIC statements are explained along with the BASIC character set, identifiers and line numbering. Instruction proceeds at a slow, but not tedious, pace. Each statement is explained in detail and examples fill every page. Some discussion of variations between different versions of BASIC is provided. The importance of flowcharting is covered, and study material is presented that will make it easy for the novice programmer to use this technique.

Appendix I lists 25 sample problems and Appendix II provides hints for their solution. These problems range from finding the area of a square, converting Fahrenheit to Celsius and figuring compound interest to calculating mortgage payments and payroll deductions. Although no BASIC programs for these problems are given, the student is supplied with all the information necessary to write his own programs. Appendix VII presents ten problems that have been flowcharted and programmed.

The authors obviously had the time-share user in mind when they wrote this manual, but this does not detract from its usefulness to the personal-computer hobbyist. A short explanation on the use of the ASR 33 Teletype will prove helpful to anyone using it as an I/O device. Appendices III to VI relate to time-share error messages, control commands, and limitations.

This text was photographically reproduced directly from the author's manuscript, which means that it is double spaced. Single spacing would have resulted in a book with half as many pages, but it would have been difficult to read propped up beside my video monitor.

I dislike mention of an item followed by the statement that it "will be discussed later." I prefer either a brief explanation or a reference to the page where the explanation can be found. Many "will be discussed later" statements appear in this manual—my only real criticism.

If this review tells you that I am sold on this book, then you have gotten the message. Too many texts have been written by authors who know their subject well but do not truly comprehend the mechanics of learning. I believe that Peluso, Bauer and DeBruzzi do! I hope they write a BASIC manual on the more advanced techniques.

Rod Hallen
Tombstone AZ

Introduction to Microcomputers & Microprocessors
Dr. Arpad Barna and
Dr. Dan I. Porat
John Wiley & Sons, NYC, 1976
108 Pages

The preface of this book contains the following sentence: "This introductory book is written for the beginner who does not have a detailed knowledge of these fields but who wants to learn the techniques required for efficient use of microcomputers and microprocessors."

This is an introductory book, supposedly written for the novice with a limited knowledge of the subjects covered in the book. However, in just 108 pages

(continued on page 24)

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NEW PRODUCTS

IC Master—1978 Edition

The *IC Master* is not your usual manufacturers' catalog; it's not just a cross-reference either. It *is* 2175 pages of catalog and cross-reference information on over 25,000 integrated circuits. Published yearly with quarterly updates, *IC Master* attempts to provide data (as soon as it is available) on every IC made.

Ever have a weird part number that you couldn't figure out? The *Master* will help you understand most standard IC numbers, including the prefixes and suffixes. Over 50 pages are used for the manufacturer symbols alone.

Just want to find what the four-digit IC number means? The part number index allows you to forget all the prefixes and suffixes and use only the numbers to find the listing for that IC in the regular catalog pages.

The majority of the *IC Master* is divided into five info-laden catalogs, one each for digital, interface, linear, memory and, finally, microprocessors. In each of these sections the typical new ICs are described with catalog pages. Did you know that Raytheon makes digital ICs? Several companies have complete catalogs in the '78 edition. Do you have the Nippon Electric Company (NEC) catalog? . . . with the *IC Master* you do.

One of the best sections of the *Master* is the cross-reference and alternate source directory. As more manufacturers second-source other designs with only slight improvements but different numbers, the number of interchangeable and functionally similar ICs increases daily. Over 130 pages with 45,000 entries are contained in the alternate source directory.

IC Master.

The functional indexes are great, too. In the front of each major catalog division are up to 60 pages describing the functions contained in the catalog pages. Suppose you want to select a quad exclusive OR chip with open collector outputs. The digital catalog index shows at least nine manufacturers of the ever-popular 74136 and a high-power TTL version by Motorola, the MC3022. Boldface type identifies those ICs with full data sheets, along with the page and line number where they can be found.

Have you ever wanted to write or call a manufacturer or distributor, but didn't have the slightest idea where to find him? A whole section is devoted to addresses and phone numbers of each IC maker, as well as his distributors in each state.

If you only have a manufacturer's number, use the 50-page product index, listed according to manufacturer. Special order or custom numbers are not included, but all common industry numbers are. If you don't know the symbols used to identify each manufacturer, the part-number guide will identify the over 60 common logos in use.

Even an application note directory is provided. If the chip you're interested in has an application note to show how to use it, the catalog pages or product index will show where to find the title and the publisher.

Did I mention the microprocessor section? This year it's over 400 pages, listing 86 microprocessor systems from AMD to Zilog. It features ten pages of index listing all the support chips for each system and 20 pages of microprocessor selection data, including supply voltages, number of pins, power dissipation, architecture, clock characteristics, support software and alternate sources. Individual microprocessor catalogs from AMI, Fairchild, Harris, National Semiconductor, Intel, NEC and Signetics (just to mention a few) are provided.

In a nutshell, it has saved me a lot of time selecting chips or just verifying numbers, and it sure beats thumbing through ten separate catalogs.

IC Master, 645 Stewart Ave., Garden City NY 11530. 1978 edition: $55 postpaid (vinyl bound) plus tax—CA, 6% sales tax; NY, 7% sales tax.

Bob Buckman
Associate Editor

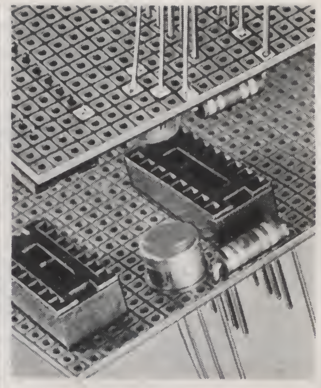
New Catalog from PAIA Electronics

PAIA's newest 24-page catalog lists dozens of useful and interesting kits for the musician/experimenter. Featured in the catalog are the most recent additions to the PAIA line: digital computer-controlled electronic music synthesizers, orchestral string synthesizer, low-cost video display module and single-board computer. Perennial favorites such as the Gnome Micro-Synthesizer and a wide variety of special-effects devices are also shown. The catalog is available without charge by writing: PAIA Electronics, Inc., 1020 W. Wilshire Blvd., Oklahoma City OK 73116.

BIT PAD

Summagraphics Corporation announces an innovation in computer input devices: BIT PAD, a digitizer designed specifically for small-system users. BIT PAD is a full capability, high-quality digitizer permitting ease of entry of positional information and is designed for fast, easy, low-cost data collection of X, Y values. The small size (11" x 11") and compact design make the BIT PAD completely portable and adaptable to a wide variety of applications. Applications exist in medical treatment, opinion sampling, education, real estate, design, games, research, computer animation and a limitless variety of additional uses.

Summagraphics' BIT PAD.



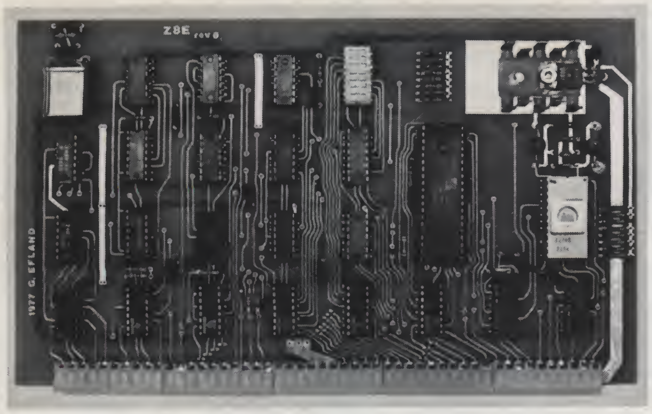
Pad-per-hole Microvectorboard[R].

The byte-oriented, 8-bit parallel output BIT PAD is easily interfaced to any microcomputer currently on the market. Its technological and manufacturing breakthroughs permit it to be sold at $555.

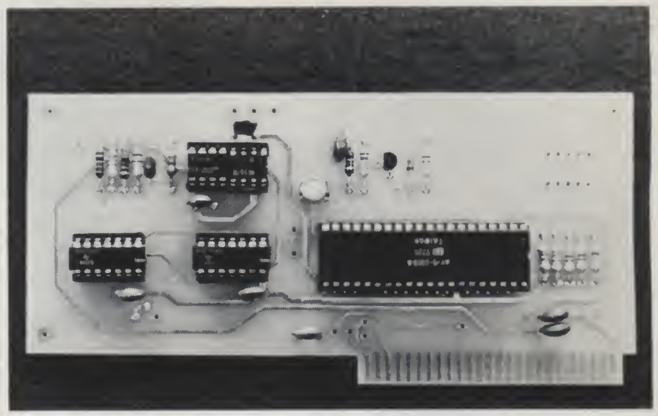
Summagraphics Corporation, 35 Brentwood Avenue, Fairfield CT 06430.

Plugboards Accommodate DIPs and Irregular-Lead Components

A family of large-area "pad-per-hole" plugboards from Vector Electronic Company permits convenient breadboarding of either custom circuits or S-100 bus compatible boards. All boards have an isolated array of square solder pads surrounding 0.1 inch spaced holes. Two are fabricated without card-edge



The Z-80 board.



Apple II serial I/O interface.

connectors and may be cut to any desired shape.

The 45P80-1 is 4.5 by 8.08 inches, giving a mounting area of 36.36 square inches. A larger version, 106P106-1, measures 10.6 by 10.6 inches for 112.36 square inches. The third, designated the Model 8801, is form and fit compatible with the S-100 bus system and accommodates DIP devices, modules and discrete components necessary for CPU, memory and interface circuits. All boards accept DIP packages from 8 leads to 64 leads as well as special modules with leads spaced on irregular multiples of 0.1 inch. For mounting, socket or component leads are tack or flow soldered to the completely isolated pads. Interconnections are made with wrapped wire or soldering.

The 8801 has 100 (50 each side) card-edge connectors on 0.125 inch centers for bus-oriented input/output. A copper-free area on the top of the board permits use of flat-cable connectors for additional peripheral I/O. The space may also be used for large-bodied discrete components.

One corner of the 8801 has an area for two T0-220-packaged regulators mounted in a low-profile heat sink. The leads of one regulator are prewired to raw power and ground, and to primary power buses such as V_{CC}. Leads of the other regulator positions are uncommitted and may be used for V_{BB} or V_{DD}.

The blue-epoxy-glass composition boards are clad with two-ounce, 0.027 inch thick copper. Pads and buses are solder-tinned, while edge connectors are gold-flashed nickel plate for low resistance and long life. Row and column markers are etched in the cladding of the 8801 plugboard. The Model 8801 is priced at \$19.95; the 45P80-1 is priced at \$9.96; the 106P106-1 is priced at \$18.99.

Vector Electronic Company, 12460 Gladstone Ave., Sylmar CA 91342.

Z-80 from National Multiplex for Your SWTP

Now you can run the Z-80 microprocessor in your SWTP computer. The Z-80 uses 8080 software or its own extended set Z-80 software. Changing to the Z-80 will improve your SWTP computer and enable you to use more readily available software.

This new MPU board replaces your 6800 MPU card. Operating software is in the ROM provided so that you can still power up and go just as you did with the MIKBUG.

Some of the board's features are: a 2 MHz clock; on-board baud rate generator for terminal or tape baud rates to 9600; extensive 1K monitor program in ROM; tape recorder read and write routines with or without file searches at baud rates to 9600; freeing up of memory so you can use up to 60K when you use the 2SIO (R) 6800 (the company's 2SIO (R) 6800 board is recommended for use with 3M3 type recorders, with dual CC-8 recorders or when continuous memory above 32K is used).

With a few restrictions, you can use most Z-80 software if you make the port changes for I/O routines given in the instruction book.

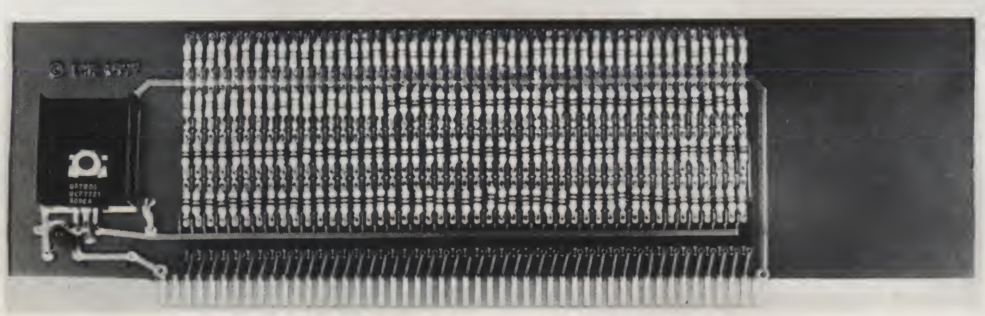
The Z-80 board sells for \$160 kit; \$190 tested and assembled (same prices for the 2SIO (R) 6800) . . . \$3 shipping and handling each board. Documentation is \$3 (refunded with purchase).

National Multiplex Corporation, 3474 Rand Ave., Box 288, S. Plainfield NJ 07080.

S-100 Bus Terminating Board

If you have a noisy S-100 bus or a board that intermittently has problems, then you may be interested in a board produced by Digital Micro Systems. The board terminates each bus line with about a 190 Ohm impedance. This matches the impedance of the output drivers on the bus and absorbs the ringing, reflection, overshoot, and noise that can sometimes be a real headache in a computer system. Large computers have used termination for years. The board is available from stock and costs \$25.

Digital Micro Systems, Box 1212, Orem UT 84057.



DMS bus terminating board.

Serial I/O for the Apple II

Electronic Systems announces a serial I/O board for the Apple II. The board comes with software for input and output of BASIC programs and monitor to a Teletype or other serial device, and a program for using the Apple II for a video terminal. Input and output are RS-232.

The board has switch-selectable parity, number of stop bits and jumper-selectable address . . . data rate to 30,000 baud.

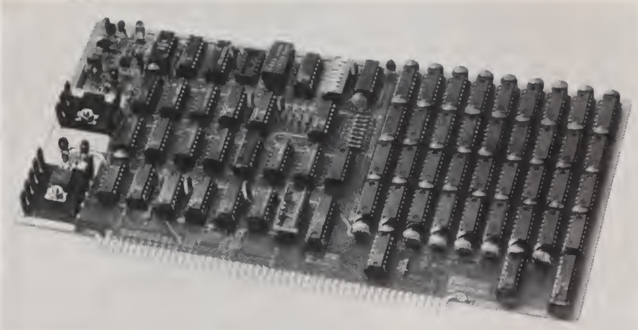
The serial I/O is available as an assembled and tested unit for \$62, or kit with parts for \$42, or circuit board only for \$15. Full documentation and software are always included.

Other kits available are a tape interface, modem, rf modulator, dc power supply, 8K static RAM for the Altair bus, UART and baud rate generator, tape interface direct memory access board for the Altair bus, stand-alone TVT, RS-232/TTL interface and RS-232/TTY interface.

Electronic Systems, PO Box 9641, San Jose CA 95157.

EMPL/8080 Interpreter

Have you exhausted BASIC? Are you looking for a new and in-



North Star's 16K RAM board.

teresting language for your microcomputer? EMPL is a popular, easy-to-learn micro version of APL for the Intel 8080. It resides in the first 5632 bytes of memory. EMPL has numeric and character vectors, user-defined niladic, monadic and dyadic functions, 22 primitive functions, 9 system commands, and other special operators and characters. EMPL can be run either in the ASCII or APL character set. The range is ±32767—double-byte integer arithmetic is used.

EMPL comes with a user's manual that includes complete information on implementing it on any Z-80/8080 system with at least 8K of memory. EMPL is $10 on Tarbell cassette; $20 on paper tape, North Star disk, CUTS cassette, or Mits cassette. Ask about EMPL on other media: Erik T. Mueller, Britton House, Roosevelt NJ 08555.

High-Performance 16K RAM

North Star Computers, Inc., announces the availability of a new, high-performance 16K RAM board for S-100 bus computer systems. North Star's 16K RAM is designed for use in *both* 8080 and Z-80 computer systems. It will operate at full speed (zero wait states) even at 4 MHz.

The low-power board uses 200 ns dynamic RAM chips and the on-board memory refresh is invisible to the processor. Bank switching capability is provided, and the addressing of the board is switch-selectable in two 8K sections. An important feature of the board is the availability of a parity check option.

The North Star 16K RAM board is offered in kit form at $399 and fully assembled at $459. The parity option costs $39 in kit and $59 assembled.

North Star Computers, Inc., 2547 Ninth St., Berkeley CA 94710.

Computer Chess Program

Software Specialists, PO Box 845, Norco CA 91760, has introduced a computer chess program for 8080 and Z-80 based microcomputers. This assembly language program conforms to all rules and conventions of tournament chess. The entire program, including I/O routines, will run in 8K of RAM.

The user selects one of two board sizes for display: large for 24 x 80 CRTs or small for TVTs and Teletypes. A level of difficulty between 2 and 5 determines how well the computer will play, with a level of 3 being an average game. The program is self-initializing, eliminating the need to reload after each game. Both the user's and computer's moves are displayed in standard chess notation.

For users with a North Star disk system, the program is available on disk and uses the DOS I/O routines. The program is also available on paper tape with a 256-byte block reserved for the user's I/O routines. Instructions are provided for loading the program and patching the I/O routines.

The program is available at computer stores or from Software Specialists in either form for $35 (California residents, add 6%).

Macro-Assembly Language for 8080/8085 uPs

CHROMOD Associates has announced the development of SMAL/80, a compiled, structured, macro-assembly language for 8080 and 8085 microprocessors that requires only 7K of memory.

SMAL/80 statements are written in a symbolic notation resembling PASCAL and PL/M that simplifies the writing of assembly-language programs. SMAL/80 also incorporates the basic structured-programming constructs, the DO-END, IF-THEN-ELSE and LOOP-REPEAT, which may be combined with and/or nested within each other without limit to form highly complex statements. The code produced by the compiler is as efficient as that written in a traditional assembly language by a skilled programmer.

The SMAL/80 package includes a 2K macro preprocessor, written in SMAL/80, that permits conditional expansion of statements, unlimited nesting of macros, and has a natural notation that is conducive to efficient, error-free programming.

Also included in the SMAL/80 package is a translator program that allows one to convert any 8080 or 8085 program written in standard Intel mnemonics into SMAL/80, but without the constructs.

SMAL/80 is being offered initially in CP/M and Isis I disk formats. Price, including documentation, is $75. In the near future, a Z-80 version of SMAL/80 in the same disk formats will also be offered, as will various relocatable tape cassette formats that incorporate linking loaders.

CHROMOD Associates, PO Box 3169, Grand Central Station, New York NY 10017.

CSC PB-6 Suggested as Entree To Solderless Breadboarding

For those interested in getting their feet wet in solderless breadboarding without wringing their wallets dry, Continental Specialities Corporation recommends its Model PB-6 Proto-Board kit, a low-cost ($15.95) way of quickly learning and appreciating the advantages of the solderless breadboarding approach.

The PB-6 comes complete with a preassembled breadboarding socket, two preassembled solderless bus strips, four five-way binding posts, a metal ground base plate, nonmarring feet and all required hardware. When complete, its 630 tie points permit flexible configurations of as many as six 14-pin DIP ICs. Following the easy assembly instructions enclosed, using only pliers and a screwdriver, you can assemble the PB-6 in less than ten minutes.

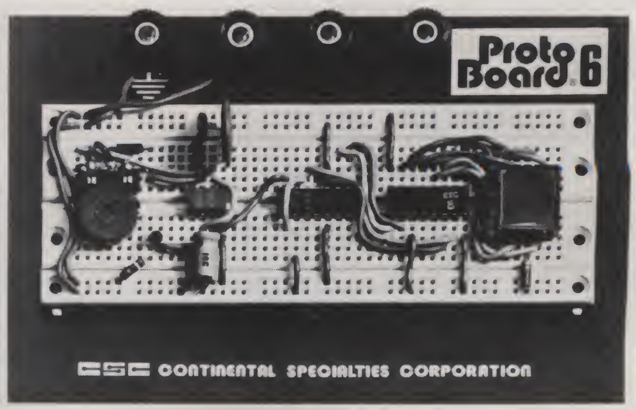
Continental Specialties Corp., 70 Fulton Terrace, New Haven CT 06509.

Microsoft Announces COBOL-80

Microsoft, the company that authored Altair BASIC and FORTRAN-80, delivers another "first" with the advent of COBOL-80. COBOL-80 is the first COBOL for 8080/Z-80/8085 microprocessor systems.

COBOL-80 conforms to the 1974 ANSI standard, thus giving users immediate access to programs already written in COBOL. All Level 1 features and the most useful Level 2 options for the "Nucleus" and for Sequential, Relative and Indexed file-handling facilities are included. Additionally, Level 1 Table Handling, Library and Inter-Program Communication facilities are provided.

Of the advanced Level 2 features, Microsoft has included the verbs STRING, UNSTRING, COMPUTE, SEARCH and PERFORM (varying/until), along with convenient condition specification by way of condition-names, compound conditions and abbreviated conditions. COBOL-80 allows a packed



CSC's Proto Board PB-6.

decimal data representation to conserve memory on floppy disks.

The COBOL-80 system consists of two complete packages: a compiler for translating source code into relocatable object code, and a run-time system containing standard routines needed by the object code at execution time. The whole system may be run in less than 32K bytes. Rate of compilation is 250 lines per minute. Complete documentation is supplied with the system or may be purchased separately for $20.

COBOL-80 is available off the shelf to run under the CP/M and Isis-II operating systems for $750 per copy. OEM and dealer agreements are available upon request.

Microsoft, 300 San Mateo N.E., Suite 819, Albuquerque NM 87108.

ComputerCo Serial-to-Parallel Data Converter

ComputerCo., Inc., announces a serial-to-parallel data converter. Initially designed to operate as an interface for the Expandor 123P and the Poly 88, on-board design has been expanded to allow for TTL, RS-232C, and 20 mA current loop options. An optional power supply will drive the converter board and the 123P.

The converter will accept data in serial form and send it out in parallel along with a strobe signal to operate an output device. A provision for a busy signal is present. An on-board clock is provided for remote installation of the output device. The converter comes assembled to the user's specifications and carries a 90-day warranty. Quantity one price with TTL only is $69; RS-232C and 20 mA current loop, $75; add $50 for power supply and $8 for a case enclosure.

ComputerCo., Inc., 5833 Dorchester Road, Charleston SC 29405.

2708/2716 EPROM Programmer

The 2708/2716 EPROM programmer can be used with the Intel 8080, Motorola 6800, MOS Technology 6502 (KIM-1), Fairchild F-8 and RCA 1802.

With the microcomputer monitor, any RAM starting address may be specified up to 65K. Also, any PROM starting address within the address space of the PROM may be specified along with the number of bytes to be programmed. The programmer has a verify mode to confirm that all bits have been correctly programmed.

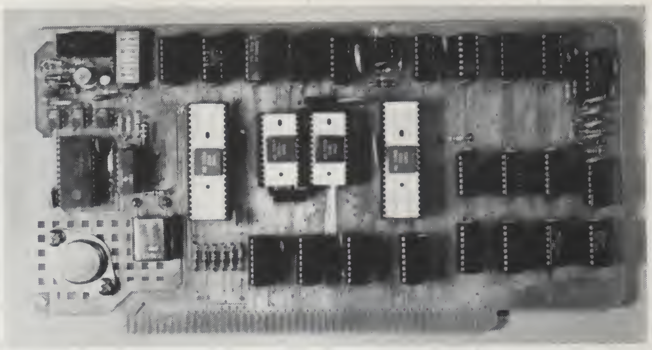
Completely assembled and tested with connector and software, the programmer is packaged on a single printed-circuit board. Only 1½ I/O ports are required to interface the microcomputer to the programmer. Price is $59.95; kit $49.95; kits without software but with software instructions $33.00 (for *all* micros).

Optimal Technology, Inc., Blue Wood 127, Earlysville VA 22936.

Floppy Controller Uses New Motorola Chip

Wintek Corp. has incorporated the new Motorola MCM 6843 floppy-disk controller IC into a low cost but extremely versatile floppy-disk controller. The 4½ x 6½ inch module interfaces to any full-size or minifloppy disk drive. The module supports both hard and soft sectoring, IBM 3740 or user programmable read/write format, automatic CRC generation/checking and programmable step and settling times. $199 unit price.

Wintek Corp., 902 N. 9th Street, Lafayette IN 47904.



The Datatronics 6800 CPU.

6800 CPU for the S-100 Bus

Datatronics, a division of Great Plains Communications & Electronics, Inc., has announced a new 6800 CPU microprocessor card for the S-100 bus, bringing all the advantages of the 6800's sophisticated bus-oriented architecture and its comprehensive, PDP-11-like instruction set to the S-100 user.

For the serious business user or hobbyist, this microprocessor card provides full turnkey operation and maximum system compatibility as well as an RS-232/20 mA interface (baud rate selectable with a DIP switch), paper-tape reader control, MIKBUG ROM operating system (other operating systems also available), power on reset, on-board dynamic memory refresh, slow memory interfacing (up to 5 us access time), and Tri-state data, address and control lines—all on one card for $179 in kit form, and $269 assembled, burned-in and tested.

A floppy-disk system, microprocessor development system, full business/accounting system and other advanced support items will also be available soon.

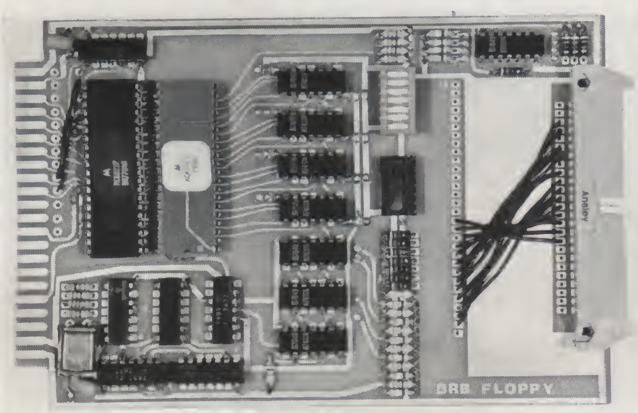
Datatronics, 208 E. Olive, Lamar CO 81052.

New Terminal from Otto Electronics

Designed to interface to any microcomputer that has a 300 baud serial data output port, the OE 1000 terminal operates in the full duplex mode with either 20 mA current loop or a RS-232 voltage swing.

The OE 1000 outputs composite video for use with a modified TV or video monitor. The screen format is 16 lines by 64 characters. It has an uppercase and lowercase mode or TTY mode keyboard and will display 96 ASCII characters and 32 special characters. The OE 1000 has full cursor control, erase to end of line, erase to end of screen, and clear screen.

The OE 1000 terminal may be ordered direct from Otto Electronics, PO Box 30066, Princeton NJ 08540, for $275 kit or $350 assembled.



WC's floppy controller.

The OE 1000 terminal.

LETTERS

Going Commercial?

You folks are doing a fine job of keeping us computer enthusiasts involved, informed and hungry for new goodies. Keep up the good work!

I would like to make some observations about one area that seems to be getting a lot of attention in the pages of *Kilobaud*. That is the area of commercializing computerists' efforts. By that I mean suggesting rather strongly that those of us who have spent a few hundred (thousand?) dollars on equipment with which to pursue our hobby should be looking for ways to make money with them.

I have nothing at all against someone making a few bucks with his hobby—more power to him! I suggest, however, that he should be made aware of Kelly's first law of computing (which I have just recently discovered): *The fun derived from a computer is inversely proportional to its size.*

Once your computer starts paying for the groceries, it's a whole new ball game.

Allow me to elaborate. One of the biggest thrills I have had in a long time (excluding sailing) was when I punched a key on my Radio Shack keyboard and it printed out on my old Model 15 TTY machine via my KIM-1. I had wired the boxes together, written the program (all 163 machine-language instructions) and sweated over some debugging. Now *that* is where computer hacking is at!

Wanna know where commercial computing is at (or, at least, where it can lead to)? Read on!

In addition to being a hobbyist, it happens that I also make my living (a very nice one, thank you) as a programmer. The programming I do to pay the rent does not provide anywhere near the satisfaction I get from my little KIM-1 system. By the way, I have never even seen the system that I program for a living. As a matter of fact, I don't know (or care) where the damn thing is. I am one of several hundred programmers who stoke this computational engine with code. There is very little fun involved in my daily routine of cranking out code to be given to a clerk who does whatever is required to get the stuff into the engine.

So, go ahead and convince people to go commercial, but at least warn them that computing just ain't the same once you become a "pro" and have to start dealing with target dates, customers, system time (up and down), etc., etc., etc.

Keep up the good work. You have a dynamite magazine, but please don't turn it into a "trade journal for professionals."

R. C. Kelly
Campbell CA

Don't worry, Dick, the fun of personal computing will never *leave the pages of* Kilobaud. *—John.*

FORTRAN-80: *Fast!*

I read with great interest the timing comparisons between the various BASIC language interpreters (*Kilobaud* No. 6, p. 66). I was sorry to see that the authors had failed to include the BASIC-E compiler/interpreter supplied with the CP/M package. Also, the Microsoft FORTRAN for the 8080 would have provided an eye-opening comparison for those interested in speed alone.

I was astonished at the huge differences I found in execution speeds between the BASIC languages listed in the article and the FORTRAN. As you can see from the program listing included, I had to add an outer multiplier loop to the FORTRAN routines so I could get meaningful results with the stopwatch. The programs were run on an Imsai using the 4 MHz Cromemco Z-80 (set to one memory wait state).

It should be pointed out for readers unfamiliar with FORTRAN-80 that there are several types of number storage formats. The DO loops, for example, use two-byte integer counters. There is also the capability to specify a one-byte counter for ultra-high-speed looping. Numbers may be stored in one- and two-byte integer format as well as four- and

```
 BENCH.FOR     BENCHMARK ROUTINES IN FORTRAN

C  BENCHMARK ROUTINE TO COMPARE BASIC AND FORTRAN
C
       PROGRAM BENCH
       DIMENSION A(5)
3      WRITE(3,100)
2      READ(3,101) N,MULT
       IF(N.LT.1.OR.N.GT.7) GO TO 2
       CALL OUT(4,7)
       GO TO (10,20,30,40,50,60,70),N
C
C BENCH 1
C
10     DO 11 I=1,MULT
       DO 11 J=1,1000
11     CONTINUE
12     CALL OUT(4,7)
       GO TO 3
C
C BENCH 2
C
20     DO 23 I=1,MULT
       X=0
21     X=X+1.
       IF(X-1000.) 21,23,23
23     CONTINUE
       GO TO 12
C
C BENCH 3
C
30     DO 32 I=1,MULT
       X=0
31     X=X+1.
       Y=X/2.*X+X-X
       IF(X-1000.) 31,32,32
32     CONTINUE
       GO TO 12
C
C BENCH 4
C
40     DO 42 I=1,MULT
       X=0
41     X=X+1.
       Y=X/2.*3.+4.-5.
       IF(X-1000.) 41,42,42
42     CONTINUE
       GO TO 12
C
C BENCH 5
C
50     DO 52 I=1,MULT
       X=0
51     X=X+1.
       Y=X/2.*3.+4.-5.
       CALL SUB820
       IF(X-1000.) 51,52,52
52     CONTINUE
       GO TO 12
C

 BENCH.FOR     BENCHMARK ROUTINES IN FORTRAN

C BENCH 6
C
60     DO 62 I=1,MULT
       X=0
61     X=X+1.
       Y=X/2.*3+4.-5.
       CALL SUB820
       DO 64 J=1,5
64     CONTINUE
       IF(X-1000.) 61,62,62
62     CONTINUE
       GO TO 12
C
C BENCH 7
C
70     DO 72 I=1,MULT
       X=0
71     X=X+1.
       Y=X/2.*3.+4.-5.
       CALL SUB820
       DO 74 J=1,5
74     A(J)=Y
       IF(X-1000.) 71,72,72
72     CONTINUE
       GO TO 12
C
100    FORMAT(' BENCHMARK CHOICE AND EXECUTION MULTIPLE'/)
101    FORMAT(I8)
       END


 SUB820.FOR   SUBROUTINE FOR BENCHMARK ROUTINES

C  SUBROUTINE FOR BENCHMARK TEST
C
       SUBROUTINE SUB820
       RETURN
       END
```

Program listing.

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COMPUTER ENTERPRISES.

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- The now-famous North Star Micro Disk System built-in (with one or two drives)
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  - —Extended disk BASIC
  - —Machine-level monitor
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- Full documentation
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Check these **standard** features:
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- Available as kit or assembled
- 24 lines by 80 characters
- Upper case (lower case optional)
- RS-232 or Current loop
- Auxiliary (printer) port
- 12 inch screen
- Directly addressable cursor
- Full cursor control

INTERTEC'S NEW INTERTUBE CRT TERMINAL

Check these **standard** features:
(all included at these special prices)

- Fully assembled only
- 24 lines by 80 characters
- Upper and lower case (128 ASCII)
- Line drawing character set
- RS-232 or current loop
- Auxiliary (printer) port
- Blinking, underline, reverse video and half intensity
- Protected, constant and print-only fields
- 12 inch screen
- Transmission by: character, line, or page
- Standard keyboard plus 14-key numeric pad
- Self-test diagnostic firmware
- Directly addressable cursor
- Full cursor control

Special complete systems (cable included)

	—KIT—		—ASSEMBLED—	
	List	Special	List	Special
Horizon 1 (one drive) with INTERTUBE*	$2408.	**$2119.**	$2708.	**$2383.**
*assembled only	**SAVE**	**$289.**	**SAVE**	**$325.**
	List	Special	List	Special
Horizon 1 (one drive) with ADM-3A	$2419.	**$2129.**	$2854.	**$2512.**
	SAVE	**$290.**	**SAVE**	**$342.**
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C33

Benchmark	Average Execution Time, Sec.
1	0.0044
2	0.0127
3	4.50
4	4.54
5	4.56
6	5.04
7	5.48

Table 1.

eight-byte floating point. In the program, I tried to choose a format compatible with the task involved.

Table 1 shows the timings I found. For accurate measurement, I used an execution multiple of 10, 100 or 1000 as appropriate.

I thought your readers would be interested to see that hobbyist computers could do some real number-crunching too!

Ronald Dove
San Luis Obispo CA

We have a review of Microsoft's new FORTRAN-80 coming up real soon!—John.

CP/M: Expensive?

Dr. Stewart's article, "CP/M Primer" (April 1978, p. 30), was a much needed excursion into the field of sophisticated software. While machine-language techniques are vitally important (treating the computer as a black box will not get you very far), and programming at a symbolic level (BASIC, say) concerns us all, not many have the training (or time) to put together a piece of software like CP/M. It's nice to know a little about what you're buying, so let's see more articles of this type and quality in *Kilobaud*.

There was only one point that bothered me. Dr. Stewart said that, at $70, CP/M's one diskette and documentation is inexpensive software . . . certainly, compared to the inflated prices charged today. But, why should software be so expensive? The fact that an operating system such as CP/M would take three to six man-months is irrelevant; the program, after all, needs only to be written once. When the cost of writing CP/M is spread out among its users, it becomes nil. The diskettes themselves must cost well under $3 in large quantities. It's analogous to the situation in the rest of the publishing industry: I could *never* write a dictionary, but I could buy one, in paperback form, for under $2.

With this one reservation in mind, I thoroughly enjoyed the article. We need this sort of information to bring about a buyer's market in software, bringing what is (by most) considered a mysterious subject into the open.

Richard Kearney
New Haven CT

The $70 is far from being unreasonable, and anyone who fails to get $70 worth of benefits probably shouldn't have bought it in the first place. I suspect the development time for CP/M was longer than three to six months . . . but that's not the real issue. You seem to be questioning the right of Digital Research to make a profit *on their product (no, that isn't a dirty word).—John.*

A Typesetter Speaks Out

Being the lowly typesetter that I am and getting as many of the derogatory comments coming from the uninformed populace as I can stand, I would like to clear up a few misconceptions lodged in the minds of some people.

I had just finished setting a letter from Joseph Roehrig (*Kilobaud*, No. 18, p. 20) and happened to glance at the feedback he received as a result of the faulty Tic-Tac-Toe program. Here's a quote from one of the letters: "It's really pathetic how the typesetters can butcher a program." I was appalled by this statement; obviously this person knows little or nothing about the editing, typesetting and proofing system involved in publication.

I have worked as a typesetter for about a year, my term at *Kilobaud* having started in November 1977. My base of operations is a Compugraphic Editwriter 7500 typesetting computer. Although I and my associates know relatively nothing about the inner workings of a computer, we are the best typesetters in New England.

There is a lot more to typesetting for a magazine than meets the eye. Not only do we have to put up with the hen scratch that editors call proof marks, authors' changes, layout fitting changes, typographical error corrections, etc.; but have you ever tried to tell the difference between a zero and an oh typed on a regular typewriter?

The symbols and characters in computer programs make perfect sense to a computer hobbyist. All they are to us is eyestrain. With floppy-disk memory storage and confidence in the sometimes aggravatingly precise proofreading system, my limited time is *not* spent scrutinizing computer listings! The rare mistakes that sometimes get published are generally the fault of the author. That's the main reason why authors are now required to have camera-ready programs.

If you would take some time to compare 1977 to 1978 *Kilobauds*, the untrained eye just may be able to see a boost in the quality of type in articles, tables, ads, etc., since the inclusion of the Compugraphic system and yours truly to the *Kilobaud* staff.

We do not try to be authorities on microcomputers, so let's not have the amateur typesetters out there snorting at the fine job the typesetters of *Kilobaud/73* do.

Jennifer Johansson
***Kilobaud* Magazine**

Let's Hear It for the Mystery Program!

I had to type in the *Kilobaud* Mystery Program (April 1978). My curiosity would not let me wait. So I did it and I really liked the results. You should have Tom and Phil explain how it works. That would be a nice article for us beginners to get some real technique experience. I made a copy of the output and attached it for your use. Some of the other readers might like to see the hardcopy results.

C. R. (Chuck) Carpenter
Carrollton TX

Sounds like a good idea. What do you say, Tom and Phil?—John.

```
]REM-   KILOBAUD MYSTERY PROGRAM

]REM-   CHUCK CARPENTER

]REM-   CARROLLTON,  TX

]RUN

***********************
     APRIL FOOL!
***********************
TRY DELETING LINES 930 AND 940....

]930
]940
]RUN

***********************
     APRIL FOOL AGAIN!
***********************
NOW REMOVE 920, 950, AND 960

]920
]950
]960
]RUN

***********************
RIDDLE.... WHAT'S A THREE TOED SLOTH?
***********************
....DELETE 970, 980, AND 990

]970
]980
]990
]RUN

***********************
   HA! HA! HA! HA!
***********************
I'M A COMPUTER, NOT A ZOOLOGIST!
***********************
BYE
```

Good Words for Midwest Scientific Instruments' Floppy System

An SWTP 6800 with MSI dual floppies, 32K and a Microterm ACTIV has proven more than adequate for *any size operation* where speed is not a factor. The reason—MSI's BASIC has a CALL command that permits overlays without destroying the variable table; in fact, called programs may add to the table. Thus, effective memory is limited only by the disks, and each drive makes almost 300K available to the user.

Our system was delivered ready to plug in and fire up, which we did, and it did. Except for a couple of cases of chip infant mortality, it has worked perfectly from day one. DOS and the disk versions of the assembler/editor and BASIC all work fine. Every problem encountered to date has resulted from operator error of one sort or another (e.g., trying to read a file that has not had anything written to it can alter your program and, possibly, the interpreter.

Recently, SWTBUG was added to the system, making it instantly usable by anyone in our office. Hal Hoffman at MSI was super helpful in providing SWTBUG patches for BASIC, and on all software questions. The vendor (The Electronics Place) here in Pittsburgh has been equally helpful. The only weak link has been documentation, which I understand MSI is correcting.

In summary, I feel that a system like this one is probably the minimal usable system for a business application (including a printer of some sort). At the same time, with the kind of software available (we do not have it, but MSI offers a compiler BASIC), it is quite possible this is the maximum system most small businesses would ever need. At the time we placed our order, the cost of $10,000 for *two* systems, assembled and burned in, was unbeatable, and I do not think anything better is available today at that price.

Robert B. Peirce
McMurray PA

Reasonable Business System Software

In response to Mr. Charles Pack's letter in the March 1978 issue (No. 15, p. 14), we would like to take issue with respect to his feelings that low-cost software development is not viable.

Our firm's philosophy is to provide businesses and professionals with high-quality, low-cost computer systems, including all software. In our estimation, the current computer manufacturers and software houses are charging exorbitant amounts for what they are putting out. The response in this community has proved us right. Several times clients we have sold systems and software to have remarked to us that other salesmen who have come in from other dealers and manufacturers have told them that it couldn't be done at our prices.

Not only do we sell an entire system including all the software personalized to that business's needs, but we price the entire system within $200-$300 of its normal retail price for the hardware alone (our basic system, which includes a 16 (not 8) bit CPU that is fully time-sharing capable, dual full-size floppies, 32K RAM, an ACT-IV CRT terminal similar to the Soroc, and all programming, cabling, etc., needed to have a fully operational system, is priced at $6969). Our software includes general ledger (with a full audit trail), accounts receivable, accounts payable, payroll and inventory, with other programs available depending on the business.

My background is in accounting and my partner is a tax attorney. We have two programmers now (with a possibility of a third soon) and they both have college degrees . . . heavy emphasis in math. Even though we have been charging reasonable prices, our clients have still been receiving the update information they need.

In closing, we feel that the future will force those who are now charging such high rates to come down to reasonable levels. We don't feel that the end user will suffer, perhaps a profit level will decrease a little and maybe some inefficient operations will quietly go out of business. But then, isn't that what the free-enterprise system is all about? That the consumer should get the best product at the least possible cost is what we are about, and we have found that more and more business people are realizing every day that it doesn't have to say IBM or cost $20,000 to $40,000 to get the job done.

Thank you very much for allowing us to use your forum as a personal soapbox.

Philip D. Mickelson
President
Microsystems, Inc.
Spokane WA

Number Crunching: Additional Points

In the May issue of *Kilobaud*, I found Osborne's article on the National 57109 interesting but somewhat inacc rate. Evidently he has not actually used the device. I have successfully interfaced the 57109 to my Z-80 system and have written a BASIC interpreter around the unit. The hardware and software to interface the 57109 required some experimentation but has turned out to be simple (seven cheap chips).

He also failed to mention that the 57109 is $20 and is readily available from Tri-Tek, while the AM9511 is $200 and very difficult or impossible to find. The 57109 is slow—you can't have everything—and does save a pile of software and memory.

Jeffrey Ehrlich
Burnt Hills NY

More on Making PC Boards

This is a combination of a fan letter for all the articles by George Young, as well as a couple of photographic suggestions that may simplify the technique for making PC boards.

I've been a programmer for many years, but I never dreamed I'd be able to understand hardware, much less make something that worked. Can you imagine how thrilled I was when I started into that first lesson of Kilobaud Klassroom and built a circuit that really made a *noise?* I've been a fan of George Young ever since that time.

Now to the article in the April 1978 *Kilobaud,* "Make Your Own PC Boards," by George Young and Bob Grater. I've been an amateur photographer for many years, and here at last was an article in *Kilobaud* relating to my favorite hobby, or I should say what used to be my favorite hobby before computing became a hobby as well as a profession. This is where I have a few suggestions that may make it easier for your readers to produce litho negatives.

First, let's consider making the copy negative, using the enlarger as if it were a camera. It isn't really necessary to remove the lamphouse and put in a ground glass. Here is what you do. Place the artwork to be copied in the enlarger easel, just where you normally would put the photographic paper. Put any old negative into the enlarger and project it down onto the artwork. Adjust the enlarger so the image just covers the artwork, and focus carefully. Then remove the negative from the carrier and replace it with litho film. The enlarger will be properly focused, and you will be photographing exactly the area where the projected image was.

After the film is in place, wrap a black focusing cloth around the enlarger to keep out stray light. This won't make it perfectly light tight, but it doesn't need to be as light tight as a camera because you will turn on the light only while making the actual exposure. Remember, there is no shutter in the enlarger, as there is in a camera.

As for lighting the artwork, it is best to have two bulbs in reflectors, one on each side and at 45° angles. Unplug the enlarger from its timer, but don't connect the bulbs directly to the timer because the timer is not meant to handle that much load. Instead, connect a relay to the timer and the bulbs to the relay. Now pressing the button on the timer will make the exposure, just as in normal enlarging.

The next suggestion is for those who lift the artwork off the page using Thermofax or Xerox, and who come out with a positive transparency, but who want a negative. The easiest way to do this is with 3M Color Key. You must get negative acting, black, opaque color key material. All those parameters are important to remember when buying the stuff. If you bought positive acting, you'd come out with another positive just like you already have. The material comes in all colors, but since you're not using this for artistic purposes, you want black. The transparent version is more commonly found in stores, but don't get that. The transparent black is black when you lay it down on a sheet of paper, but when you hold it up to the light it is only gray. The opaque black is completely opaque, just like litho film.

The sheet of color key material is opaque black to begin with. After exposure and during development, some of this washes away to leave the image.

The color key should be exposed to sunlight, similar to the way you expose the final board. A one-minute exposure should be about right. Don't worry about using a safelight. Ordinary room light won't hurt the color key, but turn off any lights if it is convenient to do so, and don't work in a very brightly lighted room, such as a screen porch.

The materials and equipment you will need to develop the color key are:

- Negative acting color key developer.
- Cotton pads, the same as you will use later to develop the resist on the final PC board.
- Rubber holder to wrap the cotton pad around.
- Piece of glass somewhat larger than the PC board you are going to make.
- Filter paper, such as used to make coffee.

To develop the color key, put it on a level piece of glass and pour the developer over it. Keep it covered with the developer for a little while, about 20 seconds, and then gently begin to rub it with the cotton wrapped around the rubber holder. The unexposed parts will wipe away, leaving you with a negative image. This should take only about a minute. Rinse the negative under running water and blot it dry using coffee filter paper. You could blot it with kitchen paper towels, but they have a lot of lint on them, so I prefer the filter paper.

The 3M Color Key supplies can be bought at large art stores or from places that sell graphic arts supplies. Contact 3M (listed under T in the phone book) for your nearest dealer.

Keep up the good articles in *Kilobaud*.

Val Schorre
Los Angeles CA

From Europe: Some Thought-provoking Comments

I think that it should be interesting to receive a reaction from good old Europe, right? I shall not start to sing a song of praise about your fantastic magazine. That's what all people do when they first get a *Kilobaud* in hand.

I buy it monthly at my local electronics store. This is the only American computer magazine I can really read each month. You cannot imagine the troubles and the time delay when trying to place a subscription order from Germany to the U.S. Did you hear about computers speeding up subscription registrations? Anybody care to make an invention . . .?

There is one point of special interest from the European point of view: Could you give your overseas fans information about the costs for handling and shipping a mainframe, a kit, etc., when ordered in Germany from a U.S. vendor? Perhaps you can write a small article on "how to order an American computer from Europe."

You should know that LSI chips, literature and special parts for S-100 systems over here are expensive. You can save up to 100 percent compared to local prices on special items if you order in the U.S. and pay all the charges, taxes, customs and insurance!! The German community of computer enthusiasts is still small, but rapidly growing. It could be most interesting for all your advertisers to extend their market to Europe!

Let me count some points I would like to have information about.

1. One can find different articles such as "my experiences assembling the XY . . ." in all the magazines. Couldn't you compare the different CPUs, RAMs . . . with a detailed discussion of the wiring diagrams? This would be for the advanced hobbyist.

2. The future for the personal computer includes floppy disks. There are several conventions (soft, hard sectored), some more drives and an avalanche of DOS's and user programs coming up. There is a need of an actual overview. In a German Foto magazine I read an article: "10 different b&w films processed with 10 different developers" (only the best combinations appreciated). Could there be an article such as "DOS X works with controller Y and CPU Z, using drive . . . "?

3. John Pierce talked in *Kilobaud* No. 15 about one excellent FORTRAN compiler and one good DOS. *Which are they?*

If you have further interest in the German hobby-computer scene I'll be glad to hear from you. Keep things running just as they do!

PS. Perhaps one day I can order a Pilot version of "English for foreigners," which is to be loaded into my future system.

Thomas Mischke
Hoegerdamm 17
2000 Hamburg 1
W. Germany

Well, Thomas, I certainly hope some of the U.S. manufacturers take your advice and at least start looking into the European market. If they don't get it . . . someone else will. Nice to hear from you.—John.

KLAATU . . . SCHMAATU?

The April *Interface Age* was a "robotics" issue, and featured the KLAATU robot of Quasar industries, Rutherford NJ. I call your attention to the Feb. 1978 *Dr. Dobb's*, where Stanford University decries the thing as a fraud. I call upon you to make this known ASAP through your magazine, as the news does not seem to have gotten far. WNBC radio of NYC did a straight news article on it Mar. 31, which galled me no end. I'm sending copies of the *Dr. Dobb's* article to the New Jersey Dept. of Consumer Affairs, the major New York broadcast stations, newspapers, wire services and the leading computer-hobbyist publications like your own, though I expect you are already aware of the article. Please make more people so!

General Technics is a group of science-fiction fans also involved with electronics and home computers. We are concerned about the image of technology as a bogeyman. Things like this don't help. I *implore* you to get this out to the masses. This hobby doesn't need another DataSync!

Robert K. Halloran III
General Technics-East

This is just a short note to let you know that we also received a copy from General Technics. Our comments and the author's comments are in the June issue of Interface Age.

Robert S. Jones
Publisher
Interface Age

More on the 1802!

How about some articles on the RCA 1802? We're computer people too—even though we usually have only a 50-pin bus. "Please!"

Craig Edmonds
Sylmar CA

They're coming, Craig, they're coming.—John.

KB CLUB CALENDAR

Steve Fuller

Ventura County CA

Many thanks to Fred Moeckel for his recent letter boosting the Ventura County Computer Society. Fred's note was prompted by a request in this column for club information in the Ojai area, so listen up, folks.

VCCS was formed in March 1976 and presently has a membership of about 30. It serves all of Ventura County, including Ojai, Ventura, Camarillo, Oxnard and Thousand Oaks. Meetings are held at 7:30 PM on the last Wednesday of each month at the Camarillo Public Library, 3100 Ponderosa Drive, Camarillo CA.

Address information requests to VCCS, PO Box 525, Port Hueneme CA 93041. For information by phone, call Fred at (805) 985-7672 or John Borders, 985-1631.

Dallas/Fort Worth TX

Here's a letter for 6800 systems users from Charles Matz of Dallas:

"A 6800 Users Group has been formed for the Dallas/Fort Worth area, and meets on the third Thursday of each month at 1220 Majesty, Dallas TX. All interested hobbyists are cordially invited to attend. We are currently presenting varied topics of interest to users of 6800 systems along with tutorials in assembly programming.

"Also of interest is our 'Ask the Chips' feature: Any questions or comments concerning 6800 systems are presented to the club and discussed during meetings. Any user worldwide may correspond at the address below, and we will make every effort to respond with any solution we might have discovered.

"We also feature a 'Tell the DIPs' segment during meetings when manufacturers, software suppliers or others desiring a forum to present ideas may address the club directly or send brochures for distribution to members."

Further information is available by writing to Charles at 4114 Avondale, Suite #2, Dallas TX 85219, or by calling evenings (214) 522-7130.

Bedford MA

The NECS Newsletter is the publication of the New England Computer Society, and it's packed full of goodies—reports on club activities, swap shops, guest speaker programs, contests, user groups within the Society and much more.

Write to New England Computer Society, PO Box 198, Bedford MA 01730, for meeting schedules and club information.

Seattle WA

The Apple Puget Sound Program Library Exchange has been formed here, according to Val Golding.

The primary function of the group is the exchange of ideas and programs through the medium of Call-Apple, a monthly newsletter. An SASE to A.P.P.L.E., c/o Val J. Golding, 6708 39th Avenue S.W., Seattle WA 98136, will get you a sample newsletter and an application blank. There is an application fee of $2.

Natick MA

Interested hobbyists are invited to attend meetings of the newly formed TRS-80 Users Group of Eastern Massachusetts, held on the second Wednesday of each month at 7:30 PM.

You can contact the group c/o President Dick Miller, 61 Lake Shore Road, Natick MA 01760, or call him at (617) 653-6136.

Orange CA

Gary Dickenson reminds us that "the North Orange County Computer Club (NOCCC) is alive and well in Southern California." Information is available from the club at PO Box 3603, Orange CA 92655, or call (714) 998-8080.

Ona WV

Oscillations is the newsletter of the West Virginia Computer Society, 167 Iroquois Trail, Ona WV 25545.

Recent meetings have included demonstrations of the Motorola 6800 and accessories, Radio Shack TRS-80, and Heath Microtrainer kit and course material.

Digital Group Owners

Owners of Digital Group systems can write to DG Users Group, PO Box 316, Woodmere NY 11598. The first issue of the newsletter features an evaluation of Micro-Com software, a Selectric interface (hardware and software) and a discussion of problems in expanding past 26K. A flea market section is also included.

Little Rock AR

The Arkansas Computer Club extends an invitation to experienced hobbyists and newcomers alike in the Little Rock area. Meetings are held in the United Electronics Institute building (7000 block), Asher Avenue, on the first Saturday each month at 1 PM.

The following members were elected to the newsletter staff at a recent meeting: Tyronne Nash, editor; Scott Lee, assistant editor; Tom Spencer, Richard Morgan and Dennis Gilman, reporters.

For more information, write to Richard L. Morgan, 4830 Oaklawn Drive, N. Little Rock AR 72116.

Alliance OH

Gary S. Fix has been elected president of the fledgling Alliance Microcomputer Club. Also elected was Bob Besse, vice-president. The group's first meeting, held at the home of a member, featured an introductory presentation of microcomputer terms and definitions.

A primary goal of the club, says Fix, is "to provide individuals in the Alliance area with the opportunity to share interests and experiences in exploring microcomputers as a hobby, career, social activity or curiosity."

Meetings are held on the first Tuesday of each month, and are open to all interested persons. Details are available from Gary at 3885 Norwood Ave., Alliance OH 44601, or call him at (216) 823-8996.

This column is available for you to report on your club's activities such as regular meeting schedules, special events or programs, swap meets or any endeavor that will be of interest to your fellow hobbyists. If your announcement contains timely information, please send it at least two months prior to the date or dates mentioned in the announcement. Also, please note the new address for Club Calendar mailings:

Kilobaud Club Calendar
c/o Steve Fuller
334 Sterling St. Unit A-3
West Boylston MA 01583

PUBLISHER'S REMARKS

(from page 6)

almost as soon as the Kansas City meeting was over. Perhaps the *Kilobaud* cassette tapes will be able to accomplish what KC was unable to do . . . aim us toward a standard.

In working with the various cassette systems, it has become obvious that few, if any, of the manufacturers have yet come up with a very good system.

Invitation

One of these days I'll take some pictures showing how we put *Kilobaud* out. I think you'll find it interesting. We have almost 80 people working full time on the magazine, so it is not a trivial project. The whole operation, one of the most complete publishing operations going, is run from a great big New England home about 250 years old.

If you are ever in the southern New Hampshire area or have an extra day around Boston, please drop up and say hello. You'll find the place hard to believe, with people everywhere, running around . . . microcomputers in the kitchen, the cellar, in the offices . . . and ham gear all over the place, too.

AROUND THE INDUSTRY

(from page 8)

Ann Arbor terminals, three 110-cps Okidata line printers and three disk drives. The work order scheduling system uses 40K bytes of mainframe memory; the lighting and air conditioning systems use 16K and 20K, respectively. Each of the three disk drives uses 300K bytes of floppy-disk storage.

Design and implementation of the lighting and air-conditioning control portions of the system entailed the installation of approximately $75,000 worth of acoustically coupled transmission and receiving equipment to control 11 separate lighting areas and approximately 50 air-conditioning units. Total cost of the computer hardware for the three-part system—excluding the transmission/receiving equipment—was $21,800. Custom programming was performed by a software contractor at a cost of $10,500. The entire system was installed and operational by December 1976.

EDITOR'S REMARKS

(from page 7)

for getting rid of all that extra "junk" you've been accumulating . . . and take home somebody else's junk! (One man's junk is another man's treasure, right?) It will also be an opportunity to pick up some of those major components and small parts for your systems because several of the large dealers from the Southern California area will be there. (Remember . . . admission is free to buyers.)

The event will be held in the Salvation Army Community Center located at 4849 Hollister Ave. (It's a beautiful and spacious building but, because of the ownership, we've decided to forego the dancing girls as a main event this year.) The map in Fig. 1 will help you find the Community Center. Time will be from 9 AM to 4:30 PM (doors open at 6 AM for sellers). Refreshments will be available and there is a nice restaurant across the street . . . and others nearby. Nearby motels include the 96-unit Turnpike Lodge, The Sandman, Holiday Inn and three Motel 6's (call information for the numbers).

Plan to sample some of the superb cuisine in the Santa Barbara area . . . and the sights (it is one of the most beautiful cities in the country). Sellers can drop me a line or give me a call for reservations and booth costs:

John Craig
RFD Box 100 D
Lompoc CA 93436
805-735-1023

THE BASIC FORUM

(from page 11)

"In other words, any number multiplied by an integer and then divided by that same integer should yield two original numbers. Of course, if the divide were to come first (i.e., I = F+ ((L − F)/D)*D), the irrational number would occur and be truncated. To test this idea (see Program 4) there is one run of a program that selects a random number, then multiplies/divides by D(D = 2 to 9), and compares results with the same number doing the divide/multiply in that order. Note that the M/D always returns the original random number, and the D/M misses for 3, 6, 7 and 9 at least, and some of the time for 8.

"Getting back to Robert's original problem, he needs only to separate the loop count function from the interval value function as in Program 5. Of course, the values V still have the 'errors,' but the loop will proceed the correct number of times in all cases."

The "casting out duplicates" puzzle of the April issue is generating considerable interest, but at this time we are still receiving entries. We will postpone presenting these results till the next Forum.

A New Puzzle

We do have another programming puzzle for your consideration. We call it the "Drive-In Movie Problem." Suppose you want to determine the best distance from the base of the screen to view a film. By "best" we mean the position that will cause the screen to subtend the greatest angle. At this position, the image on the screen will appear to be largest.

Consider Fig. 1. If you were directly under the screen ("a"),

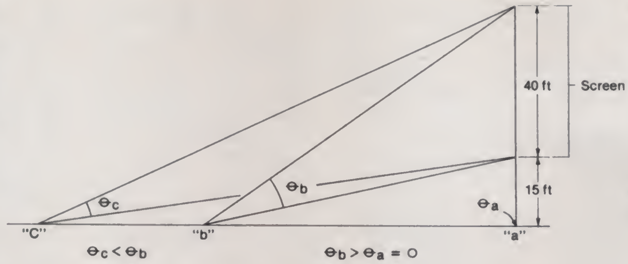


Fig. 1.

the angle subtended would be zero. Moving the screen forward increases the angle. At some position ("b") the growth of the angle ceases and it begins to decrease ("c"). The angle thus reaches what mathematicians call a *maximum*. With a little trigonometry and calculus you could get a solution analytically. What we want, though, is a computer-based solution relying on the following basic algorithm:

> Start at the screen and step outward in fairly large steps (say ten feet) until you detect a decrease in angle size. Now step toward the screen with smaller steps (say one foot) until the angle again decreases. Reverse direction, reduce step size, and continue this process until you have the value bracketed to within one-one hundredth of a foot.

Send your solution (listing and answer) to:

BASIC Forum
PO Box 7082
Tyler TX 75711

BOOKS BOOKS BOOKS BOOKS

(from page 12)

(including the index and a few appendix pages) it is difficult to teach the required techniques for even a perfunctory knowledge of microcomputers and microprocessors.

The most prevalent chapter in any introductory computer book is the one dealing with the various numbering systems used by humans and computers. This book has such a chapter and an appendix listing for octal, hexadecimal and powers-of-2 arithmetic tables.

The shining light in this chapter is the section dealing with the idea of parity-checking systems. Of course, the treatment is short but, nevertheless, important and informative.

The depth and length of the previous, and subsequent, chapters are much too limited. Granted, an introductory book should not overwhelm, but, rather, introduce and inform. The authors, then, have fulfilled their primary objective.

However, the few bright spots in this book are overshadowed by the glaring assumptions and discussions that fill the remainder of the book. Let's take a look at one such example.

Moving away from the chapters dealing with the hardware angle of microcomputers, the reader quickly finds himself reading about machine-language programming. Then, in a flash, assembly-language programming is introduced and completed. Now, on to a higher-level programming language. You would expect to read about BASIC, right?

Wrong! What the authors have done is introduce the beginner to ALGOL. Now, maybe ALGOL is the language of the future with respect to microcomputing; however, to a beginning microcomputerist this introduction is totally unacceptable. In the first place, what vendor furnishes ALGOL?

So, what do we have? Well, for an introductory book, *Introduction to Microcomputers & Microprocessors* misses the boat. The introduction of material totally alien to a beginner would tend to confuse, rather than inform, those novices wanting a good book on microcomputing fundamentals.

The major shortcoming is the total lack of BASIC programming examples. Second, the hardware portions of the book are just too short. After a short introduction and an example or two, the reader is quickly introduced to yet another hardware facet of microcomputing.

The novice microcomputerist, especially the hobbyist, can do without this book on his (or her) bookshelf. I suggest you hold off purchasing this book until you have gained at least a working knowledge of digital circuitry and a degree of expertise in BASIC programming.

Len Gorney
Clarks Summit PA

Contest!

Already it's time to choose a "best article" winner for April. T. S. Eliot may have thought of April as "the cruelest month," but that's not the case with Dr. John F. Stewart, author of "CP/M Primer," April's winner. John wins $100—and that's no fooling.

In our monthly drawing of all votes submitted, the winner was James Worthington of Charlottsville VA. Jim's prize is a choice of a book from the KB Book Nook.

Congratulations to you both, John and Jim.

Dana W. Zimmerli
2020 Robinson St.
Redondo Beach CA 90278

Two Hobbies: Model Railroading and Computing

Many hobbies are being tied in with computers; model railroading is one of the more fascinating match-ups. Part 1 of this article is an overview of model railroading.

As new hobbies develop and become popular, old hobbies either drop by the wayside or incorporate new ideas into a more interesting combined hobby. One enduring example of this phenomenon is model railroading.

In my opinion, no other hobby appeals to so many people with such widespread interests. The civil engineer can try his hand at bridge or track layout design; if you like complex strategy games, try a switching contest; if electronics is your thing, experiment with power control and signaling; woodworkers can build benchwork and model houses; artists can paint scenery; etc. . . . the variety is amazing. The microcomputer hobbyist appears to be the next likely candidate to enter the world of model railroading.

So what is the world of model railroading all about? It is an attempt to recreate in miniature the real world of railroading, including all the beauties of scenery, the challenge of operating a train, the problems of insufficient or broken equipment and the constant dilemma of too little money and too many desires. The microcomputer can add to the illusion of this make-believe world by eliminating the necessary details that do not exist in real railroads.

In this two-part article, I will describe a practical application of the microcomputer in the hobby of model railroading. A basic understanding of model railroading is essential to the design of the microcomputer system, so the first part of the article describes model railroading as it is today, and then discusses those aspects which can be aided by the microcomputer. The second part of the article will describe the circuits required to support the microcomputer-model railroad system.

Background

Most people are introduced to model railroading in their youth, and almost all model railroaders start by getting a train set, usually Lionel, as a gift. However, the hobby offers a great deal more than is available in train sets. The basis of model railroading is *scale* modeling.

Certain scale ratios have been established as standards so that manufacturers can build equipment that will match that built by another manufacturer. The most common of these scales are shown in Table 1. Locomotives, passenger cars and freight cars (these three categories are called rolling stock) are available in all of these scales. In addition, structures and track (both continuous and switches) are available in some quantity depending on the scale. The most popular scale in current use is HO, with N and O the next two popular scales. In these scales, extensive product lines have been developed to satisfy most of the needs of the model railroader.

When a model railroader decides to build his layout, he considers many variables, in addition to scale. He must assess the components available to him in the chosen scale in order to determine the exact pattern of track he can build. In the most popular scales, he can obtain already built switches (transitions from one track to two) and crossings (where one track crosses another) in various sizes (angles).

If what he wants is not available, he may plan to build it; some model railroaders enjoy

The Belmont Shore Railroad Club system.

building trackwork so much that they may construct the entire layout. In the same way, other components of the model railroad can be totally built from scratch (scratch-built), built from a kit, modified from a kit (kit-bashed) or bought ready to run (RTR). This applies to trackwork, rolling stock, structures, etc. In fact, one of the areas where this applies is support electronics.

The variety of model-railroad activities requires several discrete talents or specialties, but few individuals are able to cover all of these activities equally. As a consequence, an individual may not be able to construct as good a layout as he desires. One popular solution is to join with other model railroaders in a club.

Clubs can be either formal organizations that own a layout, or informal organizations based around the layout or layouts owned by the individual members. In either case, the talents of the individuals tend to complement and reinforce each other. In addition, the club is a good place to exchange ideas and gain talents by observation. However, the design of a club layout and all its components must be modified to accommodate the desires of the members. Additional care must therefore go into the design of a model railroad for a club.

As the model-railroad empire is planned, one of the key factors to consider is routing the track in the space available. This activity is known as *layout planning*. One of several planning methods may be used. The simplest way is to get layout ideas from a book (e.g., *101 Trackwork Designs*). Another possibility is to build a scene from the real world. (In model railroading, the real world is the "model" or pattern used as a prototype for the model to be built; therefore, it is called the "prototype" or "prototypical.")

The problem with building a direct model of the prototype is that it is too long (for example, a scale mile in N scale is 33 feet long); therefore, model railroaders use a technique called *selective compression* to cut down the length of their model-railroad empires. Selective compression is the process of shortening the lengths, while the width (direction perpendicular to the track) is maintained.

Another method of track planning is the *totally conceptual layout*. In this scheme, the designer puts together a pattern that contains consistent prototypical features but does not follow a specific prototype. This latter method is the most popular for large layouts.

As the layout plan evolves, several track patterns may be envisioned (see Fig. 1). Although the actual track may be twisted and folded back on top of itself, four basic patterns exist: oval, point-to-point, loop-to-loop and point-to-loop. Certain advantages exist for each of these patterns, which are commonly called schematics.

The most prototypical schematic is probably the point-to-point; however, it is seldom practical to build. Most operators do not appreciate the inability to turn an entire train around after it has traveled from point A to point B. The major exception to this is the second point-to-point layout, which is called a *switchback*. These were used in the early days of railroads to climb steep mountains, and can be quite interesting to watch and operate.

One additional consideration affects the track planning and the possible computerization of the layout. Many prototype railroads, particularly Eastern lines, used double, triple, and even quadruple, track in order to maintain heavy traffic densities. In the same way, model railroads frequently have double or more track. This can make the control of trains much easier because each track may be restricted to one direction.

O scale	1:48 (Lionel)
S scale	1:64
HO scale	1:87
TT scale	1:120
N scale	1:160
Z scale	1:220

Table 1.

Some Current Electronics

Many forms of electronics are currently used in model-railroad layouts. The most common requirement is the need to provide a variable voltage to the track for motor speed control. This voltage control can range from a simple reostat to sophisticated transistor amplifiers that combine a voltage level and a pulse output. Adding a pulse to a steady voltage helps to overcome the inertia of the motor at low speeds. Some controllers currently available also include variable pulse width to vary the effective voltage applied to the motor.

For more information on controllers (and some other projects that may be interesting), check your nearest model shop for *Practical Electronic Projects for Model Railroaders* by Peter J. Thorne or *Electrical Handbook for Model Railroads* by Paul Mallery. In addition, electronics magazines sometimes run articles on model controllers.

Other electronics uses on the model railroad include:

1. *Sound Systems*. Miniature electronic devices are used to create circuits that make a model locomotive sound like the prototype. These frequently include steam sounds synchronized to the speed of the engine. Extremely sophisticated systems can also include

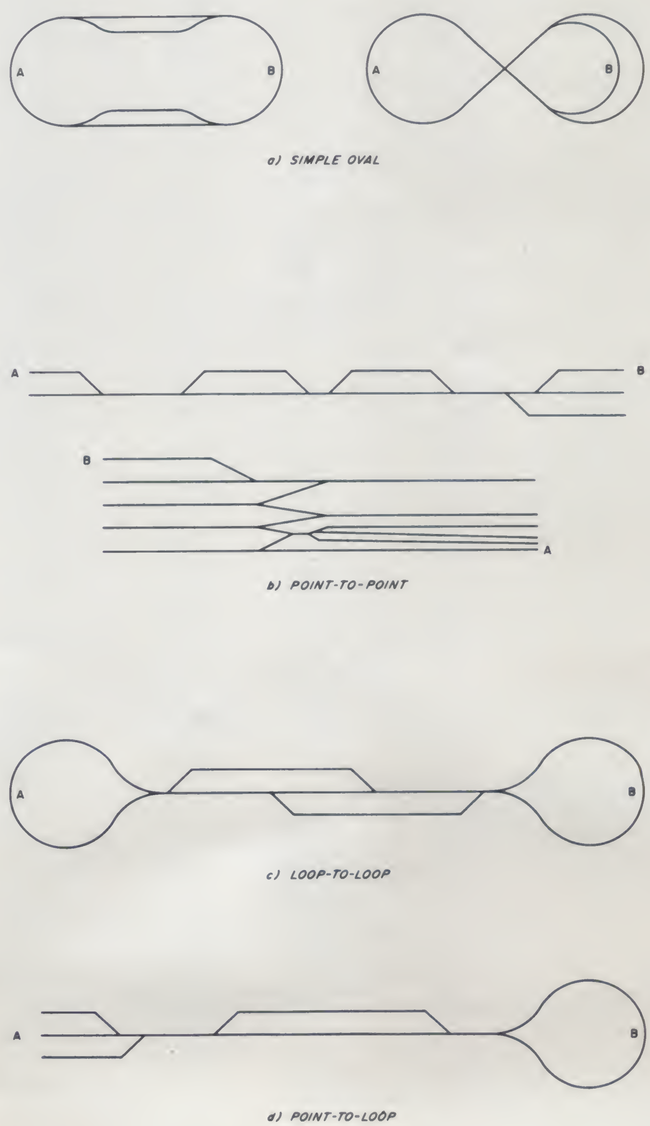


Fig. 1. Track patterns.

whistles, bells and brake sounds.

2. *High-Frequency Lighting*. The problem is to light the headlights, marker lamps and interior lights of the train with a constant brightness. Since dc motors are used in the models, a high-frequency voltage applied to the track will not affect the speed of the motor, but will light a lamp quite nicely. Isolation of the dc from the lamps may be accomplished with small capacitors; the high-frequency ac may be kept out of sensitive controllers with inductors.

3. *Fast Clocks*. Operating to a timetable doesn't seem realistic if the time between stations is only one or two minutes. Therefore, many model railroaders use a fast clock to make it seem longer. Integrated circuits can be used to make these fast clocks, which usually operate ten or twelve times faster than a normal clock.

4. *Speed Measurement*. Speed is measured essentially the same, no matter what scale you use; only the conversion factors are different. The basis for all speed measurement is the time required to travel a predefined distance. Therefore, the primary measurement is period or elapsed time.

5. *Signaling*. Two basic circuit elements are needed for signaling: first, a detection circuit to detect the presence of a train, and second, logic circuits to make up the proper combinations. More will be said about these topics later.

Operations

Some modelers may never get beyond building the layout, but those who do try some form of operations. Once again, many different methods can be considered, but all of them are attempts to imitate the prototype. Like the prototype, model railroads have many varying types of operations.

One of the first options is to decide on the type of services to be provided. Historically, the most glamorous service on any railroad was its passenger service. The best railroads always had "name trains" like the Orange Blossom Special, the Wabash Cannonball, the Empire Builder and the Super Chief. These trains were always polished and clean for the passengers. In their time, the name trains were the most luxurious means of travel available.

The bread and butter of most railroads was the freight service. Not at all glamorous, only dirty and slow, freight trains are still the major source of revenue for the railroads. They are longer and make more stops, but contain a greater variety of cars . . . so there are some advantages to freight service.

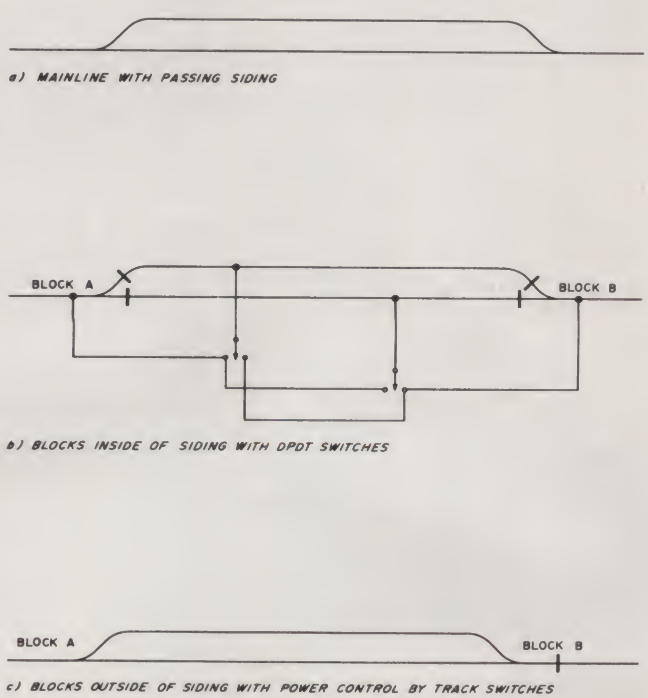


Fig. 2. Passing siding control.

Trolley and interurban service is at least partially a combination of the other two services. It combines a little bit of freight and a lot of passengers, with single cars for most of the equipment. In addition, this service uses special trackwork and, in general, runs on electricity carried by either an overhead wire or a third rail protected from accidental access.

These types of service require different forms of operation. Passenger service ordinarily includes very little picking up and setting out of cars; its primary concern is to meet the schedule published as a timetable. Freight operations, however, are mostly concerned with delivering one-to-many freight cars to the industries that need them and picking up full freight cars elsewhere. This type of operation requires a means of directing cars to and from industries, usually either by some form of paper orders or by dispatcher direction.

Some of these forms of operations are:

1. *Train Orders*. Made up for each train. These orders include explicit car sources and destinations. Each train is therefore previously determined, and cars must be set into position before the operating session begins.

2. *Timetables*. A timetable showing all the stations on the route is created. Using the average speed according to the class of the train, and arbitrary starting times, trains are scheduled to depart and arrive at the stations at specific times. The challenge of this type of operation is to make the stops at the specified times.

3. *Dispatcher-oriented Operations*. Usually based on one or both of the above. The dispatcher is able to add some variety by specifying different moves and changes to the schedule. He also assists with solutions to breakdown problems.

4. *Card Systems*. Use one card per car and a hook near each industry or place to spot cars. As each siding is reached, the cards are checked to see if a car or cars need to be dropped off or picked up. One advantage of this method is the ability to make the car movements random by simply shuffling the cards.

The above methods of providing prototypical movements are also used in model-railroad clubs. In a club environment, all the problems of operations are intensified because many more operators, with a wider range of capabilities, are available. If there is a dispatcher (and there probably must be), his job is extremely difficult because there are many more trains switching, meeting and passing. The requirements of the club dispatcher, who is doing this as a hobby, probably surpass those of the prototype. Is it any wonder that he is looking for help?

Perhaps the first way to provide help during operations is to install signals. Signaling can help at two basic levels. First, prototypical signaling indicates occupancy on the track beyond the signal. Although space does not permit a more thorough discussion of prototypical signaling, it is sufficient to say that this signaling implies permission to proceed into the next block or section of track.

The second type is dispatcher-controlled signaling. This scheme provides a means of communication with the train operators. A bank of switches for the dispatcher allows him to set the signals for each operator. This need for communication is more critical in larger layouts. For example, in an 8 x 10-foot room, voice communications are quite acceptable, but the problem of communicating with 20 operators in a club within a space of 40 x 120 feet is further complicated.

How to Make the Engine Run

After the first layout is fin-

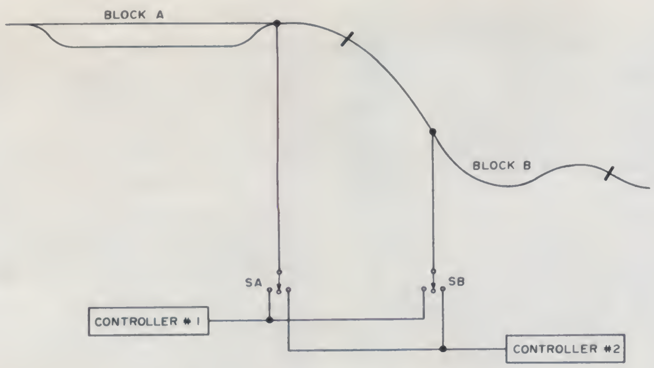


Fig. 3. Simplified cab control.

ished, hobbyists soon desire to run more than one train at a time. The problem of controlling the engine involves more than just providing a variable source of direct current. With a simple oval track, only one train may run; therefore, only one controller (the source of variable dc) is needed.

As the number of trains is increased, the number of controllers must also increase. More subtly, the layout must now be broken up into pieces or blocks to provide areas where only one controller is connected. The problem of breaking up the layout into these blocks and powering them is the subject of the following paragraphs. Note that the number of operators should be about half as many as the number of blocks in order to provide a buffer block between the trains.

Several different schemes have been devised to determine the proper places to make the block divisions. Two basic criteria should probably be used: siding or switch location, and length. In order to maximize the number of trains (thus, operators) a maximum block length should be considered. Reducing this length will allow trains to run closer together; therefore, more trains will be possible on the layout.

The problem with switches (track switches) is shown in Fig. 2. If a meet or pass is to occur on this siding, some means of changing the control is necessary. Two basic ways are shown. In the first, two external DPDT switches, usually with a center-off position, are hooked to the blocks coming into the siding. As a train comes into the siding, the operator flips the switch toward the block it is coming from. After the train is in the siding, the operator can stop from the block controller he is using, or he can continue through the siding by switching control to the block on the other end. If he wishes to stop, he can protect his train by using the center-off position to remove all power from the siding.

The biggest problem with this scheme is that it requires the use of two blocks to runaround (the movement of an engine from the front of the train to the rear or vice versa) in this siding. However, if a train is stopped in the siding to meet another train, the stopped train can start out of the siding as soon as (1) the meeting train relinquishes control of the exit block, and (2) the meeting train clears the exit switch.

The second scheme (not necessarily any better or worse) relies on the position of the track switches to switch power (controller or block) to the correct siding. (Ready-made switches frequently prevent the power from being applied to the exiting track that is not in the selected direction.) In this method, the track throughout the siding can only be controlled by one block; to leave the siding after a meet, the operator must wait until the opposing train leaves the entire block. On the other hand, a runaround movement is totally controlled by that one block.

Only one other factor needs to be mentioned before the following treatise on control methods. The final part of the puzzle is the means of controlling the direction of the track switches. Most ready-made switches do not have any switch throws to activate and change them. Electrical "switch motors" are commercially available to provide this function, or manual throws can be developed for a small cost. Layout plans and control schemes together influence the choice of the switch-throw method.

The Starting Point for Control

As noted before, the first prerequisite for multiple train control is multiple controllers. The minimum number of controllers is one per train. After controllers are obtained, blocks or sections must be determined and the track electrically isolated at these block boundaries. Then comes the problem of connecting the controllers to the blocks. The first suggested method of connection is the cab-control scheme.

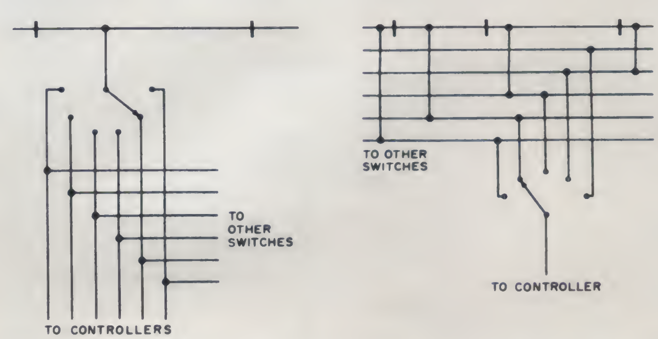
Cab control is most easily used in simple layouts where the number of simultaneous trains is less than five or six. It is most easily understood for the case of only two controllers. Cab control uses one switch per block to connect a controller to a block of track (see Fig. 3). In this example, both block A and block B are set to a center-off position. If you want to power either block, just turn the corresponding switch in the direction of the controller you want to use and the track will be connected to that controller.

If more trains (controllers) are allowed, the simple toggle switches of Fig. 3 are replaced with either rotary switches or the more expensive interlocking push buttons. Wiring such a scheme could quickly become messy, and the cost of all these switches is high. In addition, maintenance is difficult because some centralized control board will contain all of the switches and an extensive wire harness will be needed to distribute the power to the layout. A control board of this type is complicated and confusing.

Finally, an additional switch may be needed to provide initial power to a stopped train. If a rotary switch is used, as other controller positions are passed in its rotation, power from other controllers may be applied to the stopped train. This sudden application of power may result in unwanted jerks and surges, which will always cause the most damage. To avoid this reaction, a disable switch (possibly a normally closed push button) may be inserted into the block-control lead.

Advanced Concepts

The cab-control system described above is a section-oriented scheme which connects the common pole of a switch to the track section. Another orientation of these components can be arranged to connect the controller to the common-switch pole. These two versions can be compared in Fig. 4. Clearly, the number of contacts required by the two schemes depends on the number of controllers in the first case, and on the number of sections in the second case. Because of this, the second



a) SECTION ORIENTED *b) CONTROLLER ORIENTED*

Fig. 4. Cab-control techniques.

Rounding a curve near Pipestone on the Belmont Shore RR.

scheme will probably require more contacts per switch and, therefore, will be more expensive. In addition, the controller-oriented scheme can be incorrectly set to allow two controllers on the same section. This may cause a short between the two controllers or, at the least, some confusion will occur. Consequently, for proper use, the second scheme requires more care and training.

Extensions to both of these schemes have been tried. An extension to the section-oriented method is the so-called "Delaware cab control." In this scheme, the controllers are wired into a pair (or more) of rotary switches or ganged push buttons that provide a subselection function. These switches then feed the DPDT switches connected to the track sections. This scheme, which is shown in Fig. 5, is especially convenient for switching yards. The Belmont Shore Model Railroad Club has used Delaware cab control in its yards for several years.

Progressive Cab Control

One scheme that is an outgrowth of the controller-oriented technique is the route-control scheme. Route control depends on the need of trains to take specific routes, so switches should take on specific settings in a predetermined sequence. Furthermore, it is advantageous to have two sections connected to the same controller because this makes the transition between these sections much smoother.

The concept of progressive cab control is to make the switching function of route control automatic. The heart of this system is the automatic switch (it may be a stepping switch, but it must be bidirectional). Various technologies have been proposed, but all of them are quite complicated in one way or another (remember, computers are good at complicated decisions).

Walkaround Control Seeing Your Train

Although it may seem that no other methods are required to adequately control a model train, one other consideration indicates something more is required. In a large layout, such as the one being built by the Belmont Shore Club in Los Angeles, approximately 3000 square feet will be filled with an N-scale layout. In this amount of space, ability to see your train becomes very important. Therefore, some means of walking with a train is required.

Probably the most common way of providing walkaround control is to provide a controller for each block of track. This controller may either be mounted permanently in front of the block to be controlled, or be attached to a flexible cable for additional mobility. This is not really walkaround control in the most general sense, but a form of traveling cab control where the operator moves between controllers.

It must be noted that walkaround control puts some additional constraints on the layout design. Particularly, the aisles must be carefully planned to allow operator traffic. However, the total cost of construction is reduced because of the reduced wiring, as well as the possible elimination of electrical switch machines.

What Can a Computer Do for This Mess?

With the above background information on model railroading, perhaps enough concepts have been covered to enable a discussion of possible computer applications. The major reason I became interested in computer control of model railroads was because it provides an opportunity to mix my vocation (computer science) with my avocation (model railroading); I expect that there are many others like me. My views are biased, however, by my club environment, so the system and concepts presented here are probably best suited to a club. Clearly, the development of this level of system is a major task, so the following represents the rather extensive research that has gone into planning such a system.

One concept which has been used for displays and promotional shows is the totally automatic operation. By providing a complete control system by computer, no human operators are required. Although this is interesting to watch and fascinating to program (once), it does seem rigid and it takes all the fun out of running a train. In addition, if something happens, like a derailment or a stalled dirty engine, the schedule gets all screwed up. As a

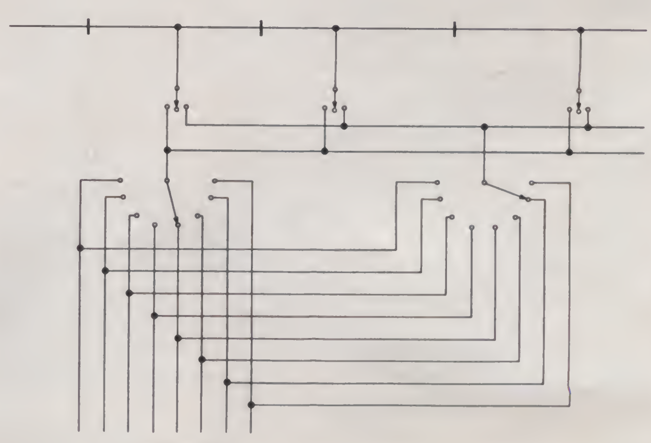


Fig. 5. Delaware cab control.

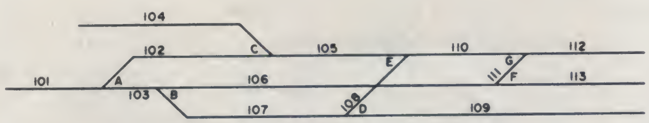


Fig. 6. Assignment of block and switch identification.

consequence, most model railroaders would rather control the system manually.

The most useful application of a computer is as an automatic switching controller. The process of switching power to track sections is totally foreign to the prototype and a great nuisance in the model. Therefore, I have adopted the following system for computerized power control. I call the system "walkaround progressive control."

In this system, the complicated connection decisions are performed by the computer, while the speed control, route control and direction are determined by the operator. This allows you to fully control your train, without being bothered by the problem of which electrical switch to throw to connect your controller to a piece of track. All you have to do is align the track switches in the proper direction to tell the computer which route you have chosen. The computer will then use this information to connect your controller (either logically or physically) to the proper blocks of the layout.

The biggest question to be answered in the walkaround progressive control system is how to provide the power-switching function. Even though a switching matrix could be devised, this is probably more trouble than it is worth. If you build a system capable of controlling O-scale trains, the switching matrix will have to handle at least 3 Amps; even in N scale, a minimum of 1 Amp is required. These currents will probably require relays that are inherently less reliable than semiconductor systems. The number of relays required for the most general case would be NxM, where N is the number of blocks and M is the number of controllers—probably a very expensive quantity of relays.

A more reliable approach is to use the computer as a transponder to receive the speed information from the operator's controller and then transmit this information out to a selected power controller connected to a track block. This could be implemented by using the input ports of a microcomputer as the connection to the operator's control (perhaps through an A-D converter) and the output port (through a D-A converter) as the section control signal. This requires some form of section controller for each block of track, as well as an operator control box for each operator.

Some of the circuitry required for such a system is quite unique and is covered in the circuitry section below. However, the following requirements are reasonably simple to satisfy and may even be software requirements:

1. In order to associate an operator (or controller) with a particular block of track, three pieces of data must be known: the initial assignment of the controller to track section; the identification of the operator (or controller); the direction of the track switches that determine the route to be taken. With these data known, an internal table can be maintained to associate a particular track section with a controller. This table represents the track layout with an indication of the connections between the sections and the switch conditions that lead to a different section. The table will therefore be partially constants and partially dynamic data.

The track layout will be assigned numbers like those in Fig. 6. These numbers will then become the offset into a table such as that shown in Fig. 7. The table is used as a definition of the layout and a decision matrix to determine the next section to be used. If, for example, the train is in section 103, and is heading to the right, the setting of switch B will determine the next section. If the train proceeds into 107, switch D is the determining switch for the next section. This table-driven logic is relatively easy to program and very simple to modify if physical track modifications are made.

2. Initial assignment of track section to operator is done only once per run and therefore could be a console operation. A command is entered to associate these variables for initialization.

3. Track switch direction is potentially the easiest data to acquire because each switch should be equipped with some type of throw mechanism, anyway. A microswitch or other contact should be added to provide the direction information. In Figs. 6 and 7 all switch directions are defined from the single track towards the double tracks. Similar definitions will aid the system development by making it more understandable.

4. Operator/controller identification can be obtained in several ways. The actual implementation of associating an operator with a controller with a train depends on two factors: how much movement will be required of the operators, and how much money is available. Four different concepts, ranging from simple to difficult, are explored below.

- The first possibility for controller location is the traditional method of putting all the operators together in one place. If the previously mentioned problem of being able to see the train is ignored, the connection to the computer can be short; the identification can be simple; and it doesn't change during the session. With the proximity of the operators to the computer, all sorts of information can be displayed to the operators. With some minor effort, the operator can end up with a console that might rival a jet airplane cockpit. At that point, the layout itself might become unnecessary, and the computer can simply give the illusion of trains running (remember, you can't see the trains anyway).
- The second possibility is to use a walkaround method like that previously discussed. Although long, the computer connections are straightforward, and at least the operator will be able to see the train. The primary problem is the continual redefinition of the operator-

Current Track Section	Right End Switch	Section to Left	Section to Right	Left End Switch	Section to Left	Section to Right
101	A	102	103	-	-	-
102	C	105	0	A	101	0
103	B	106	107	A	0	101
104	C	0	105	0	0	0
105	E	0	110	C	102	104
106	F	111	113	B	103	0
107	D	108	109	B	0	103
108	E	110	0	D	107	0
109	-	-	-	D	0	107
110	G	0	112	E	108	105
111	G	112	0	F	106	0
112	-	-	-	G	111	110
113	-	-	-	F	0	106

Fig. 7. Layout definition table.

controller relationship. As the operator moves, he must redefine which train the controller is supposed to be controlling. This may be rather bothersome, particularly when the operator is in a hurry.

- The assignment of a train to a controller would be much simpler if the assignment was only necessary at the start of the session. If the controller is carried with the operator throughout the session, no redefinition is necessary. The first and simplest way of doing this is to attach the controllers to the computer through a cable which may be plugged into any one of several receptacles scattered all over the layout. This is similar to the fixed controllers described above, except that the identification is made through internal jumpers in the portable box. A small software capability is necessary to maintain smooth operation during the time that the controller is not connected to the computer because the operator is walking between receptacles.
- The second portable controller scheme is the only one that provides true, full walkaround capability. If the previous scheme is used with a transceiver instead of a plug-in cable, then no restrictions are imposed on the operator location. Identification is by transmitter frequency, which is also an initial condition to be set only once. Each controller has to have its own transmission frequency to avoid interference and timing problems, but data transmitted back to the controller could all be transmitted on one frequency. Fortunately, very low power can be used since an "antenna" could be wrapped around the room to provide a short-distance transmission.

The alternative chosen will determine the hardware and software requirements for identification. The alternatives listed are arranged in increasing complexity, increasing cost and increasing flexibility.

5. It is convenient if information is passed to the operator in order to identify errors and other conditions. Error lamps on the controllers can aid the quick identification of error conditions. The exact method of transmitting this information is dependent on the implementation details in the previous discussion.

6. Certain prototypical characteristics, such as overcoming inertia during start-up, overcoming momentum to stop and power-load effects, require a timed acceleration and deceleration. Rather than using expensive controller circuitry to provide these functions, the microcomputer could provide a slow-speed change, in spite of how fast the operator makes the change. This feature and its degree of complexity may be one of the inputs in the initialization for the operator. It is clear that not all operators desire these features or are capable of using them.

With this concept of how to run the train, are there any other advantages to this control system? Well, yes . . . if your situation is anything like ours at the Belmont Shore Club, there will be times when not enough people are around to run all the trains specified by the schedule. If this happens, why not build in the programming logic to run those trains which run on a time schedule? I know I said that the automatic operation of trains is no fun, but a mixed-mode operation helps provide the passes and meets necessary to liven up a session with too few human operators. In addition, it will be an extremely interesting programming exercise.

What about disadvantages? None . . . unless you consider equipment failure (it will always happen either when a show is being presented or when the least technical person is alone with the system) and maintenance (whoopee, look at all that circuitry and wire). Well, maybe you can convince yourself (and your club, if it is a club layout) that it will be a much better system (which it will be).

And now that the computer is in, how else (besides Star Trek) can I use it? An additional function that is essentially a fallout of the control system above is signaling. As stated before, signaling is a means of warning a train operator of occupancy on the block or blocks ahead of him. This is accomplished by changing the position of a semaphore arm, changing the color of a searchlight or turning on a different colored lamp in a stoplight fixture. The information required to determine the correct mode is stored in the occupancy table described above. For more information on the meanings of the various modes, get a copy of *All About Signals* (Kalmbach Publishing).

And while we are on the subject of occupancy of tracks ahead, can we do something to avoid operator errors that may bring about collisions? Certainly, the computer can simply stop the train (or trains) before the collision. This function is related to the concepts of automatic stopping blocks and interlocks (mentioned previously). The same principle applies to trains heading for a track switch turned against the approach direction. This condition is detected by pointing to a zero in the columns of Fig. 7.

Two possible solutions can be tried—either stop the train or change the switch setting. These solutions are not quite that simple (what if another train is sitting directly over the switch?), but with the appropriate programming and circuits, they would save a lot of derailments.

Another valuable feature, mentioned earlier, is speed detection. Several such circuits have been devised to work with analog detectors or digital counters; but if a computer were available, it would be able to do the calculations necessary to turn a time interval into speed. More on this topic later.

An intriguing application is the control of a "hump" yard (a gravity-powered selection and sorting yard). In the prototype, the hump yard is a popular means of sorting and grouping cars bound for the same destination. A typical configuration (not necessarily accurate or complete) is shown in Fig. 8. As a string of cars is pushed over the crest of the hill (the hump), they are uncoupled and start to roll down into the selection tracks. After they leave the hump, a speed modification is necessary to allow for varia-

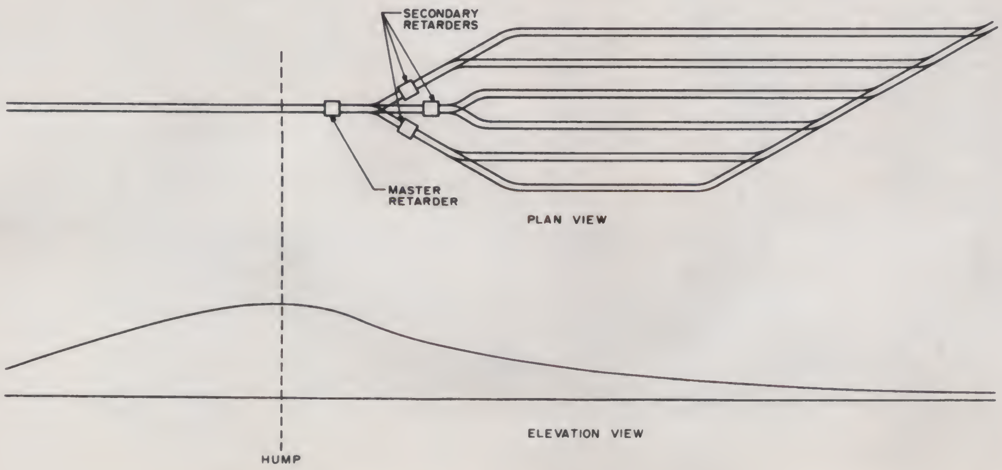


Fig. 8. A hump yard.

tions in rolling quality and the number of cars already on the selected track (the distance to roll). In addition, the proper switches must be thrown to direct the car to the appropriate track.

In a model, everything is shortened and speeded up; therefore, human reaction times are generally inadequate to do a good job of speed control because the time between release (uncoupling) and the point of speed control is probably shorter than a human's reaction time. A microcomputer would therefore be a good way to control the speed. It should also be noted that, although the prototype used only retarders, the model may also require acceleration.

The required circuitry for this application is similar to the circuits required above. Speed detection and car location are the primary requirements. To provide the retard/accelerate function, two basic ideas may be practical. First, an easily controlled form is compressed air blowing either at the front or the rear of the car. The major concern about this method is blowing the car off the track. Also, the end geometry of a car varies considerably depending on type—all the way from a flat car to a hi-cube boxcar.

A second possibility relies on a special type of coupler or, at least, enough magnetic material to be attracted by an electromagnet. I have neglected to mention the uncoupling mechanism as a problem because there exist automatic couplers that uncouple when a magnetic field is below them. These couplers rely on a small piece of wire projecting downward to a level very close (0.010 inch) to the track. Although this wire is small, magnets have been observed to attract it sufficiently to pull a car. A computer-controlled electromagnet could attract this wire to either accelerate by turning on ahead of the car or to retard by turning on after the car. The uncoupling of each car at the hump would be provided by a static magnet.

With this hump yard working at full capacity, the hump-yard controller could be a time-consuming load on the microcomputer. A separate micro of the RCA 1802 or National SC/MP class might be necessary to support the yard operations.

Almost all prototypical yards in the days of steam locomotives included a roundhouse. The roundhouse was a combination storage building and maintenance shop, contained in an economical shape. The means of access to the roundhouse was a rotating bridge or turntable. Some means of rotating the turntable is required to model this feature.

Of course, manual drives are used widely for rotation, but a more sophisticated technique is to use a microcomputer to select the shortest distance to move the turntable, adjust the speed to slow down as the proper position is approached and stop at the point that matches the selected track.

The only special requirement that has not been previously discussed is a rotational position sensor. Probably the easiest means of rotational position determination is an optical sensor consisting of six to eight photo detectors with a clear plastic disk such as the one shown in Fig. 9. If the disk is attached to a shaft, the photo detectors will sense the light coming through the clear areas and will return a binary number to represent the shaft position.

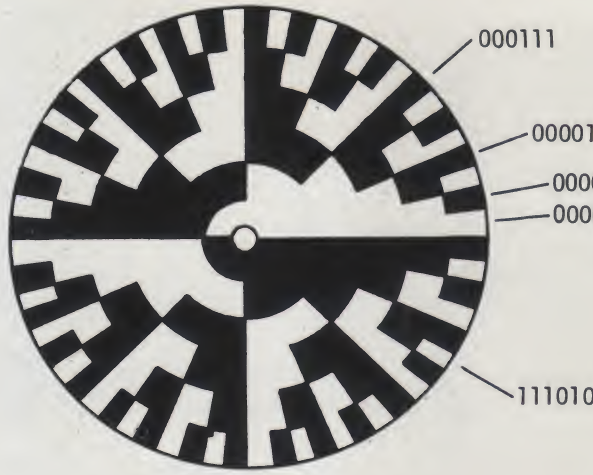


Fig. 9. Optical rotation sensor.

Now that we have provided a control system and operating aids, we should be ready for operation. To do that, we must remember that there are numerous schedules to make up. A program could be run in an off-line mode to create (or at least aid in the creation, like a word-processor) schedules. Scheduling is basically an iterative process to fit trains into time periods at certain speeds. This is just another interesting problem to be solved with a computer.

In the second part of this article, the specific circuits required to implement this system will be described in detail.■

Revolving Charge Account Calculations

This business-applications article can be utilized not only by businessmen, but by hobbyists . . . and just about everyone.

Len Gorney
Box 96 R.D. 1
Clarks Summit PA 18411

In this day and age, credit cards and revolving charge accounts are as much a part of our lives as television sets and automobiles. In fact, your car or another major item was probably purchased on some kind of time-payment plan.

Do you know the time or amount of that loan or purchase? Well, now you can have your micro give you that information before you purchase an item or borrow money for a planned purchase. The following program listing should be a useful addition to your program library. Maybe the small businessman down the block will find it useful, too.

The program calculates the various values for a typical monthly revolving charge account. You input the necessary values—the amount of the loan or purchase, the monthly interest rate, the monthly payment amount, the month and year the loan or purchase was taken and the minimum interest charge before a service charge is applied.

If everything is input properly, your machine will output the monthly values for the beginning and ending balance of your account, the monthly and cumulative interest charges and a monthly and yearly indicator to show you just how long you'll be paying.

The REM statements of the program listing should put you well on your way with this program. If your BASIC supports strings (the month and service charge variables) and the PRINT USING statement (for pretty-looking output), then you can load and go as the program is listed.

However, if you don't have strings or the option for aligned printing, then you'll have to make a few minor changes to the original listing. First, use the month number rather than the string variable M$. Second, use a plain PRINT statement for the service charge, S$. Third, use a plain PRINT in place of the PRINT USING statement. The output won't be lined up as neatly, but the values will be correct.■

Program listing of revolving charge.

```
100  REM  REVOLVING CHARGE ACCOUNT
110  REM  LEN GORNEY
120  REM
130  REM  VARIABLE NAME DESCRIPTION
140  REM        A  AMOUNT OF CREDIT DESIRED
150  REM        B  BEGINNING OF MONTH BALANCE
160  REM        C  CUMULATIVE MONTHLY INTEREST
170  REM        E  END OF MONTH BALANCE
180  REM       M$  MONTH NAME
190  REM        N  MINIMUM INTEREST CHARGE
200  REM        P  MONTHLY PAYMENT
210  REM        R  MONTHLY INTEREST RATE
220  REM       S$  SERVICE CHARGE
230  REM        T  TOTAL AMOUNT PAID TO DATE
240  REM        V  MONTHLY INTEREST
250  REM        Y  YEAR
260  REM       Y2  MONTH
270  REM
280  REM  LINE NUMBER ACTION
290  REM  1000 TO 1200 INPUT VARIABLES
```

```
RUN
ANSWER Y IF YOU WANT INSTRUCTIONS ANSWER N IF NO INSTRUCTIONS ? Y
PROGRAM WILL CALCULATE INTEREST CHARGES FOR A REVOLVING
CHARGE ACCOUNT. HERE IS THE INFORMATION YOU MUST INPUT

FORMAT OF INPUT VARIABLES IS AS FOLLOWS
A D IS A DOLLAR VALUE, A C IS A CENTS VALUE
A % IS A PERCENTAGE VALUE, M IS FOR MONTH, Y IS FOR YEAR

AMOUNT OF LOAN/CREDIT DESIRED INPUT AS DDDD.CC
TO STOP PROGRAM INPUT A ZERO VALUE (0)
MINIMUM INTEREST CHARGE INPUT AS DD.CC
IF NO SERVICE CHARGE ATTACHES INPUT A ZERO VALUE (0)
MONTHLY INTEREST RATE INPUT AS %%.%%
MONTHLY PAYMENT INPUT AS DD.CC
MONTH AND YEAR PROGRAM BEGINS CALCULATIONS
INPUT AS MM,YYYY
ONLY ENTER NUMERIC VALUES FOR ALL OF THE ABOVE


RUN
INPUT CREDIT AMOUNT DESIRED ? 100.00
INPUT MINIMUM INTEREST CHARGE ? 0.50
INPUT MONTHLY INTEREST PERCENTAGE RATE ? 1.5
INPUT MONTHLY PAYMENT ? 20.00
INPUT THIS MONTH AND YEAR ? 06,1977
YOUR CREDIT FOR $100.00 HAS BEEN APPROVED

DATE  BEGINNING    END     MONTHLY   CUMULATIVE   TOTAL
       BALANCE   BALANCE   INTEREST   INTEREST     PAID

JUN
1977   100.00     80.00      0.00       0.00       20.00
JUL
1977    81.20     61.20      1.20       1.20       41.20
AUG
1977    62.11     42.11      0.91       2.11       62.11
SEP
1977    42.74     22.74      0.63       2.74       82.74
OCT
1977    23.24      3.24      0.50       3.24      103.24
       SERVICE CHARGE APPLIED TO ABOVE
NOV
1977     3.74      0.00      0.50       3.74      106.98
       SERVICE CHARGE APPLIED TO ABOVE
```

Sample output of revolving-charge program.

```
300  REM  1000 TO 1020 INPUT AMOUNT OF CREDIT DESIRED
310  REM  1040 TO 1060 INPUT MINIMUM INTEREST CHARGE
320  REM  1070 TO 1090 INPUT MONTHLY INTEREST RATE
330  REM  1100 TO 1160 INPUT MONTHLY PAYMENT
340  REM  1170 TO 1180 INPUT MONTH/YEAR PURCHASE/LOAN IS MADE
350  REM  1210 TO 1260 INITIALIZE VARIABLES
360  REM  1210         MONTHLY INTEREST RATE
370  REM  1220         TOTAL AMOUNT PAID TO DATE
380  REM  1230         MONTHLY INTEREST PAID
390  REM  1240         CUMULATIVE MONTHLY INTEREST PAID
400  REM  1250         BEGINNING BALANCE
410  REM  1260         END OF MONTH BALANCE
420  REM  1270 TO 1290 OUTPUT HEADING
430  REM  1300         OUTPUT LINE OF INFORMATION
440  REM  1320         CALCULATE THIS MONTH'S INTEREST
450  REM  1330 TO 1350 APPLY SERVICE CHARGE WHEN
460  REM               MONTHLY INTEREST DUE IS LESS THAN
470  REM               MINIMUM INTEREST CHARGE
480  REM  1360         TALLY CUMULATIVE MONTHLY INTEREST PAID
490  REM  1370         CALCULATE NEXT MONTH'S BEGINNING BALANCE
500  REM  1380 TO 1400 INCREMENT MONTH COUNTER
510  REM  1410         BRANCH TO 1500 WHEN BEGINNING BALANCE
520  REM               IS LESS THAN MONTHLY PAYMENT, I.E., PAY
530  REM               BEGINNING BALANCE AND CLOSE ACCOUNT
540  REM  1420         CALCULATE THIS MONTH'S ENDING BALANCE
550  REM  1430         TALLY TOTAL AMOUNT PAID TO DATE
560  REM  1440 TO 1470 INCREMENT MONTH COUNTER TO NEXT MONTH
570  REM  1480         OUTPUT LINE OF INFORMATION FOR THIS MONTH
580  REM  1490         GO TO CALCULATION OF NEXT MONTH'S CHARGES
590  REM  1500 TO 1520 PAY OFF REMAINING BALANCE
600  REM  1530         OUTPUT LINE OF INFORMATION
610  REM  1540         GO TO ENTER NEW INPUT DATA
620  REM  1550 TO 1610 OUTPUT LINE OF INFORMATION ROUTINE
630  REM  1620 TO 1960 DETERMINE MONTH NAME ROUTINE
640  REM  1980         STOP/END PROGRAM
650  REM
660  REM  PROGRAM STARTS EXECUTING FROM LINE NUMBER 700
670  REM
680  REM
690  REM
700  PRINT"ANSWER Y IF YOU WANT INSTRUCTION, ANSWER N IF NO INSTRUCTIONS";
710  INPUT I$
720  IF I$ = "N" THEN 1000
730  PRINT"PROGRAM WILL CALCULATE INTEREST CHARGES FOR A REVOLVING"
740  PRINT"CHARGE ACCOUNT. HERE IS THE INFORMATION YOU MUST INPUT"
750  PRINT
760  PRINT"FORMAT OF INPUT VARIABLES IS AS FOLLOWS"
770  PRINT"A D IS A DOLLAR VALUE, A C IS A CENTS VALUE"
780  PRINT"A % IS A PERCENTAGE VALUE, M IS FOR MONTH, Y IS FOR YEAR"
790  PRINT
800  PRINT"AMOUNT OF LOAN/CREDIT DESIRED INPUT AS DDDD.CC"
810  PRINT"TO STOP PROGRAM INPUT A ZERO VALUE (0)"
820  PRINT"MINIMUM INTEREST CHARGE INPUT AS DD.CC"
830  PRINT"IF NO SERVICE CHARGE ATTACHES INPUT A ZERO VALUE (0)"
840  PRINT"MONTHLY INTEREST RATE INPUT AS %%.%%"
850  PRINT"MONTHLY PAYMENT INPUT AS DDD.CC"
860  PRINT"MONTH AND YEAR PROGRAM BEGINS CALCULATIONS"
870  PRINT"INPUT AS MM,YYYY"
880  PRINT"ONLY ENTER NUMERIC VALUES FOR ALL OF THE ABOVE"
890  PRINT
1000 PRINT"INPUT CREDIT AMOUNT DESIRED";
1010 INPUT A
1020 IF A<=0 THEN 1970
1030 PRINT"INPUT MINIMUM INTEREST CHARGE";
1040 INPUT N
1050 IF N<0 THEN 1030
1060 S$ = "NO"
1070 PRINT"INPUT MONTHLY INTEREST PERCENTAGE RATE";
1080 INPUT R
1090 IF R<=0 THEN 1070
1100 PRINT"INPUT MONTHLY PAYMENT";
1110 INPUT P
1120 IF P<=0 THEN 1100
1130 IF P<A THEN 1170
1140 PRINT"FULL CREDIT PAID OFF IN FIRST MONTH"
1150 PRINT"NO INTEREST CHARGES APPLIED. THANK YOU!"
1160 GO TO 1000
1170 PRINT"INPUT THIS MONTH AND YEAR";
1180 INPUT Y2,Y
1190 PRINT
1200 PRINT"YOUR CREDIT FOR $";A;" HAS BEEN APPROVED"
1210 R = R/100
1220 T = P
1230 V = 0
1240 C = 0
1250 B = A
1260 E = A - P
1270 PRINT
1280 PRINT"DATE  BEGINNING    END     MONTHLY  CUMULATIVE  TOTAL"
1290 PRINT"        BALANCE  BALANCE  INTEREST   INTEREST    PAID"
1300 GO SUB 1550
1310 PRINT
1320 V = E * R
1330 IF V>N THEN 1360
1340 V = N
1350 S$ = "YES"
1360 C = C + V
1370 B = E + V
1380 IF Y2<=12 THEN 1410
1390 Y2 = 1
1400 Y = Y + 1
1410 IF B<P THEN 1500
1420 E = B - P
1430 T = T + V + P
1440 Y2 = Y2 + 1
1450 IF Y2<=12 THEN 1480
1460 Y2 = 1
1470 Y = Y + 1
1480 GO SUB 1550
1490 GO TO 1320
1500 T = T + B
1510 E = 0
1520 PRINT
1530 GO SUB 1550
1540 GO TO 1000
1550 PRINT
1560 GO SUB 1620
1570 PRINT"  ";M$
1580 PRINT USING" #### ####.## ####.## ####.## ####.## ####.##";Y,B,E,V,C,T
1590 IF S$ = "NO" THEN 1610
1600 PRINT TAB(23);"SERVICE CHARGE APPLIED TO ABOVE"
1610 RETURN
1620 IF Y2<12 THEN 1650
1630 M$ = "DEC"
1640 RETURN
1650 IF Y2<11 THEN 1680
1660 M$ = "NOV"
1670 RETURN
1680 IF Y2<10 THEN 1710
1690 M$ = "OCT"
1700 RETURN
1710 IF Y2<9 THEN 1740
1720 M$ = "SEP"
1730 RETURN
1740 IF Y2<8 THEN 1770
1750 M$ = "AUG"
1760 RETURN
1770 IF Y2<7 THEN 1800
1780 M$ = "JUL"
1790 RETURN
1800 IF Y2<6 THEN 1830
1810 M$ = "JUN"
1820 RETURN
1830 IF Y2<5 THEN 1860
1840 M$ = "MAY"
1850 RETURN
1860 IF Y2<4 THEN 1890
1870 M$ = "APR"
1880 RETURN
1890 IF Y2<3 THEN 1920
1900 M$ = "MAR"
1910 RETURN
1920 IF Y2<2 THEN 1950
1930 M$ = "FEB"
1940 RETURN
1950 M$ = "JAN"
1960 RETURN
1970 STOP
1980 END
1990 REM  END OF PROGRAM
```

A Tour of the Faire (Part 2)

Editor John Craig concludes his look at the San Jose show with more of the people and products involved.

John Craig

I hope you had a good time touring the Second West Coast Computer Faire with me last month. There was a lot to show you . . . and I'm afraid I didn't have enough space last time. As it is, I can't show you everyone or everything, but this time around we're going to finish up the tour with four more pages of sights of the Faire. ■

Whew! Talk about impressive-looking displays! Information Terminals Corporation had their full line of Verbatim minidisks, cassettes, data cartridges and standard diskettes on display for dealers and OEM customers. 323 Soquel Way, Sunnyvale CA 94086.

Peripheral Vision has some nice software offerings these days (PHIMON along with their S-100 Phi-deck system . . . and a word processing system). They also have a new printer in the low-cost range. 1031 W. Center, PO box 6267, Denver CO 80206.

Here's a unique "pairing up." The folks from Mountain Hardware (Box 1133, Ben Lomond CA 95005) were demonstrating their remote-control system (through your house wiring) along with Heuristics, Inc. (Box B, 900 N. San Antonio Rd., Los Altos CA 94022) and their fantastic speech-recognition system (with SpeechBasic).

Creating data bases . . . that's what it's all about, right? Computer Headware has a $20 book with listings and instructions for developing your own data-base system, or for $60 you can get the book and a North Star diskette of the program. Box 14694, San Francisco CA 94114. (The package is called "Whatsit?".)

PET expansions! They seemed to be everywhere! Convenience Living Systems, 648 Sheraton Dr., Sunnyvale CA 94087, has a RAM/EPROM/I-O expansion board for the PET that has too many configurations and options to list here. Drop Dick Tobey a line and see if CLS has what you're looking for.

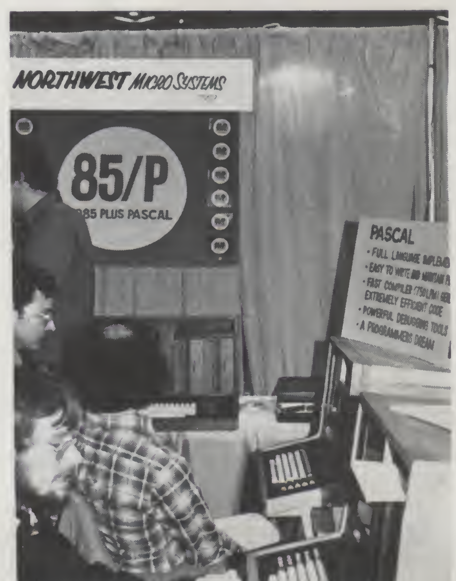
Shelley Howard (the gentleman behind the counter), president of Micro Computer Devices, would like to hear from you if you're considering a Selectric for your system (his is called the SELECTERM). He has the interface and terminals to make the whole thing a snap! (Be sure to catch Sheila Clarke's article in the May issue of Kilobaud *. . . and see if you don't agree.) 960 E. Orangethorpe, Bldg. F, Anaheim CA 92801.*

Community and intercommunity networks are the wave of the future. If you have a PET and want to get started communicating with other PET owners over land lines, the Net Works may have what you're looking for. They have an IEEE-488 low-speed modem, which has Auto Originate/Answer and pulse dialing (and more), for $320 assembled. Drop 'em a line and ask about their options, partial kits, etc. 5924 Quiet Slope Dr., San Diego CA 92111.

If you don't have the latest copy of "Periodical Guide for Computerists" (an index to all the hobbyist and professional computer magazine articles), then drop a line to Eldon Berg, the publisher (the smiling gentleman in the background), and ask for a copy; but be sure to enclose $5 with the request! 1360 SW 199th Court, Aloha OR 97005.

That's IC Master *publisher, Manley Ludwig, discussing his all-in-one IC reference book with one of* many *customers . . . they were going like crazy! And . . . at 55 bucks a whack! 645 Stewart Ave., Garden City NY 11530.*

Can you think of many things that are more fun than speech recognition and control with a computer? If you haven't seen it demonstrated, then, by all means, do it! (Actually, I think we'll see it applied to a lot of practical applications as the years go by.) Phonics, Inc., has a new S-100 board that you should see demonstrated (which is the only way to buy a speech recognition or speech synthesizer board!). Ask 'em where you can find a dealer: POB 62275, Sunnyvale CA 94086.

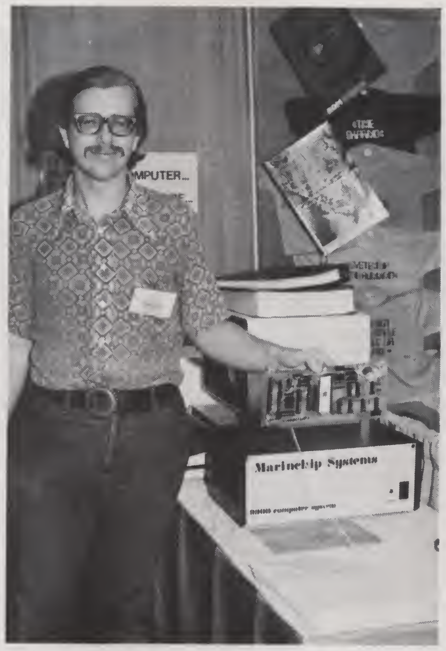


PASCAL! The excitement and interest generated at this show over PASCAL was incredible! And most of the excitement was generated by the folks from Northwest Microcomputer Systems and their 8085-based system, which has a full-blown PASCAL Compiler/Interpreter— and CP/M. Gordon Staley, one of their sharp tech writer/programmers, will be generating an article on PASCAL for us in the near future. 121 East Eleventh, Eugene OR 97401.

The PolyMorphic 8813 and their super DOS is finding its way into many homes and small businesses . . . for a very good reason: quality. If you haven't seen it demonstrated then head for your nearest computer store without delay! Bob Martin, Poly's Software Vice-President, is shown in the photo above demonstrating the improvements to their text editor and BASIC to Wayne Green, Kilobaud's publisher. PolyMorphic Systems, 460 Ward Drive, Santa Barbara CA 93111.

There's Mark Garetz, Kilobaud author extraordinaire . . . and owner of HUH Electronic Music Productions. Guess what they've got for you PET owners? Yep, an S-100 interface! Sells for $199.95 kit and $279.95 assembled. They have other PET products you might want to check into . . . and a kit for upgrading the SOL-20 to a Z-80. PO Box 259, Fairfax CA 94930.

Kids! Have you ever noticed how they have a tendency to tie up computers? (I know, I've got five of 'em!—Kids, that is.) Anyway, this young man was having quite a ball with Summagraphics' Intelligent Digitizer. Their 11 x 11 inch Bit Pad sells for $555 . . . and I sure would like to see an article on applications . . . any takers? 35 Brentwood Ave., Box 781, Fairfield CT 06430.



Aha! Another 16-bitter! Designer John Walker is standing next to Marinchip Systems' new S-100 system built around Texas Instruments' TMS 9900 16-bit microprocessor. They're offering a BASIC, assembler, text editor, linker, debugger . . . and more coming down the line. The CPU board will be selling for $550 kit or $700 assembled . . . and includes a diskette with all the software. 16 Saint Jude Rd., Mill Valley CA 94941.

You won't find the word powerful used too much in Kilobaud . . . but when I think of the hardware/software combination that has been put together in Alpha Microsystems' AM-100, it's the first word which comes to mind! The only way for the word to take on any real meaning for you is to get a demonstration of what their 16-bit, disk-based system can do. If you're seriously looking at business systems, it'll be worth the effort to find a dealer carrying the system. At the least, drop John French (the distinguished gentleman on the left) a line and ask for more info: 17875 Sky Park North, Suite N, Irvine CA 92714.

Floyd Hill, marketing VP of Vector Electronic Co., Inc., has temporarily unseated Elizabeth Brody (on the left) from her regular job of demonstrating their fantastic Slit-N-Wrap wire-wrapping tool. (Actually, she was doing it better!) That's Erich Pfeiffer, one of Kilobaud's authors, looking over Floyd's right shoulder. Why don't you send off for Vector's short form catalog? Lots of hardware for you home-brewers! 12460 Gladstone Ave., Sylmar CA 91342.

Larry Page, hidden behind the gentleman on the right, can take care of your wirewrap needs with precut kits, bulk, sockets, tools and more. (It's really no great loss that he didn't show up in the photo; his fiancée is much better looking!) Page Digital Electronics, 135 E. Chestnut St. 4A, Monrovia CA 91016.

Bob Ulrickson, president of Logical Services, Inc., and Pat Jarrett were selling Modu-Learn home-study courses like hotcakes! (At a previous show they had to fly in more because they ran out!) If you want to learn programming from the ground up, using structured techniques, this would be a good way to spend $49.95 (plus $2 shipping and 6 percent tax for Californians). PO Box 60968, Sunnyvale CA 94088.

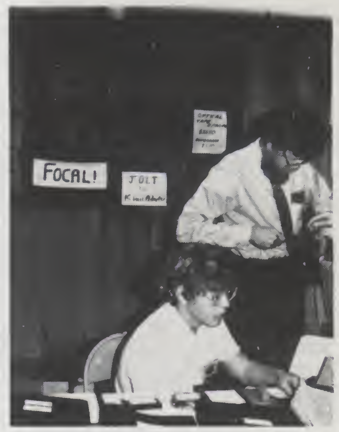
Oh, boy! This is a hot one! Roger Marcus, on the left, and Chuck Ryan were demonstrating Star Systems' do-it-yourself data-base system. The package is broken up into 3 sections; you develop the form *for your particular data base (accounts receivable, payroll, mailing lists, inventory or whatever), then* create *the file on the disk, then* input *the data (with automatic tabbing to each field). Watch the pages of* Kilobaud, *folks. We're certainly going to have an article on this one. (By the way, Roger and Chuck are developing it for PolyMorphic's 8813, North Star and CP/M.) 12 East Sola, Santa Barbara CA 93101.*

Micromation's EXP floppy system is well named. The EXP undoubtedly stands for expansion. *The drives can be converted to double heads and the controller can be modified for double density (both at additional cost, of course). And . . . they offer CP/M and Electric Pencil II for the system. 524 Union St., San Francisco CA 94133.*

That's Ronald Surratt of Future Business Systems (783 Acacia, Suite C, Goleta CA 93017), and they also have some business software for the Alpha Micro AM-100 . . . as you can see from the sign in the background.

Objective Design has a new programmable character-generator board (S-100) that generates some rather spectacular graphics and sells for $149.95 assembled and tested. PO Box 20325, Tallahassee FL 32304.

So where was Anny? They told me she had stepped out, but because of the large crowds was unable to get back into the booth. Believe me, it doesn't take a good-looking young lady (cartoon or not) to attract computerites to a Tri-Tek booth; they have some of the best buys anywhere on components. See their ads in Kilobaud *if you don't believe me!*



If you 6502 owners aren't getting the "6502 Program Exchange" newsletter, then stuff $1 in an envelope and send for a copy! Donald Marsh, on the left, is the president of the company, and his father, David Marsh, is vice-president (how's that for a switch?). 2920 Moana, Reno NV 89509.

Computer stores, system designers, industrial users . . . if you're in the market for an S-100 logic analyzer then check into the models being offered by Paratronics, 800 Charcot Ave., San Jose CA 95131.

Telpar has a new thermal printer (very quiet), which is 48 columns wide and has four interfaces (TTL parallel and serial, 20 mA, RS-232). The print quality looked very nice . . . and so did the price of $666. 4132 Billy Mitchell Rd., PO Box 796, Addison TX 75001.

Need a Selectric interface? Drop a line to John Bailey of Escon and get more details on what they've whipped up. (Heck, you can even kid John about his tie . . . he can take it!) 171 Mayhew Way, Suite 204, Pleasant Hill CA 94523.

Emerson Brooks
517 Melody Lane
Richardson TX 75081

Taming the I/O Selectric (Part 2)

Part 1 of this article explained interfacing the Selectric to your computer. Now it's time to look at the software.

In this second article on interfacing an I/O Selectric to his SWTP 6800, Emerson discusses the software involved . . . and I believe he has a Kilobaud *first. He has presented the software in "unassembled" source code. (He has assembled it, but for ease of explanation, and to give your assembler some work to do, he is presenting only the symbolic code.) Because of this approach, you can assemble the program where you would like it . . . and easily do customizing. — John.*

Photo 1. I used my system as a text editor while writing this article. From left to right are two tape cassette recorders — the stacked SWTPC CT-1024 TVT, AC-30 Cassette Interface and Sharp TV. Partly hidden is the SWTPC M-6800 next to the Selectric typewriter.

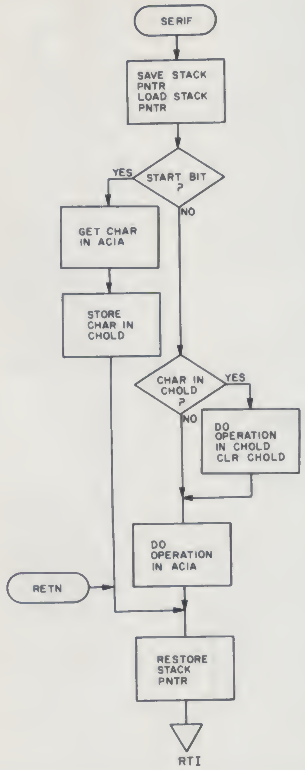
In part one I described the circuitry to interface an IBM Selectric typewriter to my SWTPC M-6800 computer. The essentials were a simple circuit that attached to the output port of the PIA and, with the proper 8-bit word, would control all typewriter functions. An ACIA in the computer had its serial input line connected through a switch to the input of the TVT, and was jumpered to interrupt the computer when its receive buffer was filled.

The software must perform three functions. The first is to convert the ASCII code the TVT understands to the proper control words for the Selectric and provide the timing for the operation. The second is to provide system control, such as turning the typewiter on and off, setting up the PIA and ACIA, etc. The third is working around some incompatibilities between the Selectric, the computer and ASCII code.

Table 1 lists the nine control commands. A left slash(\), which my Selectric can't print, is used as a control flag, and the single letter following tells which control function. The control functions need a little explaining.

The format function goes with the use of continuous roll paper or fanfold paper. I gather up old computer tab runs at work and type on the blank back side. When in FMTON mode, the typewriter types 60 lines and then puts in six line feeds, so the resulting copy may be cut into standard-size pages with proper top and bottom margins.

My TVT puts out only capital alphabetic characters, but the typewriter has both upper and lowercase letters, which makes for better appearing text. In the LCON control mode the typewriter types all alpha characters in lowercase unless it is preceded by the up arrow or exponent sign (↑).




```
SERIF    STS      SAVSP
         LDS      #TYPESP

         LDA  A   PIADA ($8004)
         ROR  A
         BCS      NOSBIT

         LDA  A   ACIAD
         STA  A   CHOLD
         BRA      RETN

NOSBIT   LDA  A   CHOLD
         BEQ      NOHOLD

         BSR      CNTLSW
         CLR      CHOLD

NOHOLD   LDA  A   ACIAD
         BSR      CNTLSW

RETN     LDS      SAVSP

         RTI
```

Fig. 1. SERIF — serial interface.

Flowcharts and Assembly Language

It is my opinion that computer hobbyists are like radio hams — they want to customize everything for themselves. So I am going to describe the software by flowcharts and assembly language, not object code, so you can easily add your own special touches. I am also doing it this way to show the beginner how easy it is to write programs if you go about it in an organized manner. You break up the program into many small pieces, which are easy to program, and then tie them all together to get the complete program.

In the accompanying figures, each program segment has a flowchart and the assembly language (M-6800) listing. Each segment has a label, which appears in the oval at the top of the flowchart. Segments branch to other segments by the label shown near the arrowheads.

All branching is shown as relative (BSR,BRA). When you put all of the program segments together, some of the branching targets will be out of range. These can be handled by changing branches to jumps (JSR,JMP).

Serial interface (SERIF) (Fig. 1) is the program segment that the computer jumps to when it is interrupted by the ACIA. SERIF uses a subroutine with a label CNTLSW (Fig. 2) that contains two examples of what I call software switches. These consist of a branch instruction (BRA) with an operand of either 00 (on) or 02 (off). When the operand is 00, the program executes the next instruction, which is either a BRA or BSR (branch to subroutine) instruction. When the operand is 02, the following branch instruction is skipped. The various control functions described in Table 1 are turned on and off by switching operands from 00 to 02 or from 02 to 00.

SERIF first sets up its own stack, after saving the stack pointer. The next set of operations is to correct a poten-

Symbol	Label	Function
T	TYPON	Sets up typewriter to type following output.
N	TYPOFF	Stops typing, turns off typewriter.
F	FMTON	Formats output with 60 lines of typing on 66-line page.
U	FMTOFF	Unformatted output.
P	PAGEUP	Fills rest of 66-line page with line feed.
S	SNGLSP	Single spaces output.
D	DBLSP	Double spaces output.
L	LCON	Types alpha characters in lowercase unless character is preceded by ↑.
C	LCOFF	Types alpha characters in uppercase.

Table 1. Control functions.

```
CNTLSW   BRA      CNTFL (02/00)
         BRA      CNTRL

CNTFL    CMP  A   #'\
         BNE      TYPSW
         CLR      CNTLSW+1
         BRA      OPEX

TYPSW    BRA      OPEX (02/00)
         BRA      TYPE

OPEX     RTS
```

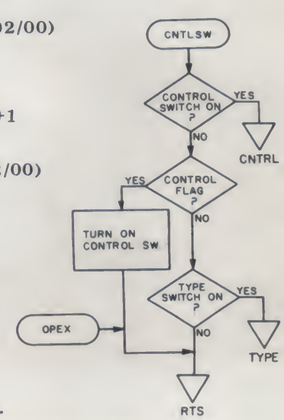
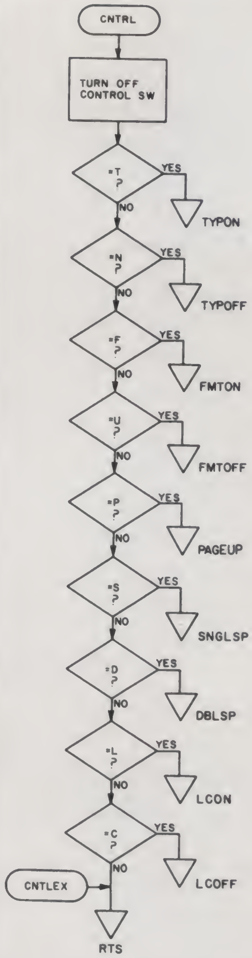


Fig. 2. CNTLSW — control switch.

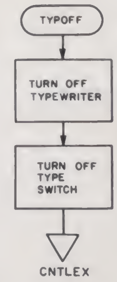



```
CNTRL    LDA  B  #$02
         STA  B  CNTLSW+1
         CMP  A  #'T
         BEQ     TYPON
         CMP  A  #'N
         BEQ     TYPOFF
         CMP  A  #'F
         BEQ     FMTON
         CMP  A  #'U
         BEQ     FMTOFF
         CMP  A  #'P
         BEQ     PAGEUP
         CMP  A  #'S
         BEQ     SNGLSP
         CMP  A  #'D
         BEQ     DBLSP
         CMP  A  #'L
         BEQ     LCON
         CMP  A  #'C
         BEQ     LCOFF
CNTLEX   RTS
```

Fig. 3. CNTRL — control function.

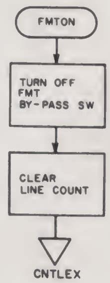

```
TYPON    CLR     PIAC
         LDA  A  #$FF
         STA  A  PIAD
         LDA  A  #$37
         STA  A  PIAC
         LDA  B  #FF
         BSR     DELAY
         CLR     TYPSW+1
         BRA     CNTLEX
```

Fig. 4. TYPON — typewriter on.




```
TYPOFF   CLR     PIAD
         CLR     PIAC
         STA  B  TYPSW+1
         BRA     CNTLEX
```

Fig. 5. TYPOFF — typewriter off.




```
FMTON    STA  B  FBPSW+1
         CLR     LNCNT
         BRA     CNTLEX
```

Fig. 6. FMTON — page formatting on.

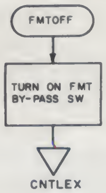
tial timing problem. Apparently the software serial interface (using the control interface PIA) that the Motorola monitor MIKBUG uses finishes slightly ahead of the ACIA serving the Selectric Interface program. If the computer puts out a character immediately after receiving a character from the TVT keyboard, this leads to the possibility of having the ACIA interrupt the computer in the start bit. This is detected by examining the LSB out of the control PIA. If it is low, then the computer is outputting a character. The previous character (the one from the TVT into the computer) is read out of the ACIA, thus clearing the interrupt signal. The character is stored in CHOLD and the computer returned from interrupt (RTI) to complete the outputting of the next character. Note that the MIKBUG output timing is from a hardware timer and isn't effected by the program going off to do other things, as long as the time involved is less than a bit time, or 3300 microseconds.

After the computer has completed the new character, the ACIA again interrupts the computer. Now there is no timing problem, so the program goes to the next step and checks to see if a character has been stored in CHOLD. If so, the program does the operation called for before doing the current character, using the subroutine CNTLSW. CHOLD is cleared after this to show that no character is being held. Next the current character is obtained from the ACIA, and branching to the CNTLSW subroutine does the operation. Following restoring the stack pointer, the program returns from interrupt (RTI). The buffering of a character is required only following an input from the TVT keyboard, and then only if there is an immediate computer reply. I used the program without this fix for three months before discovering the need for it.

About the middle of the CNTLSW subroutine, the character is examined to see if it is the left slash, the control flag. If it is, CNTLSW is turned on by clearing its operand. This will cause the program to jump to CNTRL when processing the next character.

TYPSW is a software switch that directs the program to type the character or not, depending on its setting. The segment ends by returning to SERIF.

CNTRL (Fig. 3) begins by turning off (setting operand to 02) CNTLSW so the next character won't be interpreted as a control command. Then it compares the character with all the possible command characters and, if it finds a match, branches to the appropriate segment to set up the function and then returns to CNTLEX (control exit). If no match is found,




```
FMTOFF   CLR   FBPSW+1
         BRA   CNTLEX
```

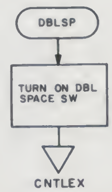
Fig. 7. FMTOFF — formatting off.


```
SNGLSP   STA  B  DBLSSW+1
         BRA     CNTLEX
```

Fig. 9. SNGLSP — single spaced typing.


```
PAGEUP   BSR   PAGE
         BRA   CNTLEX
```

Fig. 8. PAGEUP — start new page.




```
DBLSP    CLR   DBLSSW+1
         BRA   CNTLEX
```

Fig. 10. DBLSP — double spaced typing.

the program exits without doing anything.

All control segments except PAGEUP set software switches. Note that CNTRL loaded 02 into the B Accumulator to be used for turning off switches. CLR turns them on.

TYPON (Fig. 4) sets up the PIA connected to the typewriter, including turning on CA2, which causes the typewriter power to be turned on and then branches to a software delay subroutine to wait for the typewriter to come up to speed, and the power supplies to come up. Finally, TYPSW is turned on.

TYPOFF (Fig. 5) turns off TYPSW after clearing the PIA.

FMTON (Fig. 6) enables page formatting by turning off FBPSW, the format bypass switch. It also clears the line count register LNCNT to start counting lines from the top of the page.

FMTOFF (Fig. 7) turns the format bypass switch FBPSW back on.

PAGEUP (Fig. 8) causes a branch to the PAGE subroutine, which fills the rest of the page with blank line feeds.

SNGLSP (Fig. 9) turns off DBLSSW, the double space switch. DBLSP (Fig. 10)

Address	Content Hex	Typewriter Function	ASCII Code
6F80 LUTBL	00	none	00
•	•	•	•
•	•	•	•
6F88	08	BS	08
6F89	00	none	09
6F8A	20	LF	0A
6F8B	00	none	0B
6F8C	00	none	0C
6F8D	10	CR	0D
6F8E	00	none	0E
•	•	•	•
•	•	•	•
6FA0	04	SPACE	20
6FA1	23	!	21
6FA2	B5	"	22
6FA3	EF	#	23
6FA4	F3	$	24
6FA5	F5	%	25
6FA6	F7	&	26
6FA7	35	'	27
6FA8	E1	(	28
6FA9	F1	)	29
6FAA	E7	*	2A
6FAB	8D	+	2B
6FAC	07	,	2C
6FAD	01	-	2D
6FAE	2D	•	2E
6FAF	13	/	2F
6FB0	71	0	30
6FB1	53	1	31
6FB2	6D	2	32
6FB3	6F	3	33
6FB4	73	4	34
6FB5	75	5	35
6FB6	65	6	36
6FB7	77	7	37
6FB8	67	8	38
6FB9	61	9	39
6FBA	57	:	3A
6FBB	17	;	3B
6FBC	06	LT	3C
6FBD	0D	=	3D
6FBE	0A	GT	3E
6FBF	93	?	3F
6FC0	ED	@	40
6FC1	A7	A	41
6FC2	C1	B	42
6FC3	C7	C	43
6FC4	D7	D	44
6FC5	D5	E	45
6FC6	8F	F	46
6FC7	9F	G	47
6FC8	D1	H	48
6FC9	A5	I	49
6FCA	83	J	4A
6FCB	C5	K	4B
6FCC	D3	L	4C
6FCD	BF	M	4D
6FCE	CD	N	4E
6FCF	B3	O	4F
6FD0	95	P	50
6FD1	85	Q	51
6FD2	B7	R	52
6FD3	B1	S	53
6FD4	C3	T	54
6FD5	CF	U	55
6FD6	AF	V	56
6FD7	A1	W	57
6FD8	DF	X	58
6FD9	91	Y	59
6FDA	E3	Z	5A
6FDB	FF	[	5B
6FDC	00	control flag	5C
6FDD	7F	]	5D
6FDE	0E or 00	EX or cap flag	5E
6FDF	81	_	5F
6FE0	00	none	60
6FE1	27	a	61
6FE2	41	b	62
•	•	•	•
•	•	•	•
6FFA	63	z	7A

Lowercase table content is uppercase content with hex 80 subtracted.
i.e., A = A7
a = 27

Look-up table address is ASCII Code + hex 6F80.

Typewriter codes are for use with IBM Selectric type element #070 "DELEGATE" or equivalent.

Table 2. Look-up table.

turns DBLSSW on.

LCON, lowercase on, (Fig. 11), turns on LCSW, the lowercase switch. It also substitutes 00 for 0E (typewriter code for up arrow) in the look-up table so that the up arrow used as the capital flag will not print. The capital switch (CAPSW) is then turned off so that the next character will not be capitalized unintentionally.

LCOFF (Fig. 12) turns off the lowercase operation by turning off LCSW and restoring the up arrow code in the look-up table.

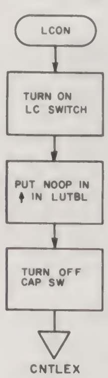
TYPE is the Heart of the Program

TYPE is the program segment that does many things. It arranges to take care of the carrier-return/line-feed peculiarities of the Selectric, converts from ASCII to typewriter code, takes care of shifting and handles special characters that are not on my type element.

The conversion from ASCII to typewriter code is handled by a look-up table (Table 2). I placed the table at the top of my RAM, starting at hex 6F80. The table is addressed by adding the ASCII code to 6F80 to get the address of the corresponding typewriter code. The typewriter code tells the typewriter how much to rotate and tilt to print the character. No-operation ASCII codes give 00 typewriter code. The table ends with lowercase z at address 6FFA.

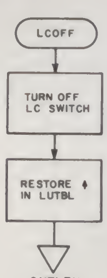
The ASCII code is a 7-bit code (bits 0 through 6). Some programmers use bit 7, the most significant bit in a byte, as a flag bit. This, of course, would cause error in the table look-up, so it is stripped off by ANDing with hex 7F. The character is then checked to see if it is out of range of the look-up table (greater than hex 7A), and if it is the program exits through TYPEY. Next the lowercase switch, (LCSW), if on, causes branching to the lowercase segment, LRCSE, where the uppercase ASCII code is converted to lowercase ASCII code. LRCSE returns to TSTCR when completed.

The Selectric mechanically couples carrier return and line feed so that a line feed always accompanies carrier return. However, a line feed can be done without a carrier return. This creates a problem since most programs provide line feed with carrier return, and this would cause the typewriter to always double space if something didn't prevent it. Also, some programs, like the SWTPC Assembler, throw in extra carrier returns. This is



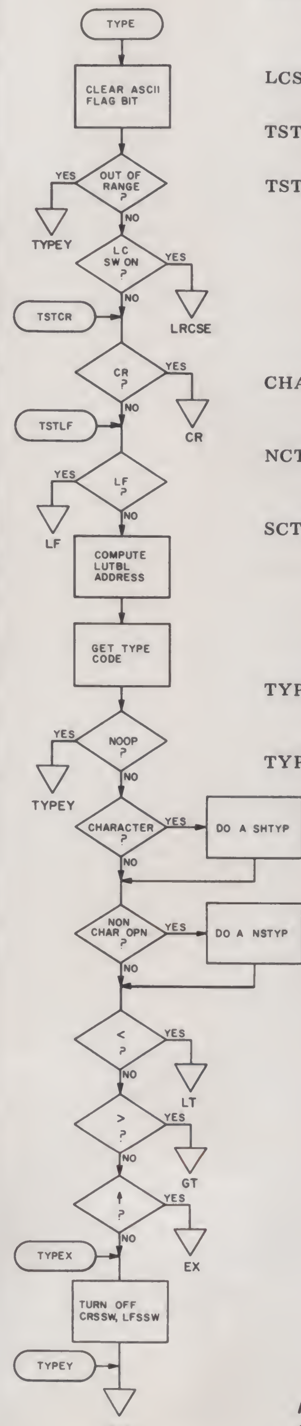

```
LCON     CLR        LCSW+1
         CLR        LUTBL+$5E
         STA   B    CAPSW+1
         BRA        CNTLEX
```

Fig. 11. LCON — enables lowercase characters.




```
LCOFF    STA   B    LCSW+1
         LDA   B    #$0E
         STA   B    LUTBL+$5E
         BRA        CNTLEX
```

Fig. 12. LCOFF — type capitals only.




```
TYPE     AND   A    #$7F
         CMP   A    #'z+1
         BPL        TYPEY
LCSW     BRA        TSTCR(02/00)
         BRA        LRCSE
TSTCR    CMP   A    #$0D
         BEQ        CR
TSTLF    CMP   A    #$0D
         BEQ        LF
         ADD   A    #$80
         STA   A    LUTADD+1
         LDX        LUTADD
         LDA   A    0,X
         BEQ        TYPEY
CHAR     BIT   A    #$01
         BEQ        NCTST
         BSR        SHTYP
NCTST    BIT   A    #$02
         BNE        SCTST
         BSR        NSTYP
SCTST    CMP   A    #$06
         BEQ        LT
         CMP   A    #$0A
         BEQ        GT
         CMP   A    #$0E
         BEQ        EX
TYPEX    LDA   B    #$02
         STA   B    CRSSW+1
         STA   B    LFSSW+1
TYPEY    RTS
```

Fig. 13. TYPE — ties the rest of the program together.

no problem for a TVT because multiple returns do nothing, but on the Selectric each one would make another line feed. The next part of TYPE takes care of most of these problems by branching to CRSW if carrier return is the current character, or LFSW if line feed is called for. These will be discussed later.

The address in the look-up table is now computed, as described previously, and the typewriter code obtained at that address. If the typewriter code is 00, indicating no operation, the program exits at TYPEY.

If the operation is typing a character, then the shift condition must be checked, and changed if wrong, before typing. A typing operation is recognized by the least significant bit, bit 0, being on and is checked by BIT (bit test). The segment SHTYP (shift type) takes care of shifting. Next the operation is checked to see if it is a special character, which is indicated by bit 1 being on. If not, the program branches to NSTYP (no shift type), which does the operation without changing the shift.

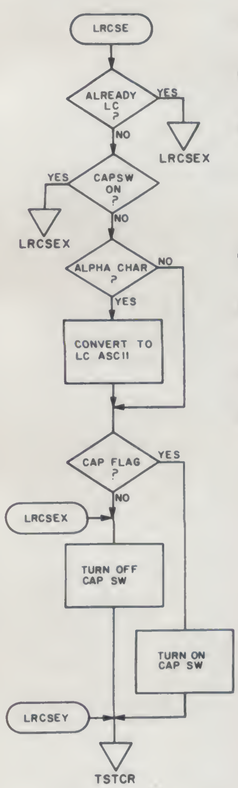
The special characters are the greater than (>), less than (<) and up arrow or exponent (↑), which are not on my type element. The program substitutes overprinted characters for these — (G/T) for greater than, (L/T) for less than and (E/X) for up arrow. These are recognized by their typewriter code, which contains a 1 for bit 1, and the program branches to the proper segment for execution.

The TYPE segment exits either through TYPEX or TYPEY depending on whether the carrier return and line feed switches are to be turned off. The need for this will be discussed later.

LRCSE (Fig. 14) begins by two tests. If the character is already lowercase ASCII or if the capital switch CAPSW is on, the segment exits through LRCSEX, turning off CAPSW. Next the character is tested to see if it is an alphabetic character. If it is not, the conversion routine is bypassed. The conversion recognizes that the difference between upper and lowercase ASCII is hex 20, and so lowercase is obtained by adding hex 20 to the ASCII code. The next step is to test to see if the character is the capital flag (↑). If it is, CAPSW is turned on. Other-

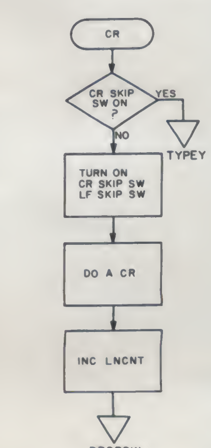
at	063C	change	0D	to	00
	07F4		0D		00
	07F8		0A		00
	0A21		0D		00
	0A25		0A		00
	0C1D		0D		00
	0C21		0A		00
	1409		0D		00
	140D		0A		00
	1510		0D		00
	1514		0A		00

Table 3. Assembler modifications.



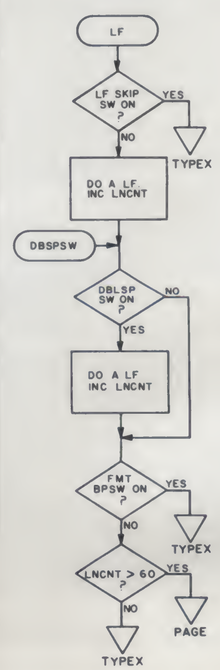

```
LRCSE    CMP  A  #$60
         BPL     LRCSEX
CAPSW    BRA     ALPHA(02/00)
         BRA     LRCSEX
ALPHA    CMP  A  #'A
         BMI     CAPFLG
         CMP  A  #'Z
         BGT     CAPFLG
         ADD  A  #$20
CAPFLG   CMP  A  #'↑
         BEQ     CAPSON
LRCSEX   LDA  B  #$02
         STA  B  CAPSW+1
         BRA     LRCSEY
CAPSON   CLR     CAPSW+1
LRCSEY   BRA     TSTCR
```

Fig. 14. LRCSE — provides for upper and lowercase.



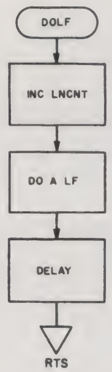

```
CR       NOP
CRSSW    BRA     CRSWA(02/00)
         BRA     TYPEY
CRSWA    CLR     CRSSW+1
         CLR     LFSSW+1
         LDA  A  #$10
         BSR     NSTYP
         LDA  A  #$FF
         BSR     DELAY
         INC     LNCNT
         BRA     DBSPSW
```

Fig. 15. CR — carrier return routine.



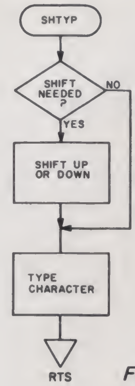

```
LF       NOP
LFSSW    BRA     LFSWA(02/00)
         BRA     TYPEX
LFSWA    BSR     DOLF
DBSPSW   BRA     FBPSW (02/00)
         BSR     DOLF
FBPSW    BRA     PAGTST(02/00)
         BRA     TYPEY
PAGTST   LDA  B  LNCNT
         CMP  B  #60
         BPL     PAGE
         BRA     TYPEX
```

Fig. 16. LF — line feed routine.



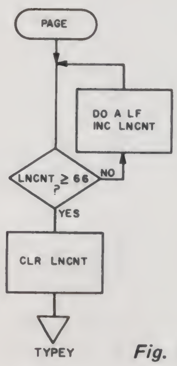

```
DOLF    INC       LNCNT

        LDA   A   #$20
        BSR       NSTYP

        LDA   B   #58
        BRA       DELAY

        (HIDDEN RTS)
```

Fig. 17. DOLF — do a line feed.




```
SHTYP   PSH   A
        AND   A   #$80
        LDA   B   PIAD
        AND   B   #$80
        CBA
        BEQ       SHTYPA
        BSR       TYPOP
        LDA   B   #19
        BSR       DELAY
SHTYPA  PUL   A
        BRA       TYPOP

        (HIDDEN RTS)
```

Fig. 20. SHTYP — types with shifting if needed.

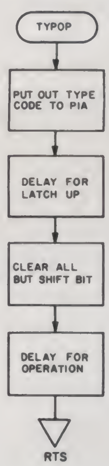



```
PAGEA   BSR       DOLF

PAGE    LDA   B   LNCNT
        CMP   B   #66
        BMI       PAGEA

        CLR       LNCNT

        BRA       TYPEY
```

Fig. 18. PAGE — finish a page with line feeds.

SAVSP	2 bytes to save stack pointer.
SAVX	2 bytes to save index register.
CHOLD	1 byte holding register for character.
LNCNT	1 byte linecount register.
LUTADD	2 bytes for address in look-up table.
TYPESP	address of top of stack for typing program.
LUTBL	address of first entry in look-up table ($6F80).
NMIV	nonmaskable interrupt vector ($A006).
PRGMV	starting address of program using SERIF.
ACIAD	serial interface data register.
ACIAC	serial interface control register.
PIAC	parallel interface control register to Selectric.
PIAD	parallel interface data register to Selectric.
PIADA	parallel interface data register for MIKBUG.

Table 4. Labels not previously defined.




```
TYPOP   STA   A   PIAD

        LDA   B   #10
        BSR       DELAY

        LDA   B   PIAD
        AND   B   #$80
        STA   B   PIAD
        LDA   B   #9
        BRA       DELAY

        (HIDDEN RTS)
```

Fig. 19. TYPOP — outputs code to typewriter.

wise, exit is through LRCSEX, which turns off CAPSW. LRCSE returns to the TYPE segment at TSTCR.

Taking Care of CR-LF Incompatibility

Both CR and LF segments start with switches that can be set to skip the functions. To cancel one line feed or multiply carrier returns following a carrier return, the carrier return segment, CR (Fig. 15), turns on both the skip switches, CRSSW and LFSSW. After executing the carrier return function, using NSTYP (no-shift type) and added software delay, the line count register (LNCNT) is incremented to count the line feed, which with the Selectric always accompanies a carrier return. The segment then branches to DBSPSW in the LF segment for double spacing if called for.

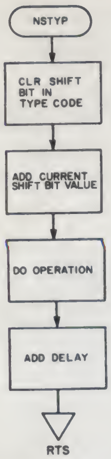
If LF (Fig. 16) is the operation, and LFSSW is off, a line feed is done using DOLF (Fig. 17), which also increments LNCNT. Then if DBSPSW is on, DOLF is done again to produce the double space. CR entering at this point would also produce a line feed to do double space after a carrier return if DBSPSW was on. Now the format bypass switch, FBPSW, if on, returns the program to TYPEY, otherwise the segment tests the line count, LNCNT, and if it is greater than or equal to 60 branches to PAGE (Fig. 18).

PAGE tests LNCNT, and if not greater than 66, does line feeds with DOLF until it is. Then LNCNT is cleared and the program returns to TYPEY in TYPE.

Now you can see the reason for two exits in TYPE. TYPEX turns off both CRSSW and LFSSW, while TYPEY doesn't. Any character other than LF or CR turns off CRSSW and LFSSW. The first LF after a CR doesn't do a line feed, but turns off LFSSW so the second and subsequent LF immediately following CR are done because of exit through TYPEX. All CRs immediately following a CR are skipped. PAGE has no effect on CRSSW or LFSSW.

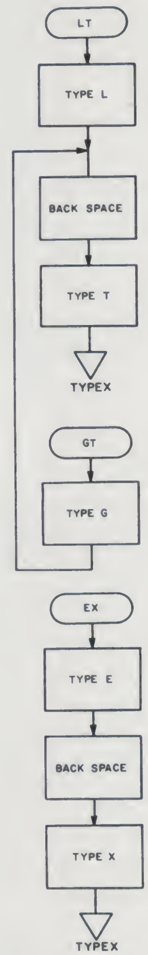
Making the Selectric Do Its Thing

TYPOP (Fig. 19) is the segment which puts out the command to the typewriter interface. It loads the typewriter code in A Accumulator into the PIA, and then delays for the solenoids to latch up. Then the typewriter code is cleared, except for the shift bit, and loaded into the PIA. This holds the shift in whatever condition it was in, so it won't change while typing.




```
NSTYP   AND A  #$7F
        LDA B  PIAD
        AND B  #$80
        ABA
        BSR    TYPOP
        LDA B  #8
        BRA    DELAY
        (HIDDEN RTS)
```

Fig. 21. NSTYP — types holding current shift.




```
LT      LDA A  #$D3
LTA     BSR    SHTYP
        LDA A  #$08
        BSR    SHTYP
        LDA A  #$C3
        BRA    CHAR
        (HIDDEN RTS)
GT      LDA A  #$9F
        BRA    LTA
EX      LDA A  #$D5
        BRA    SHTYP
        LDA A  #$08
        BSR    SHTYP
        LDA A  #$DF
        BRA    CHAR
        (HIDDEN RTS)
```

Fig. 22. LT, GT, EX — special characters.

The Selectric has mechanical interlocks that prevent shifting while typing or typing while shifting, so you can't hurt the typewriter. However, since all timing is by software and is open loop, the program has to provide timing delays for all operations.

SHTYP (Fig. 20) does a typing operation after first making sure that the shift is in the right condition. This is done by comparing the shift bit in the typewriter code with the shift bit in the PIA. If they are equal the character is typed, if not the shift is changed, with delay for the operation, before typing the character. TYPOP is used to output the function to the typewriter.

NSTYP (Fig. 21) is the complement of SHTYP. It is used for nontyping functions and holds the current shift condition. The shift bit is cleared from the typewriter code by ANDing with hex 7F. Then the byte in the PIA, which contains the current shift condition, is added to the typewriter code before going to TYPOP to do the operation.

The special characters, a substitution for >,< and ↑, are made by typing a character, back spacing and then overtyping the second character. The LT, GT and EX segments (Fig. 22) do this sequence. These segments load the proper typewriter code into A Accumulator and then branch to SHTYP to type them. You may wonder why SHTYPE was used for back space rather than NSTYP, since the type code for back space is 08, and thus the typewriter shifts down for the back space, and then back up for the second character. Of course this takes time, and that is the reason, to stretch out the time a little as a substitute for the ACIA time. The next paragraphs will clarify that last sentence.

Keeping Track of the Time

Timing for these program segments is done with a simple software timing subroutine, DELAY (Fig. 23). The segment is entered with a value in the B Accumulator. The segment returns after a time equal to 1.74 milliseconds times the value in the B Accumulator. The 1.74 milliseconds is set by the clock cycles of the MC6800 and the clock frequency of SWTPC M-6800 CPU. Since DELAY is fequently the last step in many of the other segments, these other segments may use BRA, branch, rather than BSR, branch to subroutine, and thus use the DELAY RTS to return to the main program, saving a program step. I call this a "hidden RTS."

The Selectric takes a certain time to perform each of its operations. The software timing provides the equivalent time so that the program won't try to make the Selectric do an operation before it has completed the previous operation. The time required for the ACIA to receive a character (33 ms at 300 baud) is a built-in time of all operations because the computer has to go through the ACIA time delay before it can command the typewriter to do another operation. An exception is back space and the second character of special characters, and the DOLF on double space and PAGE. The special character timing was taken care of by sneaking in some shift operations. The timing for DOLF is made long enough to cover the Selectric LF operation

```
INNER LOOP EXECUTES                     DELAY   PSH B
256 (HEX 100) TIMES                             CLR B
AND TAKES 1.74 MS.             INNER  { DEL     DEC B
TOTAL DELAY TIME               LOOP   {         BNE    DEL
EQUALS 1.74 X CONTENTS                          PUL B
OF ACC B ON ENTERING                            DEC B
SUBROUTINE.                                     BNE    DELAY
                                                RTS
```

Fig. 23. DELAY — software timing subroutine.

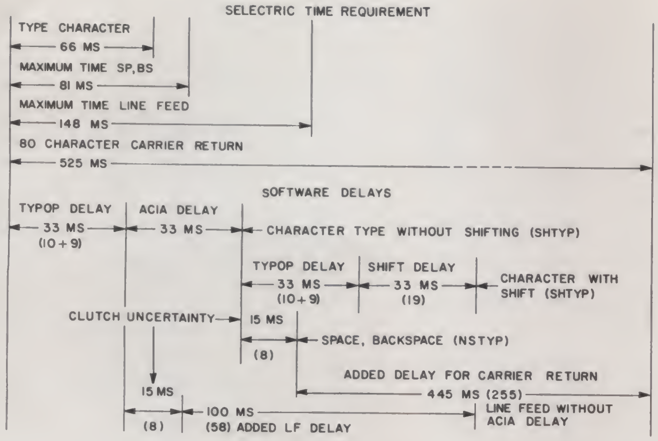


Fig. 24. Timing chart.

without including ACIA time.

The timing chart (Fig. 24) shows the time required by the Selectric for various operations at the top; and below the way the software delays in various segments plus the ACIA delay add up to equal the operation time.

Getting Things Set Up

For the Selectric Interface program to work, the ACIA must be set up. This is done by SETUP (Fig. 25). The ACIA is set for the number of bits, etc., to be the same as the M-6800 control interface. In addition the NMI vector must be set. For the MC6800 CPU using Motorola MIKBUG monitor, the NMI vector is stored in location hex A006 and A007. The address put in this location is the address of SERIF, which in my system is 6B00.

In addition SETUP clears the PIA, so that its initial condition is known, and sets the various function switches to the default condition: typing off, single space, capitals and unformatted output. SETUP is used ahead of a program that will use the typing function. After completing SETUP the program jumps to the address which is stored in PRGMV.

An Alternate Interface

Some programs have alternate output ports, such as SWTPC Assembler, which also has parallel output as well as the serial output that the TVT uses. PRGMIF is an alternate interface that may be adapted to parallel output. The character to be typed is put in the A Accumulator, and the program subroutine jumps (JSR) to PRGMIF (Fig. 26). After initiating the stack and saving registers the program simulates the delay of the ACIA to keep the timing correct. Then the program jumps to the TYPE subroutine to do the typing. After completion of the typing, the registers are restored and the program returned to the calling program. This arrangement bypasses the control function so the switches for single or double space, capitals or upper and lowercase, page formatted or unformatted must be set before the program is run.

Program Modifications

You may have gotten the impression that the Selectric Interface program I have described solves all the problems; but I am sorry to say it isn't so. Following are some problems I have encountered and solved, and I am sure there are others:

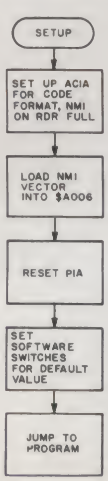
Programs like SWTPC Editor and Assembler, and 4K and 8K BASIC begin by filling all contiguous memory above the program with some pattern such as 55. This will wipe out the Selectric Interface programs. Here are two solutions: You can put a gap in memory that separates the Selectric Interface software from the rest of the memory; or you can find in the offending program where it fills memory with 55 and modify the program so it stops before it gets to the Selectric Interface program.

Some programs, such as SWTPC 8K BASIC, reset the NMI vector (A007) to 0100, which would prevent the Selectric Interface program ever being reached. The cure for this is to modify the program so it puts the address of SERIF in A006;

SWTPC Assembler and 8K BASIC have provision for alternate output terminals. However, even if alternate terminals are not used, these programs try to reset all interface terminals, including the ACIA and PIA you are using with the Selectric Interface. You can fix this by modifying the programs so that these interfaces are not changed.

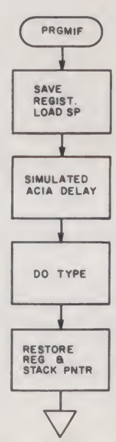
Finally, in spite of the effort to take care of multiple carrier returns. the SWTPC Assembler still does funny things with spacing. The changes listed cure the problems for the Selectric Interface, and also improve the TVT presentation by condensing it to fewer lines, thus, putting more data on the screen at one time.

Recently I've noticed several ads in computer hobby magazines for Selectric typewriters. If you decide to join me with a Selectric hard copy printer, I hope this article will be helpful to you. It isn't easy, but the results are very satisfying. ■




```
SETUP   LDA A #$13
        STA A ACIAC
        LDA A #$95
        STA A ACIAC

        LDX   #SERIF
        STX   NMIV

        CLR   PIAD
        CLR   PIAC

        LDA A #$02
        STA A TYPSW+1
        STA A DBLSSW+1
        STA A LCSW+1
        CLR   FBPSW+1

        JMP   PRGMV
```

Fig. 25. SETUP — sets up the ACIA interface.




```
PRGMIF  STS   SAVSP
        LDS   #TYPESP
        STX   SAVX
        PSH B
        PSH A
        LDA B #19
        BSR   DELAY
        BSR   TYPE

        PUL A
        PUL B
        LDX   SAVX
        LDS   SAVSP

        RTS
```

Fig 26. PRGMIF — an interface for parallel output.

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Build It, Tear It Down!

Heath's ET-3300 breadboard is as close to the "commercial" version as you can get . . . without paying the commercial price.

Gary Sabot
38 Woodland Rd.
Roslyn NY 11576

A solderless breadboard is a must for the hardware hobbyist. It enables you to set up and experiment with circuits, then tear them down and reuse the parts; it is a fast construction technique, quicker than wire-wrapping and much faster than soldering; it is perfect for designing computer peripherals, such as music interfaces and A/D converters, because you can easily modify the circuit.

The Heathkit ET-3300 breadboard is an excellent addition to anyone's workbench. It has four full-size breadboarding strips . . . more than enough to build most medium-size circuits. In fact, Mark Borgerson's eight-channel A/D converter (see *Kilobaud*, March 1977, p. 64), which I set up on the breadboard, took less than one strip.

Besides the strips the kit also comes with two power supplies: 5 V at 1.5 A and ±12 V at 100 mA. It also has three distribution sockets located between the breadboard sockets, which are used for power distribution. The kit cabinet measures 3½ x 12 x 12 inches. The breadboard's power supply can operate on either 120 or 220 V ac. You have to choose one of these during assembly.

Assembly

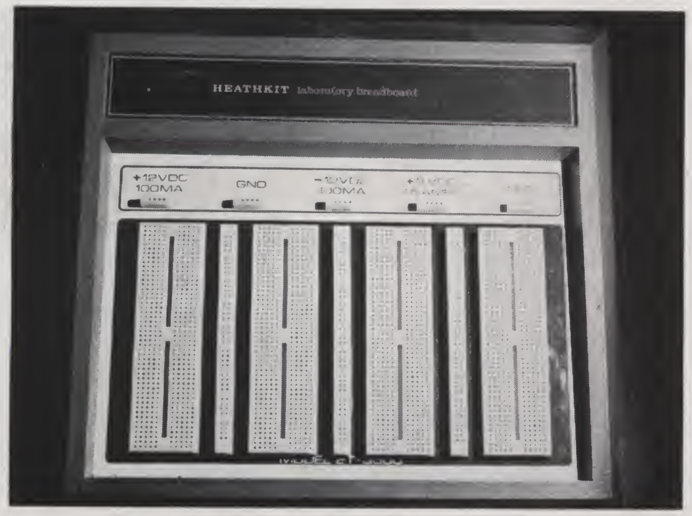
The Heathkit breadboard can be assembled easily and quickly. Its simplicity (only 36 electrical components!) and excellent documentation combine to make building this kit a cinch. For people with all thumbs, Heath charges more than $50 extra for the assembled version; I recommend the kit version for those more dextrous.

Circuit Description

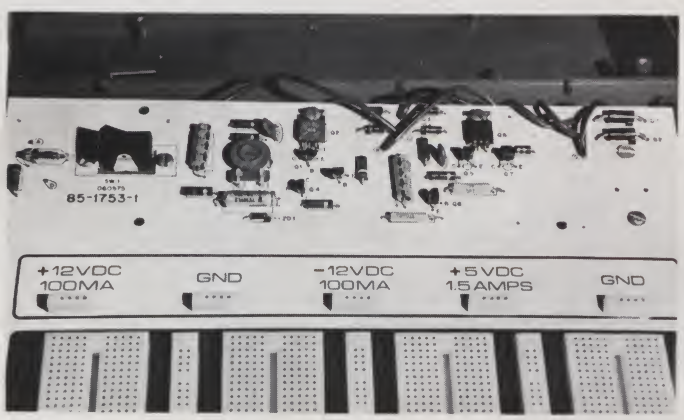
The 5 V power supply is IC regulated, and is perfect for TTL ICs. The ±12 V supply is filtered and regulated by 15 discrete components.

You have to initially set the +12 V half of the supply to its correct voltage by adjusting a reference potentiometer. The −12 V half of the supply uses the positive part as its reference, and so it needs no adjustment. The ±12 V supply is perfect for working with those op amps that require a differential power supply.

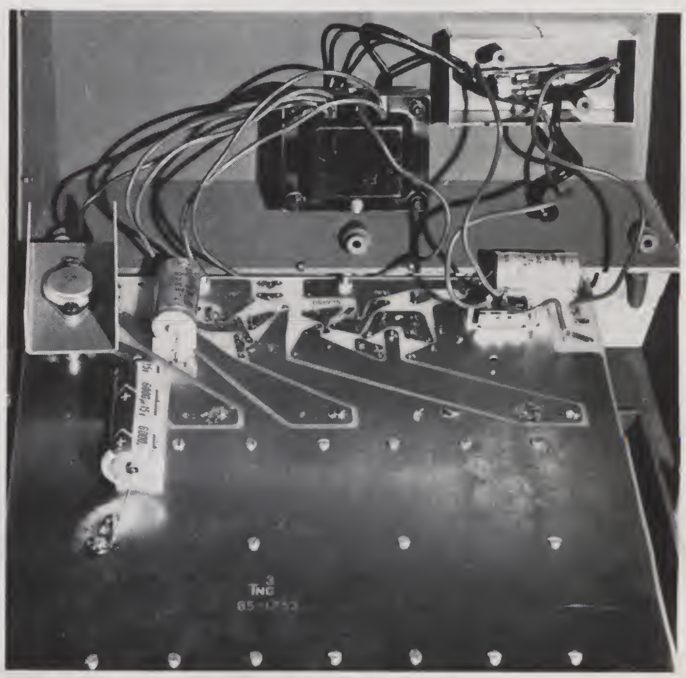
In conclusion, if you are the type of person that loves to tinker with the kind of circuits you see in *Kilobaud* or with ones of your own design, the ET-3300 is perfect for you. The kit version's price is $84.95; the assembled version costs $140. Both are available from Heathkit, Benton Harbor MI 49022. ■



The Heathkit ET-3300 Laboratory Breadboard. (All photos by Eric Parker)



Component side of PC board.



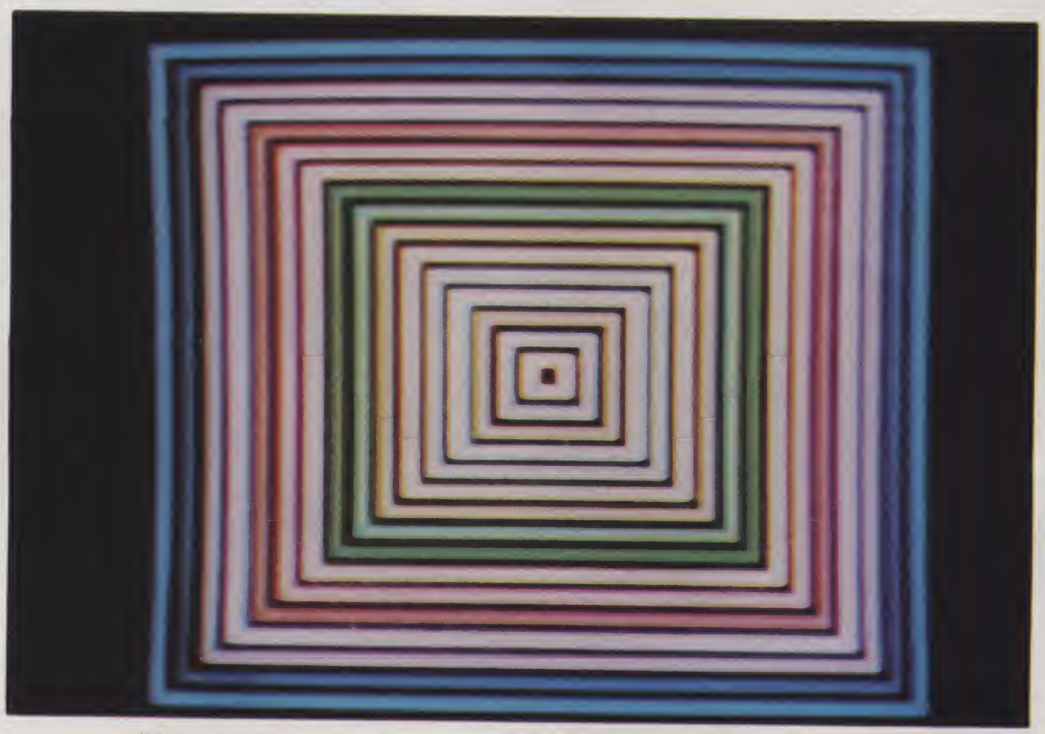
Fuse box and foil side of PC board.

Draw Dazzling Color Graphics

Cromemco's TV Dazzler can add color and excitement to your screen . . . it's better than network programming.

Jon A. Rick
531 Community Drive
Battle Creek MI 49017

Cromemco's TV Dazzler is probably the single most exciting peripheral for the hobby market. At reasonable cost the hobbyist can have a color graphics interface for his Altair bus system, a feature not often found on the large multimillion-dollar super computers. Once you see a demonstration of the Dazzler you will want one. After building, testing and installing the Dazzler, that great moment suddenly arrives — you key in Cromemco's test program, press Run and there it is, a bright colorful patchwork quilt on your TV screen. Next you spend several minutes flipping the sense switches, observing the various options and learning the difference between 512 and 2K displays, and normal and times-four resolution. Finally, you'll decide to draw a picture. This is when you discover that the Dazzler is more fun to watch than to program. This article will present some assembly-language subroutines that make drawing pictures on the Dazzler a little less tedious.



"Concentric Squares" by David Couch of Battle Creek using the Dazzler Drawer.

From Memory to CRT

Before examining the subroutines, it is important to understand how the Dazzler translates pictures from memory to the TV screen. The documentation supplied with the kit is quite detailed, but for those of you not fortunate enough to own a Dazzler, this will serve as an introduction.

Basically, memory locations are mapped onto the screen. Whatever you place in a particular memory address will appear at its corresponding position on the TV. In normal resolution, each dot or square on the screen is generated from four bits, called a *nibble*, in memory. The high order bit of the nibble, when set to one, causes that square to be displayed with high intensity, and when set to zero causes the square to be of low intensity. The remaining three bits of the nibble, in color mode, determine the color of the dot and, in black and white mode, the shade of gray. In color mode, the low order bit, when set to one, colors the dot red. The next bit, when set to one, colors the dot green, and the third bit colors the dot blue. Combinations of bits are permitted and can be used to create seven different colors

HEX	BINARY	COLOR
0	0000	Black
1	0001	Red
2	0010	Green
3	0011	Yellow
4	0100	Blue
5	0101	Purple
6	0110	Blue-green
7	0111	Gray
8	1000	Black
9	1001	Bright red
A	1010	Bright green
B	1011	Bright yellow
C	1100	Bright blue
D	1101	Violet
E	1110	Bright blue-green
F	1111	White

Fig. 1. Nibble values and the corresponding color.

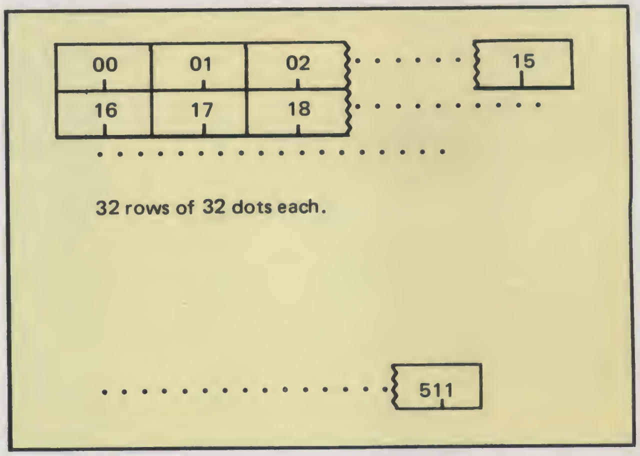


Fig. 3. Illustrating the mapping of bytes in the 512 normal resolution modes.

(see Fig. 1).

Since each dot on the screen is presented by a 4-bit nibble and each computer word contains eight bits, each memory location is used to represent two adjoining dots. Of the two dots, the leftmost is presented by the low order nibble and the rightmost by the high order nibble. Cromemco's documentation shows the low order, or least significant bit (LSB), of the word to the left, which is the opposite of most front panel displays; their diagram can lead to confusion. Fig. 2 shows this relationship with the most significant bit (MSB) on the left.

In a 512-byte display, the first memory byte is mapped into the first two squares of the first row in the upper left corner of the screen. The next memory location represents the next two squares to the right in the first row. This continues for 16 words, which represent 32 squares across the top of the screen. The seventeenth word defines the first two dots of the second row. See Fig. 3. Thus 512 bytes of memory defines the picture for the entire screen.

A 2K mode display uses 2048 bytes to define the picture. The screen is divided into four 512-byte quadrants, and each 512 bytes of memory is mapped into its respective quadrant — upper left, upper right, lower left and lower right (as shown in Fig. 4).

The difficulty in programming the Dazzler arises when a picture crosses one of the quadrant boundaries. For example, if a single straight line is to be drawn across the top of the screen, it would require placing picture information in relative memory locations zero through 15, and 512 through 527. To eliminate the drudgery in determining which nibble repesents which dot on the screen, here is a series of

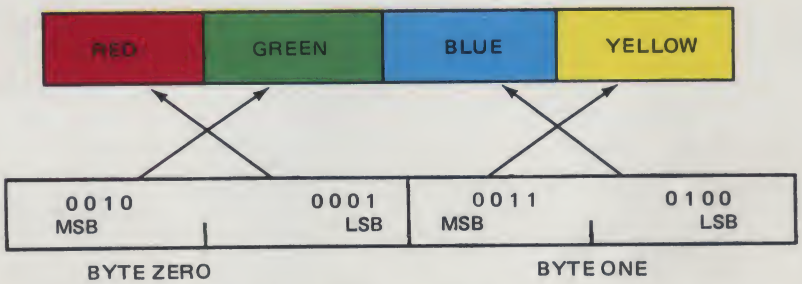


Fig. 2. Illustrating the mapping of two memory locations on the screen.

```
DAZ     PUSH    B           Save the registers.
        PUSH    D
        PUSH    PSW
        MOV     A,D         Ensure the maximum row
        ANI     63          number is a 63.
        MOV     D,A
        CPI     32          Top or bottom half
        JC      THAF        of the screen?
        SUI     32          Adjust HL pointer to lower half
        MOV     D,A         of the screen and subtract 32
        LXI     B,1024      from the row counter.
        DAD     B
THAF    MOV     A,E         Limit column value to 63.
        RAR                 Divide by 2 because one byte
        ANI     31          equals two dots.
        MOV     E,A
        CPI     16          Left or right half
        JC      LHAF        of the screen?
        SUI     16          Adjust column value and HL
        MOV     E,A         to right side of screen
        LXI     B,512
        DAD     B
LHAF    LXI     B,16        Add 16 bytes for each
ROW     DCR     D           additional row.
        JM      COL
        DAD     B
        JMP     ROW
COL     MVI     D,0         Add any extra columns.
        DAD     D
        POP     PSW         Restore registers.
        POP     D
        POP     B
        RET
```

Program A. Compute Dazzler location. Given the address of the beginning of the Dazzler display area in the HL registers, the column number in E and the row number in D, this routine computes the memory address of the specified dot.

subroutines to help draw pictures on the Dazzler.

The Drawing Routines

For the purposes of these routines, the entire screen, whether in 512 or 2K mode, is assumed to be a single block of dots in ordered rows and columns. The rows are numbered vertically from the top, starting with zero. The columns are numbered across the screen, left to right, also starting with zero. The first subroutine, called DAZ, will take a row and column number and compute the address of the corresponding memory byte. The user places the desired row number in the D register, the desired column in the E register and the base address of the display area in the HL registers. The subroutine then updates the HL registers to point to the corresponding byte. All other registers are preserved.

The second subroutine, DAZZ, has the same input parameters. DAZZ first calls DAZ to determine the memory address of the selected row and column. DAZZ then stores the low order nibble of the A register in either the left or right half of the memory byte as required by the input column number.

Using these two routines, it is now possible to color any dot on the screen by specifying row, column, starting address and color. The programmer need not be concerned about quadrant or high/low order nibble. As a demonstration of these two subroutines, the program Book uses another Cromemco product, the D+7AI/O board, which permits analog input. With two analog ports determining row and column, and the front panel switches setting the color, the Dazzler can turn your TV into an electronic coloring book.

The two subroutines DAZ and DAZZ make it easy to color a specific dot; but to draw an entire picture the user must still compute each row and column. The next routine allows you to define an entire figure in memory and then position that figure at any spot on the screen by specifying only the starting row and column. Not only is it easy to display the figure, it can be repeatedly redrawn elsewhere to give the illusion of motion.

For this routine, the user allocates a memory array somewhere outside the Dazzler display area. Allocate one memory location for

```
DAZZ    PUSH    H           Save HL.
        CALL    DAZ         Compute memory address.
        PUSH    PSW         Save registers.
        PUSH    D
        ANI     15          Isolate nibble.
        MOV     D,A         Save it in the D register.
        MOV     A,E         Determine if dot belongs in
        RAR                 the left or right nibble.
        JC      LEFT        Odd column number means left.
        MVI     A,0F0H      Prepare mask.
        JMP     STBYT
LEFT    MOV     A,D         Shift nibble to left side
        RLC                 of the byte.
        RLC
        RLC
        RLC
        MOV     D,A
        MVI     A,15        Mask.
STBYT   ANA     M           Get other nibble from memory.
        ORA     D           OR in the new nibble.
        MOV     M,A         Store final byte.
        POP     D           Restore registers.
        POP     PSW
        POP     H
        RET
```

Program B. Store a nibble. This routine has the same parameters as "Compute Dazzler Location" with the nibble to be stored in the low order portion of the A register. All registers are preserved.

```
BOOK    LXI     SP,STK      Initialize stack pointer.
        LXI     H,AREA      HL points to Dazzler area.
        MOV     A,H         Turn on the Dazzler.
        RAR
        ORI     80H
        OUT     14
        MVI     A,30H       Set Dazzler modes to
        OUT     15          2K with color.
LOOP    IN      1EH         Read row value from analog
        CALL    ADJ         port and adjust it.
        MOV     D,A         Save row in D register.
        IN      1FH         Read, adjust and save column.
        CALL    ADJ
        MOV     E,A
        IN      255         Read front panel switches and
        RLC                 move bit seven to carry bit.
        JC      0BAH        If switch seven is on, then
* return control to the IMSAI monitor.
        RLC                 Move next bit to carry flag.
        JC      CLER        If switch six is on, execute
* a routine to clear the screen.
        RAR                 Restore A to its original
        RAR                 value.
        CALL    DAZZ        Draw point on screen.
        LXI     D,200H      A delay loop is used to
DLY     DCX     D           reduce the flicker that
        MOV     A,E         results when using the analog
        ORA     D           and Dazzler at the same time.
        JNZ     DLY
        JMP     LOOP
CLER    MVI     A,3FH       Clear the screen by storing
CLR2    MVI     M,0         zeros in the entire Dazzler
        INX     H           display area.
        CMP     H
        JNC     CLR2
        JMP     BOOK
* The analog port supplies a number between -128 and +128.
* The following routine adjusts that value to a number
* between 0 and 256, then divides by four (two right shifts)
* to obtain a number between 0 and 64.
ADJ     ADI     128         Make value positive.
        RRC                 Divide by four.
        RRC
        RET
SP      EQU     6
AREA    EQU     3800H       Display area.
STK     EQU     1200H       Stack area.
```

Program C. Book. A program that allows the user to draw on the television screen using Cromemco's Dazzler and analog I/O boards. Two analog ports control the horizontal and vertical while front-panel switches determine color.

each dot, plus one extra location for each row in the figure, plus one extra at the end of the figure. The contents of each element of the array represent the color of the corresponding dot on the screen. An ASCII character has been assigned to represent each possible color. Two special control characters are used to indicate the end of a row (an ASCII ← or Hex 5F) and the end of a figure (an ASCII / or Hex 2F). The routine takes a starting row and column and begins placing the coded dots from left to right. When the end-of-row character is encountered, the routine returns to the original column in the next row; i.e., it performs a carriage return, line feed and tab to the starting column. When the end-of-figure character is found (if you forget the end-of-figure character some "dazzling" displays can result), the subroutine returns to the caller.

The easiest way to use this routine is to first plan your figure on a piece of graph paper. Determine the final size of the figure and block off a section of the paper. Then, using colored pencils or crayons, color the squares in the shape of the desired picture. Using the values in Fig. 5, translate the drawing into assembler code. Fig. 6 shows an example from the short-range scan routine of a Star Trek program. In addition to figures for the Enterprise, stars, torpedos, Klingons, etc., there is an empty figure with all black squares. This empty figure is drawn over another figure, and the subject figure is redrawn elsewhere to simulate motion.

The Dazzler also has a times-four resolution option. In this mode there are four

```
DAZP     PUSH   PSW          Save registers.
         PUSH   B
         PUSH   D
DAZP2    PUSH   D            Save starting row and column.
DAZP3    LDAX   B            Next picture element.
         CPI    '/'          Is it the end of the picture?
         JZ     DAZP5
         CPI    '←'          End of line?
         JZ     DAZP4
         CALL   DAZZ         Store the nibble.
         INR    E            Next column.
         INX    B            Next picture element.
         JMP    DAZP3
DAZP4    POP    D            Restore original column.
         INR    D            Increment to next row.
         INX    B            Step over the left arrow.
         JMP    DAZP2
DAZP5    POP    D            Pop off row/column pointer.
         POP    D            Restore registers.
         POP    B
         POP    PSW
         RET
```

To use this routine in the times-four resolution:

1. Change the CALL DAZZ to CALL DAZ4.
2. Coded picture information should be stored one byte for each dot as follows.

HEX	ASCII	MEANING
30	0	Dot off.
31	1	Dot on.
5F	←	End of row.
2F	/	End of picture.

3. The Dazzler must be turned on by the user to the times-four mode with the desired color.

This sample program draws the Enterprise in times-four mode.

```
PIC      LXI    SP,STK       Initialize stack.
         MVI    A,9CH        Turn on Dazzler at
         OUT    14           location 3800 (hex).
         MVI    A,7CH        Set mode to 2K, times four
         OUT    15           and bright blue.
         MVI    E,20         Draw picture at row and
         MVI    D,20         column twenty.
         LXI    B,ENTR2      Address of picture.
         LXI    H,3800H      Dazzler area.
         CALL   DAZP         Draw it.
         JMP    0BAH         Exit to monitor.
ENTR2    DC     '00000000←00000000←' First two rows are empty.
         DC     '11110000←01001111←'
         DC     '00100100←01111110←'
         DC     '00000000←00000000/'
```

Program D. Dazzler picture drawer. The Dazzler area is pointed to by HL, the starting row and column by D and E respectively, and BC points to the picture array. Each array word represents one dot. Only the low order four bits are used for picture information. An ASCII left arrow indicates the end of a row and an ASCII slash is end of picture.

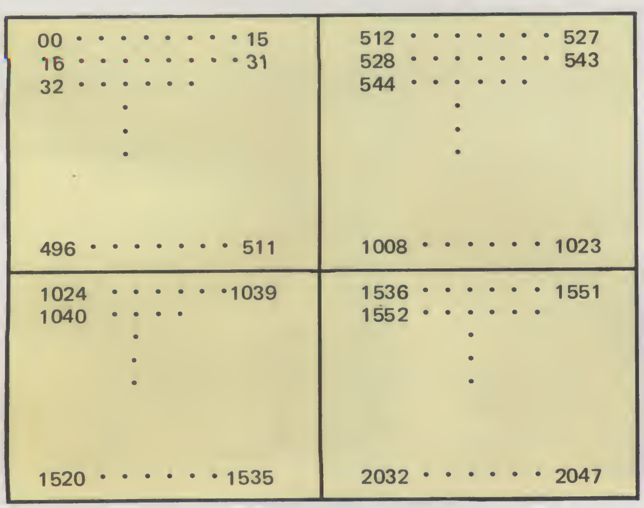


Fig. 4. A 2K display is divided into four quadrants of 512 with relative memory addresses mapped as shown.

ASCII	HEX	COLOR OR CODE
A	41	Red
B	42	Green
C	43	Yellow
D	44	Blue
E	45	Blue-green
F	46	Purple
G	47	Gray
H	48	Black
I	49	Bright red
J	4A	Bright green
K	4B	Bright yellow
L	4C	Bright blue
M	4D	Bright blue-green
N	4E	Violet
O	4F	White
←	5F	End of row
/	2F	End of figure

Fig. 5. ASCII characters, hex values and coded color for the figure-drawing routine DAZP.

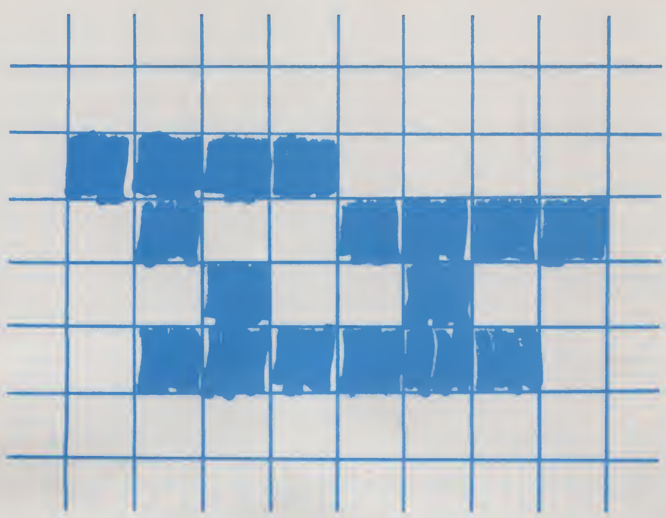
```
DAZ4    PUSH    D           Save registers.
        PUSH    B           First the routine determines
        PUSH    H           which bit in the byte is being
        PUSH    PSW         addressed.
        MOV     A,E         Isolate the low order three
* bits of the column. i.e., column modulo four because
* each byte contains four columns of dots.
        ANI     3           If the result is zero then
        MVI     B,5         the desired bit is 0 or 2.
        JZ      MSK2
        MVI     B,10        Value one indicates bit
        DCR     A           1 or 3.
        JZ      MSK2
        MVI     B,50H       Value two is bit 4 or 6.
        DCR     A
        JZ      MSK2
        MVI     B,0A0H      Otherwise it's bit 5 or 7.
MSK2    MOV     A,E         Divide column by two.
        RAR
        MOV     E,A
        MOV     A,D         If row value is even then
        MVI     C,33H       the described bit is
        ANI     1           0, 1, 4 or 5.
        JZ      MASK
        MVI     C,0CCH      Otherwise it's bits 2, 3, 6 or 7.
MASK    MOV     A,C         AND results together to
        ANA     B           determine which bit was selected.
        MOV     B,A         Save mask
        CMA                 and its complement.
        MOV     C,A
        MOV     A,D         Divide row value by two.
        RAR
        MOV     D,A
        CALL    DAZ         Compute memory address.
        POP     PSW         Get a register back again.
        PUSH    PSW
        RAR                 Set all bits of A equal to
        SBB     A           Low order bit.
        ANA     B           Select out desired bit
        MOV     B,A         and save it.
        MOV     A,M         Get selected byte from memory.
        ANA     C           Turn off selected bit.
        ORA     B           Selectively turn bit on.
        MOV     M,A         Return to memory.
        POP     PSW         Restore registers.
        POP     H
        POP     B
        POP     D
        RET
```

Program E. 4X Dazzler routine. This routine allows the user to turn any dot on or off in the times-four mode. HL points to the Dazzler area, DE the desired row and column, and the low order bit of the A register is stored. All registers are preserved.

times as many dots on the screen. In a 512-byte display they are arranged in 64 rows of 64 columns. In the 2K display there are 128 rows with 128 columns, for a maximum total of 16,384 dots! This permits very good resolution for a graphics display using only 2K of memory.

The internal representation in the times-four mode differs from the normal mode. Rather than having each dot defined by a nibble, each dot is now mapped from a single bit. Each dot on the screen is either turned on or off depending on its corresponding bit being on or off. The mapping of bits is different than the mapping of nibbles. The bits from each memory location are mapped into two rows of four dots each (see Fig. 7). The placement of bytes remains the same. Byte zero goes to the upper left corner of the screen, byte 1 immediately to its right, etc., with byte 16 immediately below byte zero. In the 2K mode, the four-quadrant concept remains the same.

In the times-four mode, the color of all the "on" dots is determined by the value of the low order nibble of one of the Dazzler control ports. The values for the various colors are the same as in normal resolution (Fig. 1.). To change the color of the display, a new value must be sent to the output port. Note that the high order bits that set the various mode options



```
ENTR    DC      'HHHHHHHH ←'     ; First two rows are empty.
        DC      'HHHHHHHH ←'
        DC      'LLLLHHHH ←'     ; Engine pods.
        DC      'HLHHLLLL ←'
        DC      'HHLHHLHH ←'
        DC      'HLLLLLLH ←'
        DC      'HHHHHHHH ←'     ; Last two rows empty.
        DC      'HHHHHHHH / '    ; End of picture.
```

Fig. 6. A sample picture from Star Trek.

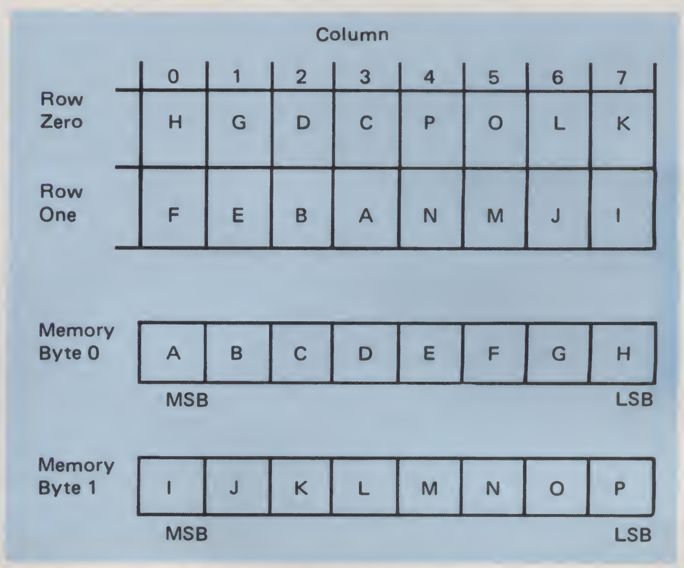
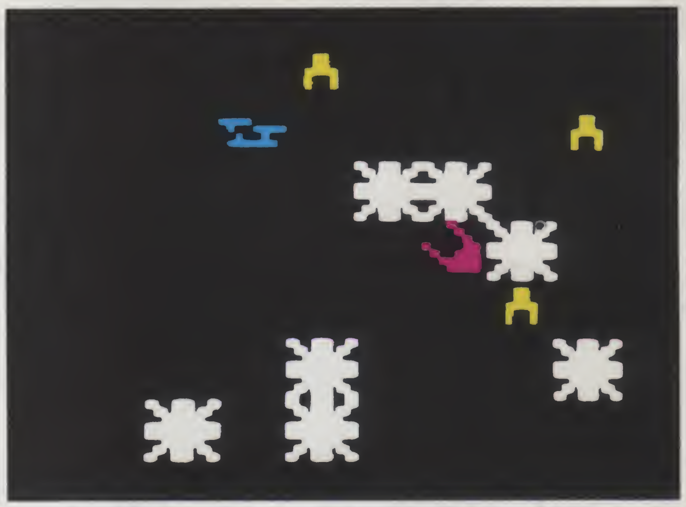


Fig. 7. Mapping of bits in 4X resolution.

must also be set to the appropriate value whenever outputting to this port. To achieve a multicolor display in the times-four mode, the user must constantly change the values at the control port.

The next subroutine is used to turn a selected dot on or off by row and column number in the times-four mode. As before, the rows are numbered from top to bottom, except now the values range from zero to 127. The input parameters are the same as before: DE contains the row and column numbers, HL contains the starting address of the display area, and the low order bit (bit zero) of the A register is set to zero or 1 depending on whether the selected dot is to be turned off or on. The routine is called DAZ4.

The sample program to demonstrate the times-four mode is an updated version of the coloring book used before. The program accepts input from the keyboard rather than the analog ports. The user draws on the screen by directing a cursor from the keyboard. The letters R, L, U and D direct the cursor right, left, up and down. If the front panel sense switch zero is on, the bit at the current cursor position is turned on; otherwise it is turned off. The carriage-return key causes the screen to be cleared and the ESCAPE key causes an exit to the Imsai monitor. Since the keyboard input routine is usually unique to each system, it is omitted from the program listing.



Short-Range Scan from Star Trek in normal resolution with 2K bytes. The Enterprise is in a quadrant with three Klingon cruisers and a Klingon commander who is hiding out of photon torpedo range behind a star.

```
FBOOK   LXI   SP,STK     Initialize stack pointer.
        MVI   A,9CH      Turn on Dazzler with display
        OUT   14         area at address 3800 (hex).
        IN    255        Get desired color from
        ANI   15         front panel switches. (Fig. 1 for values)
        ORI   A,70H      Set modes to 2K, times four
        OUT   15         color.
STK     EQU   1200H
SP      EQU   6
START   LXI   D,3800H
        LHLD  RC         Current cursor location in
        XCHG             DE and address in HL.
        MVI   A,15       Turn cursor on.
        CALL  DAZ4
        CALL  KB         Get character from keyboard.
        PUSH  PSW        Save it.
        IN    255        If front panel switch zero
* is on, turn on the dot, otherwise turn it off.
        CALL  DAZ4       In either case the cursor
* is overlaid.
        POP   PSW        Restore keyboard input.
        CPI   13         Test for carriage return.
        JNZ   ESC
        MVI   A,3FH      If carriage return then
C2      MVI   M,0        clear the screen.
        INX   H
        CMP   H
        JNC   C2
        JMP   START
RC      DB    0          Current column, initially zero.
        DB    0          Current row, initially zero.
ESC     CPI   1BH        Test for ESCAPE key.
        JZ    0BAH       Exit to Imsai monitor.
        LXI   H,RC       Address of column number.
        CPI   'R'        An R means to move the
        JNZ   LEF        cursor to the right by
        INR   M          incrementing column value.
        JMP   START
LEF     CPI   'L'        An L means to move cursor
        JNZ   DWN        to the left by decrementing
        DCR   M          the column value.
        JMP   START
DWN     INX   H          Address of row number.
        CPI   'D'        Move cursor down by
        JNZ   U          incrementing the row
        INR   M          pointer.
        JMP   START
U       CPI   'U'        Cursor up by
        JNZ   START      decrementing row value.
        DCR   M
        JMP   START
PSW     EQU   6
        END
```

Program F. Book times four. This program allows the user to draw figures on the Dazzler in times-four resolution. The keyboard is used to direct a cursor about the screen. This routine can also be used in the normal resolution mode. To do so, change CALL DAZ4 to CALL DAZZ and set Dazzler mode with ORI 30H rather than ORI 70H. It was with these modifications that Dave drew "Concentric Squares" (see color photo).

Summary

The "Dazzler Picture Drawer" subroutine can be used in the times-four mode if the CALL DAZZ instruction is changed to CALL DAZ4. This, however, will result in a tremendous waste of memory for all except the smallest picture. To store a full-screen picture for the DAZP routine would take 16K.

Now that it is easier to draw on the Dazzler, nearly all my new programs incorporate some form of graphic output. If you own a Cromemco Bytesaver board, the various routines can be stored in PROM ready for instant use. In my Imsai 8080 system, I save RAM by executing the utility subroutines directly out of PROM. Each new source program contains a series of equate (EQU) statements to permit symbolic references to PROM subroutines. If your BASIC permits assembler subroutines, having these programs in PROM makes it easy to have graphic output from BASIC. ■

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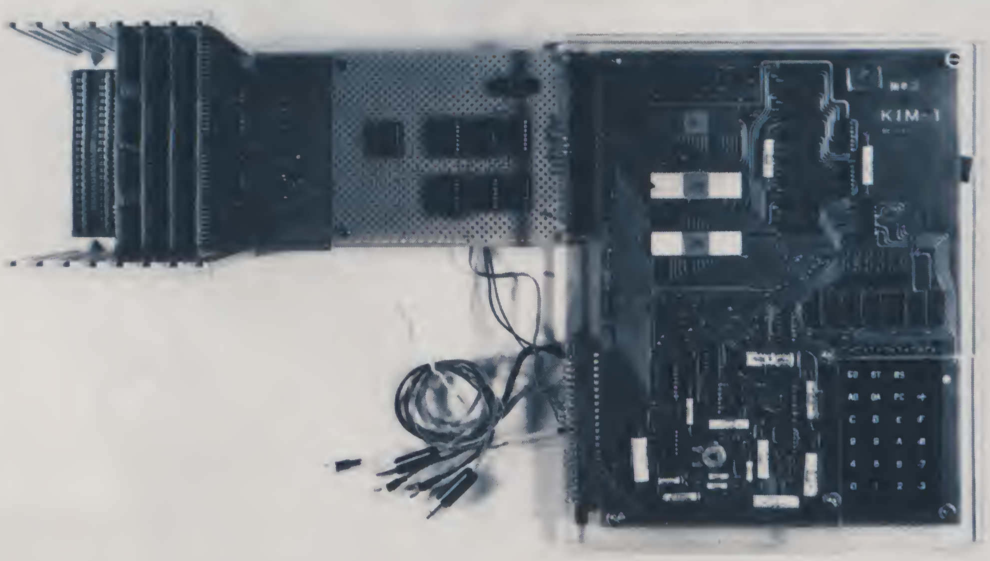
Groton CT 06340

A Sensible Expansion: Atwood Memory for your KIM

There is a variety of techniques—commercial and home-brew—for KIM memory expansion. Use of Atwood boards ranks among the lower-cost methods.



KIM-1, interface/decoding circuit and Atwood Enterprises motherboard with 16K of memory.

An inexpensive way to expand the memory of a KIM-1 is to use the 4K memory cards made by Kathryn Atwood Enterprises. A single 4K card costs about $90, fully assembled. The cost of a 16K expansion for the KIM is under $400, including the cost of interfacing, connectors and mounting requirements.

Atwood's memory board comes fully buffered with CMOS on the address lines and Tri-state buffer drivers on the data lines. On-board decoding of the address lines is also provided. The board is not designed for S-100 bus operation; thus the KIM does not require additional circuitry for S-100 bus operation. Documentation includes an interconnection diagram, application notes and parts layout.

A motherboard, available for the memory card, is supplied free with the purchase of four memory cards. The motherboard construction and the bus used enable the memory card to be inserted in either direction without causing damage to the memory board. No connector is provided for the motherboard so you should purchase a connector, depending on your use of the KIM. I simply soldered directly to the motherboard, which worked, but made disconnecting the memory unit from the KIM slightly difficult.

The 4K Board

A functional schematic, provided in the interconnection diagram, is shown in Fig. 1. The data bus buffers are 8T26A and the address buffers are CMOS 4050. A 74LS138 is used to select each of the 1K banks of memory chips.

Basic operation of the memory card requires three steps: (1) connection of the 12 least significant address lines; (2) connection of the eight data lines; (3) application of the proper control signals. The control signals are defined in the Application Notes and are labeled Board Select, Output Enable and Read/Write.

Board Select is an enable signal that must be provided by some kind of decoder circuitry, depending upon where you choose to locate it in KIM memory allocation. The Board Select signal enables a 74LS138 on the expansion board, which determines the memory chips that will be enabled. If the Board Select is low, the memories will not be enabled, and you will not be able to read or write from them.

The Output Enable signal determines the direction of data through the Tri-state buffers. The Output Enable is a logical AND with the Board Select signal to determine data direction. If either signal is low, the buffers will be in a write state and appear as a high impedance to the microprocessor.

Only when both signals are high will you be able to drive the data bus from the memory (i.e., read from memory). When the Board Select is high, enabling the memory, and Output Enable is low, you will be able to write from the data bus to memory. Since the KIM R/W is a high read and a low write signal, it

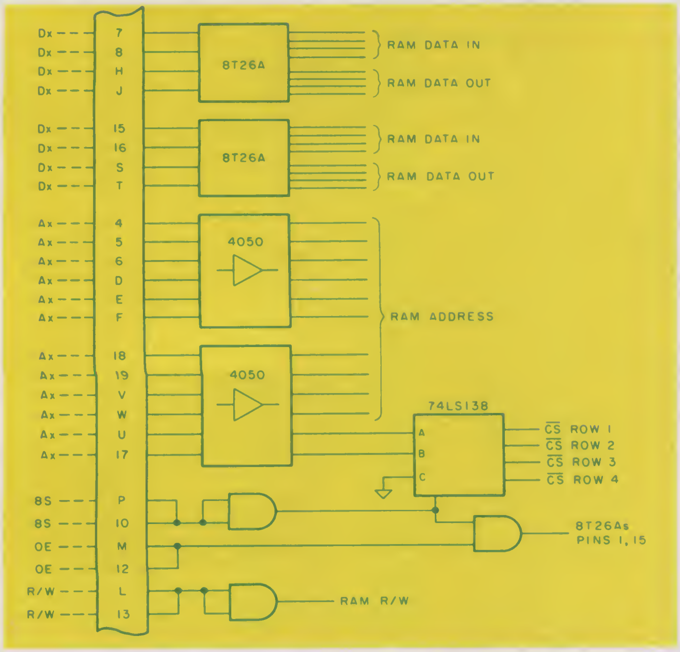
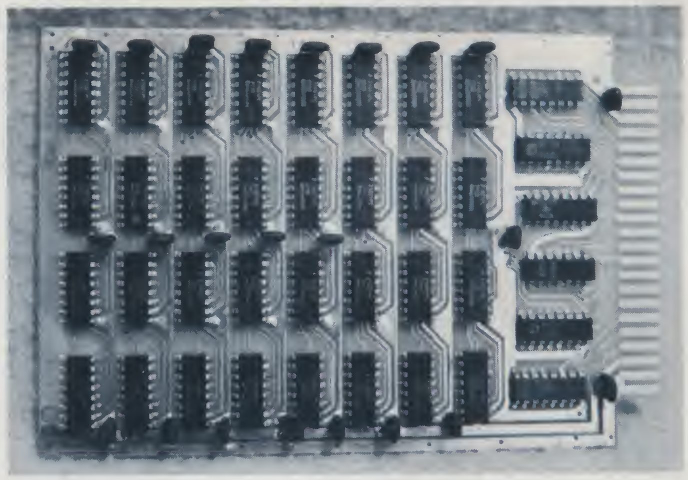


Fig. 1. Functional schematic of memory board.



The assembled Atwood 4K board.

can be used as the Output Enable signal for the expansion board.

The Read/Write signal indicates to the memory chips whether to read or write data. According to the Application Notes, the line should remain high until the address has been present at the RAMs for a minimum of 170 ns and should return high 40 ns before the data becomes invalid. The RAM R/W signal on the KIM meets those criteria and can be used for this signal. Pages 17, 18 and 19 of the *KIM Hardware Manual* show that the address will be valid for approximately 400 ns before RAM R/W goes low; the RAM R/W returns high about 30 ns before data becomes invalid.

Memory Decoding

If you wish to expand your KIM by only 4K, the job is simple. As seen in Fig. 2, the main problem of a 4K expansion is with the interconnections: the connection of the address and data lines. The Output Enable and Read/Write of the memory card are connected to the KIM R/W and the RAM R/W, respectively. The Board Select signal is generated by "wire-ORing" K1, K2, K3 and K4 on the KIM and then inverting this signal for the memory card.

Expanding the KIM above the 8K that is already decoded on the KIM causes two problems: the need for additional decoding and vector management for $\overline{NMI}$, $\overline{IRQ}$ and $\overline{RST}$.

Page 75 of the *KIM User's Manual* shows that whenever an $\overline{RST}$ (for example) is activated, the addresses FFFC, FFFD are placed on the address bus by the 6502, and the data fetched from these locations is loaded in the program counter. The basic KIM-1 does not decode the three highest address bits so that FFFC, FFFD will be read as 1FFC, 1FFD, which places you in the KIM monitor program. Whenever the KIM is expanded above the lowest 8K of memory, it becomes necessary to decode the three highest address lines.

Now when an $\overline{RST}$ occurs, U4 on the KIM will be deselected and K7 will not be activated to place you in the KIM monitor program. The solution to this problem is to generate a special signal whenever an interrupt vector occurs and "wire OR" this with the K7 output of U4.

The generation of the vector select signal is shown in Fig. 3. The method used is the same as that illustrated on page 74 of the *User's Manual*. Whenever an interrupt vector is generated, AB15, AB14 and AB13 will go high and output 7 (pin 9) of U1 will go low; this will enable U3. Since AB12, AB11 and AB10 will also be high, output 7 (pin 9) of U3 will go low. This will force K7 on the KIM low and read the vector address from the KIM monitor program. This enables the programmer to handle the interrupts as he would in the basic unexpanded KIM.

The decoding for the 4K boards is different from the decoding shown in the KIM 65K expansion shown on page 74 of the *User's Manual*. Instead of generation of a select line for each 1K of memory, you need a select for every 4K. Since 4K of memory equals 1000 hex (AB12 high and all other address lines low), the four highest-order address lines are all that need to be decoded. The highest decoded address on basic KIM is 1FFF, which means we must start decoding at 2000 hex (AB13 high, all other address lines low).

In Fig. 3, U1 and U2 are used to generate the Board Select signals. AB15, AB14 and AB13 are used to select a line for each 8K of memory. Whenever the address is below 1FFF, the 0 output of U1 will be low and you will be in the basic KIM memory. When AB13 goes high (2000 hex), output 1 (pin 2) will go low. The KIM memory will be disabled and the B input (pin 14) of U2 will be high. AB12 will be low, making Input A (pin 15) of U2 low. Output 2 (pin 3) of U1 will be high, making U2 input C (pin 13) low.

These input conditions on U2 will select output 2 (pin 3) of U2. Output 2 will remain enabled as long as the address is between 2000 hex and 2FFF. When 3000 hex is reached, AB12 will go high, changing the input A of U2 to a high, and output 3 of U2 will be enabled. This continues for other addresses with U1 selecting an 8K block and U2 dividing it into a low and high 4K block.

The decoder circuit in Fig. 2 will decode addresses 200 hex to 5FFF. By using outputs 3 and 4 of U1, The decoder will work

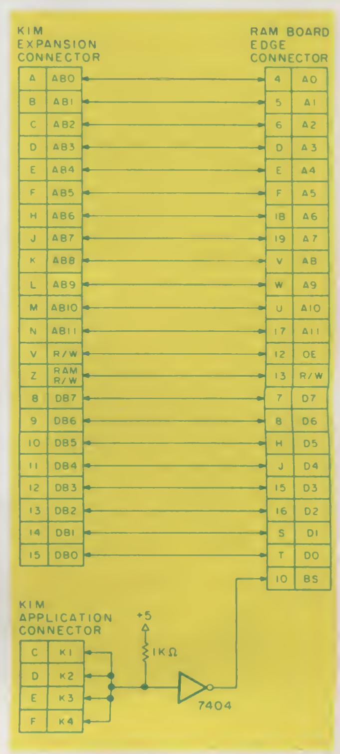


Fig. 2. 4K memory expansion.

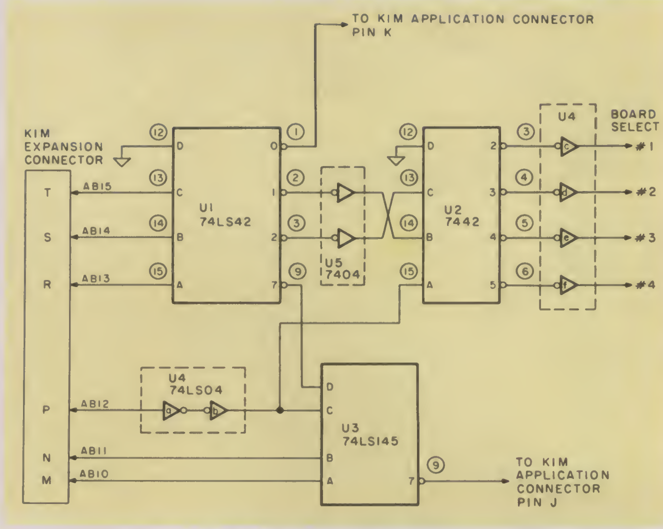


Fig. 3. 16K memory expansion.

from 6000 hex to 9FFF. Adding two more 7442 decoders to the U1 outputs allows expansion to 48K of RAM without any additional circuitry.

The outputs of U1 are active low and the inputs of U2 are active high, so the inverters of U5 are needed for the proper signal on the input to U2. The Board Selects for the memory cards are again active high, so the outputs of U2 must be inverted. U2 inverters A and B are used to reduce the loading on AB12.

Expansion Tips

I recommend three steps when you expand your KIM.

1. Use 74LS series TTL circuits because they are only 1/5 of a normal TTL load. If you choose not to do this then you must use buffers.

2. Use wire-wrap construction, as opposed to printed circuits. This will make construction much simpler and will make future changes and expansions easier.

3. Obtain a fairly heavy power supply. The KIM and four memory cards require about 3.1 Amps so a 5 Amp power supply is enough, but future expansion soon forces you to get another supply. A 10 Amp supply should allow expansion to a full 48K of RAM.

I constructed my expansion on a Vectorboard-punched terminal board. A 44-pin connector was mounted on one side of the card to mate with the KIM expansion connector. The other end was supported by 3/4 inch spacers. The motherboard for the memories was placed adjacent to the expansion board, which allowed the use of short wires for interconnections of about 7 inches.

After constructing the expansion, if nothing happens when you press KIM reset (RS), and the display remains blank, check pin 9 of U3. It should go low every time reset (RS) is pressed. If the board select is inoperative, the data byte will be the same as the high-order address byte.

The Atwood Enterprises memory card is an inexpensive and easy way to expand your KIM. The hardware needed to expand is minimal and there is no need to worry about S-100 bus compatibility. The board is available for $79.95 in kit form ($89.95 assembled and tested) from Kathryn Atwood Enterprises, PO Box 5203, Orange CA 92667.

Although not mentioned in my article, several other boards are available for use with the Atwood motherboard. These include an EPROM board, an I/O board and a KIM interface board that accomplishes the same expansion as the circuit I've described in this article (it sells for $24.95 kit and $34.95 assembled). ■

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MIKBUG with Muscle!

Microware Systems' RT-68/MX can out-punch—and outperform in other ways—the old, less developed standby.

You have probably read before that dear old MIKBUG was designed by Motorola for use in their evaluation kit. As a result, MIKBUG is rather lacking as a monitor/operating system for a general-purpose computer. Although several firms have developed MIKBUG replacements, Microware Systems Corporation (PO Box 954, Des Moines IA 50304) has produced the Mr. America of MIKBUGs—The RT-68/MX.

Like MIKBUG, the RT-68/MX is a mask-programmed MC6830 ROM, making it hardware compatible with MIKBUG. The RT-68/MX contains a MIKBUG-compatible monitor and a real-time 16-task executive. What exactly is meant by MIKBUG compatible, and why worry about it?

By MIKBUG compatible, I mean that RT-68/MX contains (sub)routines which perform the same functions as the user-callable routines in MIKBUG at the same addresses those routines are found in the MIKBUG ROM. The reason for worrying about MIKBUG compatibility is the large volume of currently available software written for MIKBUG-based 6800 systems; much of this software is priced from free to cheap! By having MIKBUG compatibility, this software can be used in RT-68/MX-based 6800 systems with little or no modification to the software.

In the above paragraph, I mentioned a "real-time 16-task executive." This might sound like a lot of computer jargon but is actually self-explanatory. An executive is a program that supervises the running of other programs (for additional definitions, see the accompanying glossary). It determines which jobs can be done, their priority, etc. Calling it a 16-task executive simply means that it can supervise the running of up to 16 other programs at any given time. Adding the real-time portion means that the executive can alter its work in response to changing conditions in the real world.

Your brain has an excellent real-time executive! Don't believe it? Suppose you were driving to work and had a flat tire. If you were not operating in real time, you would just continue the program you had been executing (driving). But you do operate in real time, so you interrupt your current task and call a routine to rectify the problem (fix the flat tire), then resume your original task (driving to work). The RT-68/MX's real-time 16-task executive responds to real-world conditions in much the same manner; that's why it can allow your 6800 to be your fire alarm and burglar alarm, and to play games with your kids—all at the same time!

The Console Monitor

The console monitor of the RT-68/MX represents a substantial improvement over the MIKBUG monitor. Fig. 1 is a chart containing a comparison of the MIKBUG and RT-68/MX monitors and may be used for quick reference. The MIKBUG monitor has five command-level functions: (1) punch paper (or magnetic) tape from memory; (2) load paper (or magnetic) tape to memory; (3) open memory location for examination/change; (4) print registers from stack; and (5) execute program from stack. The RT-68/MX also contains these command-level functions plus an additional five. Where possible, Microware has improved upon the MIKBUG functions—the punch command, for example.

Using MIKBUG to punch a tape, a user must first use the memory-examine/change function to open memory locations \$A002 - \$A005 and put the starting address of the program into locations \$A002 + \$A003, and the ending address of the program into locations \$A004 + \$A005. He must then use the punch function to actually punch the tape.

To punch a tape using the RT-68/MX, the user types the following: P,LLLL,HHHH (LLLL is the starting address and HHHH is the ending address). Also, RT-68/MX begins a tape with a two-second header (at 300 baud) of nulls to allow the recorder to get up to speed, while MIKBUG does not. Tapes made by RT-68/MX use the Motorola format and are, therefore, directly loadable by MIKBUG-based 6800 systems. Most of RT-68/MX's additional functions are sufficiently covered

Command		Function
MIKBUG	RT-68/MX	
P	P,LLLL,HHHH	punch paper (or magnetic) tape from memory.
L	L	load paper (or magnetic) tape from memory.
M LLLL	M,LLLL	open memory location for examination/change.
R	R	print registers from stack.
G	G	execute program from stack.
N/A	D,LLLL,HHHH	print formatted memory dump on control terminal.
N/A	B,LLLL	insert a breakpoint.
	B	remove a breakpoint (see text).
N/A	E,LLLL	execute a program beginning at LLLL.
N/A	S	activate real-time executive (see text).
N/A	ESCape	user defined (intended as a jump to the user's disk system bootstrap PROM).

Fig. 1. A quick-reference comparison chart of the features of MIKBUG vs RT-68/MX. In all cases where a command requires an address, it is indicated as LLLL; where two addresses are required, they are shown as LLLL and HHHH.

by Fig. 1; however, two of them are worth a closer look.

Breakpoints

The BREAKPOINT command has two formats and represents a considerable increase in sophistication compared to the breakpoint capability of MIKBUG.

To enter a breakpoint (software interrupt), type B,XXXX (XXXX is the address where the breakpoint is desired). The contents of address XXXX are replaced with a software-interrupt instruction, and the original contents are saved for future use. When the breakpoint is encountered, the contents of the 6800's registers are displayed on the control terminal; then control is given to the RT-68/MX monitor. At this point, typing G will restart the execution of the program at the breakpoint location (as though the breakpoint were not there).

To remove a breakpoint, type a B, followed immediately by a carriage return. This not only removes the breakpoint but restores the original contents of the memory location.

If a breakpoint is encountered at an address other than the one specified in a BREAKPOINT command, an error message is printed on the control terminal. RT-68/MX supports seven different error messages, which are printed in response to an unrecognizable command from the operator or a bad checksum when loading tape, for examples, as well as the breakpoint error.

The Real-time Executive

To understand how Microware is able to get a powerful real-time executive into the RT-68/MX, you must first understand how the 6800 reacts to interrupts.[1] When the 6800 receives either a maskable interrupt, nonmaskable interrupt or software interrupt, the contents of all the 6800's registers are pushed onto the stack; then the 6800 vectors are pushed onto the appropriate interrupt-handling routine. Also, when a return from interrupt instruction is encountered, all of the 6800's registers are loaded from the stack, and program execution is resumed.

Microware utilizes these characteristics to the fullest in their RT-68/MX real-time executive. For the 6800 to operate under the RT-68/MX's real-time executive, it must receive interrupts at regular intervals (Microware recommends 10 Hz to 100 Hz rates and suggests, in their manual, several inexpensive methods of attaining this). These clock interrupts are handled in a transparent manner when in the console monitor or when running programs in the single-task modes.

Why all the talk about interrupts and clocks? Because the RT-68/MX's real-time executive is only active immediately following an interrupt. Usually, these interrupts are from the real-time clock, which causes the executive to check on the task the system is currently running or, perhaps, change tasks. Sometimes the interrupt comes from the outside world.

Say your house was on fire. The RT-68/MX's executive would run the necessary task to determine the problem; this task could then call on another task to take corrective action (turn on the sprinklers).

To schedule tasks in the multitask mode, the executive uses a task-status table (in RAM), which contains three bytes for each possible task. The first byte of each entry is the task-status byte (TSB), which tells the real-time executive several things about the task: first, whether the task is turned on (runnable) or is turned off (not runnable); second, the priority level of the particular task—eight levels of priority are allowed, and higher-priority tasks are given preference over lesser tasks; finally, how long the task is allowed to run before being deferred in favor of another task at the same priority level.

Because Microware has chosen this method of scheduling tasks, tasks may be turned on or off, their priority level changed or the amount of time they are allowed to run modified dynamically (i.e., by themselves or by other tasks) by merely changing the TSB.

The second and third bytes used for each entry in the task-status table contain the address of the stack for that particular task. Thus, tasks are rotated in a round-robin fashion by first examining the TSB for each task to find the highest-priority runnable task, then loading the 6800's stack pointer from the two bytes following the task's TSB. The task is then executed by a return from interrupt instruction.

As the above implies, to run under the RT-68/MX's real-time executive a task must establish and maintain its own individual stack. While the work of the RT-68/MX's real-time executive sounds quite complex, it is important to remember that it actually uses a minute percentage of the 6800's time. The tasks themselves receive the lion's share.

Using the RT-68/MX

The power the real-time executive gives to the 6800 computer system must be seen to be appreciated. The very first day I had the RT-68/MX in my Southwest Tech system, I had my disassembler printing a listing of BASIC on the PR-40 printer *while* I was using BASIC to play Star Trek at the control terminal. The PR-40 was going full bore, and I could detect no decrease in the speed of the game!

It is easy to envision many uses for this powerful system. Perhaps the 6800 could be used as a resource controller for a large multiuser system. Think about this computer system for a high school. Instead of terminals, each user could have a Commodore PET (for very low cost). The PETs could easily be interfaced to the 6800 via the IEEE bus since it is very easy to use a 6800 with the IEEE bus. The PETs could access the 6800 on a demand (interrupt) basis. Since the communication on the IEEE bus is in par-

Glossary

Breakpoint: See Software Interrupt.
Compiler: A program that converts a program written in a high-level language, such as BASIC, into machine language.
Executive: A program that supervises the running of other programs.
Interrupt: A machine instruction or a signal from a device external to the computer that causes the computer to suspend the execution of its current program in favor of a program that determines the cause of the interrupt and deals with it accordingly.
Maskable Interrupt: An interrupt that may be enabled or disabled under program control.
Nonmaskable Interrupt: An interrupt that may not be disabled under program control. Normally used only by the real-time clock and/or highest-priority device.
Real Time: The ability of the computer to alter its work in response to unexpected, changing conditions in the outside world.
Real-time Clock: A source of interrupts at regular, timed intervals.
Software Interrupt: A machine instruction that suspends the execution of the current program and calls an interrupt-service routine. Often referred to as breakpoint and used as a tool for program debugging.
Stack: A group of memory locations used for temporary storage by the computer. The computer's "scratchpad."
Task: A user program in a time-shared system.
Time-sharing: A system that allows the computer to give the impression of running two or more programs at the same time. Accomplished by having the computer alternate between the different user programs several times each second.

allel form, this communication could take place *very* rapidly. The 6800 would be used to control access to the system resources such as disk drives, tape drives, printers, plotters, etc.

In addition to being cost-efficient, such a system should be competitive compared to a time-shared minicomputer because each user would have his own processor. Thus, increasing the number of users would not slow the processing speed for the users. The only time any user would be involved in time-sharing would be when communicating with a system resource.

This could be speeded up when the use of a printer was desired, for example, by sending the entire message to be printed to the 6800 as a batch and stored in a disk file. The 6800 could print the message from the file when it had the opportunity without user involvement. In fact, the message might be printed while the user was running another program. The possibilities are limitless!

The Documentation

The 78-page user's manual provided with the RT-68/MX includes a complete source listing of the RT-68/MX. It is an excellent example (to other firms in the hobby-computing field) of how to do it right. Microware is to be commended on the completeness and quality of the documentation for the RT-68/MX! In addition to the expected discussion of the console monitor, the manual is a virtual textbook on time-sharing the 6800. Some of the topics covered in detail are:

- interrupt processing
- task programming techniques
- system planning
- real-time reference clock
- multiprogramming overview
- task selection
- task switching
- I/O handling

System hardware considerations are also discussed in sufficient detail for easy understanding by those with a limited hardware background. Two methods for obtaining a real-time clock for about a dollar, as well as other hints and suggestions, are provided. The source listing in the manual is the most thoroughly commented listing that I have ever seen (see Fig. 2).

```
                          *LOOP TO SEARCH THROUGH TABLE FOR
                          *HIGHEST RUNNABLE TASK
                          *STARTS WITH CURRENT TASK AND COUNTS
                          *DOWN SO LAST TASK TESTED IS THE
                          *CURRENT TASK #-1. THIS ALLOWS TASKS
                          *AT SAME PRIORITY LEVEL TO EXECUTE
                          *ROUND ROBIN.
E2F3   8D   48            EXEC03  BSR     FNDTSB   FIND TSB
E2F5   2A   0D                    BPL     EXEC04   BRA IF TASK OFF
E2F7   C4   07                    AND B   #$07     MASK PRIORITY
E2F9   D1   09                    CMP B   PTYTMP   COMP. TO HIGHEST SO FAR
E2FB   25   07                    BCS     EXEC04   BRA IF LOWER
E2FD   D7   09                    STA B   PTYTMP   MAKE IT LATEST
E2FF   16                         TAB              CHANGE SET TASK #
E300   CA   80                    ORA B   #$80     SET FOUND FLAG
```

Fig. 2. A small excerpt from the source listing provided with the RT-68/MX. Please note that it is so well commented that you can read it like a newspaper.

The manual's introduction contains a most unusual feature: inclusion of Microware's phone number and an invitation to call if you need assistance. The introduction is also signed by Ken Kaplan and Tom Callahan. These people are proud enough of their work to sign it—again, most unusual. They actively solicit comments from users for improvements to their software and documentation. The documentation explains how the RT-68/MX can help you recover from hopeless situations (such as having your 6800 "go bye-bye" so you can't regain system control by punching the RESET button). For me, this feature alone has been worth more than the $50 that RT-68/MX cost!

By now you are probably wondering how Microware is able to get all of this in a one-kilobyte ROM. Well, think about this: The RT-68/MX also has the capability of assuming either port 0 or port 1 (in the SWTPC 6800 computer) as the control port. This is done under hardware control, but Microware suggests in their documentation several possible methods of giving software control over this decision. Port 1 is assumed to be a standard MIKBUG modified PIA, while port 0 is an ACIA. By virtue of the way RT-68/MX's I/O routines are written, they may be used to communicate through an ACIA (or ACIAs) at any address(es). Since RT-68/MX's real-time executive can support a maximum of 16 tasks, the I/O routines in RT-68/MX could easily provide the I/O for 16 simultaneous users!

Conclusion

The RT-68/MX is a superior product—both the firmware and the documentation. It was produced and is sold by people who care about their product and who will bend over backward to assure their customers' satisfaction. Microware's first newsletter for RT-68 users told of a bug in the original RT-68 (the RT-68/MR) and how to correct it. Microware also offered to swap one-for-one, RT-68/MXs for RT-68/MRs, with all dissatisfied RT-68/MR users. I think that's good product support for a ROM! If I sound biased, so be it; but I have found Microware's product excellent and Microware a good firm with which to deal.

As I mentioned earlier, the RT-68/MX has many more user-callable subroutines than does MIKBUG; Microware takes full advantage of this feature in their new A/BASIC *compiler* for RT-68-based 6800 systems. A/BASIC will allow you to convert most of your favorite BASIC programs to machine language, time-share your 6800, and still have your programs run faster than they did with your old single-user BASIC interpreter! I can hardly wait to tell you all about it! ■

[1]An in-depth discussion of interrupts in the 6800 is beyond the scope of this article. In fact, interrupts in the 6800 could be fully dealt with in an article (much larger than this one) devoted only to interrupts. If you want more information on interrupts and the 6800, you might try the following:

1. *RT-68/MX User's Manual*, Microware.
2. *M6800 Applications Manual*, Motorola.
3. "Using Interrupts for Real Time Clocks," *Byte*, Nov. 1977, p. 50.
4. "Do You Need Real Time," *Byte*, Nov. 1977, p. 166.

Little Bits

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String Expansion for SWTP's BASIC

That the string length in SWTP's 6800 BASIC is preset to 32 characters really bothers me (I have version 2.0). It wastes tremendous amounts of memory if you are using short strings. Conversely, if you need a long string . . . such as when you are attempting to implement a justification routine, you must resort to some pretty strange wizardry. I tried to input two strings for each line of text I wanted to justify and the result was very confusing for the operator.

I was sure there was a location somewhere in memory that was used to set the string length. I knew I was looking for 20 hex and guessed that it would be preceded by a 26 hex (branch if not equal) instruction.

As it turned out, I found that 20 hex was stored at location 62 or $003E hex in the first page of memory. It is loaded into a register when needed and decremented until the string is full. The same location is used by the dimensioning statement in BASIC to set the amount of memory allocated for string arrays.

Here's the solution. The following statement inserted at the beginning of a BASIC program will set the string length —"POKE (62,6)." The string length in this example will be six characters. It could just as easily be "POKE (62,72)," etc. Of course, if you set the string length at 72, you won't be able to use nearly as many elements in your arrays as you are accustomed to with a fixed value of 32 characters.

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First Statement

A good first statement in every program you copy from a magazine reads like so:

```
0010 REM **ELECTRONICS CALCULATOR**, KILOBAUD, AUG. 77, PG. 60
```

The advantage is quick reference to the source if you want to reread the article; want to rewrite portions of the program but want to be able to check the original; or if for some reason your stored program bombs.

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Write Around What You Don't Have

Don't be alarmed because your BASIC doesn't have some of the statements you see in program listings in *Kilobaud* and other magazines. Improvise is the name of the game. Remember, you can't hurt anything (other than your ego) by trying different techniques. If you think it might work, try it. If it does, share it with others. For instance, Dave Culbertson's "Time Bomb" program (*Kilobaud* August 1977) was written in Mits 8K BASIC and contained the following use of an "AND" statement and a ≠ symbol (not equal to).

```
120 IF Z ≠ 13 AND Z<32 THEN B1 = 1: GOTO 340
130 IF Z = 82 THEN Z = 1: GOTO 180
```

SWTPC (and other) 8K BASIC doesn't contain an "AND" statement nor does the average keyboard contain ≠. Don't despair, write it like so:

```
120 IF Z<>13 GOTO 125
122 GOTO 130
125 IF Z<32 THEN B1 = 1: GOTO 340
130 IF Z = 82 THEN Z = 1: GOTO 180
```

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Develop Your Own Square Root Routine

There is no doubt that BASIC has become the language of choice among computer hobbyists. Yet there are so many versions of the language that it has become quite difficult to transfer a program from one company's system to another. The mathematical functions supplied with a given BASIC constitute a main part of this problem. Often you'll find a program you'd love to use but can't because it employs some function your BASIC doesn't have.

There's a way out of this mess. I'm going to present some commonly used routines in algorithm form. In order not to hurt anyone's feelings, I won't give any actual programs, but I will provide both a verbal description of the algorithm and a flowchart. The only requirement is that your BASIC have the capability to do

1. Make an initial guess at the square root (R) of the number (N). Let's make the guess one-half of N (R = N/2).

2. Multiply R by itself and compare the result to the original number, N. If they are equal, we're finished. Otherwise, continue with step 3.

3. If the difference (D) between R × R and N is less than or equal to some arbitrarily established constant (say .001), we're finished. This step keeps the program from looping forever. The constant you chose will depend on how many digits of precision your version of BASIC maintains.

4. Now we will refine our guess at the square root. This is the heart of the algorithm, and the speed of execution depends on how we refine the guess. Newton's method tells us that the next guess should be: $R_n = \frac{1}{2} * (R_{n-1}/N + R_{n-1})$. In words, the new guess is half of the old guess divided by the original number plus the old guess (R_n being the new guess and R_{n-1} being the previous old guess).

5. Go back to step 2.

Table 1.

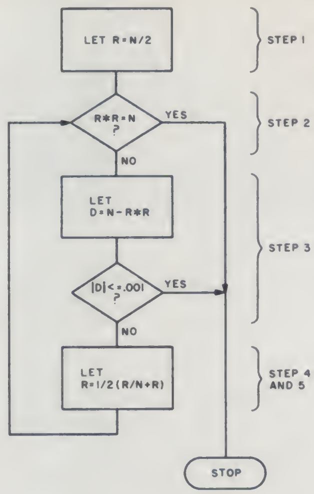

Fig. 1. Flowchart.

floating-point math.

To facilitate entry into the world of mathematics, we'll start with one of the simpler algorithms: the square root. This particular algorithm is known to mathematicians and students of computer science as Newton's Iterative Square Root. This rather imposing name (you can use it to impress your friends at parties) merely tells who discovered the algorithm (Newton), how it works (iterative means it loops, performing the same calculations repeatedly until some condition is satisfied) and what it actually does (gives you the square root of some number).

Before going any further, let's make sure we know exactly what the term square root means. The square root of a given number is that number which, when multiplied by itself, gives the original number. For examples, the square root of 4 is 2 (2 × 2 = 4); the square root of 42.25 is 6.5 (6.5 × 6.5 = 42.25). You may have noticed that the square root of a number can also be a negative number. For simplicity's sake, though, we'll limit ourselves to positive roots.

The algorithm for Newton's Iterative Square Root is explained sequentially in Table 1. Read it carefully and try it on a couple of numbers whose square roots you already know.

Everything is clear as mud, right? For this reason, the Creator and IBM invented the flowchart. If you check out Fig. 1, things should become at least a little clearer. Notice that the brackets to the side of the flowchart are numbered. These numbers correspond to the numbers of the steps in Table 1. If things are still hazy, try a couple of run-throughs by hand using the flowchart. As in most problems of this type, you probably can't "see the forest for the trees." Have someone help you look over your work.

The final step is to actually program this little gem. If the program works, you either know what you're doing or you lucked out. If it doesn't work, either you messed up or your BASIC doesn't have floating-point math. This algorithm will loop forever if your BASIC uses only integer arithmetic.

String Search . . . added MIKBUG capability

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FINSTR is a short routine that will help you locate a two byte string in memory and print out every address where it appears on the control terminal. I use it with a monitor program I use to supplement MIKBUG.

```
TARGET   RMB     2
TARTEM   RMB     2
FINSTR   JSR     BADDR       This is a MIKBUG routine that leaves a two byte address
                             in the X register. In this case it is used to input
                             the two byte string you are looking for.
         STX     TARGET
         LDX     #0          Point to the beginning of memory.
LOOP2    LDA A   0,X         Get a character or byte.
         CMP A   TARGET
         BEQ     FNDONE      Branch if found.
         INX                 Bump pointer.
         CPX     #3FFF       See if done. $3FFF is the top of my memory.
         BEQ     MIKBUG      If so, go back to monitor.
         BRA     LOOP2
FNDONE   LDA A   1,X         Get second Byte.
         CMP A   TARGET+1
         BEQ     FNDTWO      Branch if second byte is correct also.
         INX                 If not, bump pointer.
         BRA     LOOP2       Try again.
FNDTWO   STX     TARTEM      If you have found the two byte string, store the address
                             temporarily.
         LDX     #TARTEM     Point to it.
         JSR     OUT4HS      A MIKBUG routine which outputs 4 hex characters (2 bytes).
         LDX     TARTEM      Restore pointer.
         INX                 Increment it.
         BRA     LOOP2       Continue till done.
```

It's Here: Cook's Memory Test

Here's something a lot of people have been looking for: a comprehensive memory test for the 8080.

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In the short time that my computer has been running, I have written two memory diagnostic programs. Both of these programs were helpful, but not completely satisfactory. When I read "Memory Troubleshooting Techniques" by Charles E. Cook (*Kilobaud*, October 1977, p. 58), I knew that I found what I had been looking for.

Memory Monitor III

Memory Monitor III was written from the flowchart in Cook's article (Fig. 1), but, as he predicted, a few changes were needed. The changes relate to the failure branches. In MM III, when a memory location fails a test, the program branches to a screen-print routine in my SOL System monitor PROM. This prints the branch identification (A, B, C or D) and the address of the location that failed. Control then reverts back to MM III and the test continues. When the test is finished I should have a list of all failed locations on my video monitor.

I didn't like the halt after a failure because it requires that I find and clear that trouble with only one clue, or rewrite the program to start after the failure in order to find other defective locations. I changed it to give me printouts that make patterns obvious and troubles easier to find.

Since I had made my two 8K RAM boards trouble free before I decided to write this article, I created some artificial shorts and opens for testing the program. Fig. 2 shows the results of these tests. Defects reacted exactly as Cook said they would, and this gave me confidence in MM III. Some faults cause numerous errors which print the screen so rapidly that it is unreadable. In cases like this, I set the program to test only 256 bytes at a time . . . this is more easily handled.

Fig. 1 starts with a processor check. MM III does not contain such a specific test, but during a test run all registers and many instructions are exercised.

Program A is the listing for MM III. It should be compatible with all 8080 machines and possibly with Z-80. My computer (SOL) has one kilobyte of RAM on the CPU board starting at C800H; since I am convinced that it is trouble free, I load all my memory diagnostic programs in that area. With a little rewriting you can relocate it elsewhere. Change C9 in Program A to the page number where you want to locate MM III. If you want to start loading it at 6800H, change C9 to 68 wherever it appears.

The first instruction (C900 MVI C 01) sets the number of times you want the entire test to run. It can be set from 1 to 256 times (01H to FFH). I set this to 01 until I have cleared the major defects; otherwise, the screen printout becomes tremendous.

The second instruction (C902 LXI SP CB30) locates the stack. You can put it wherever you like . . . it doesn't take much room. Just remember that the stack works backward from its starting location.

Instructions C905, C918 and C92D (LXI H 0000H) load the starting address for the memory test; instructions C908, C91B and C930 (LXI D 1FFFH)

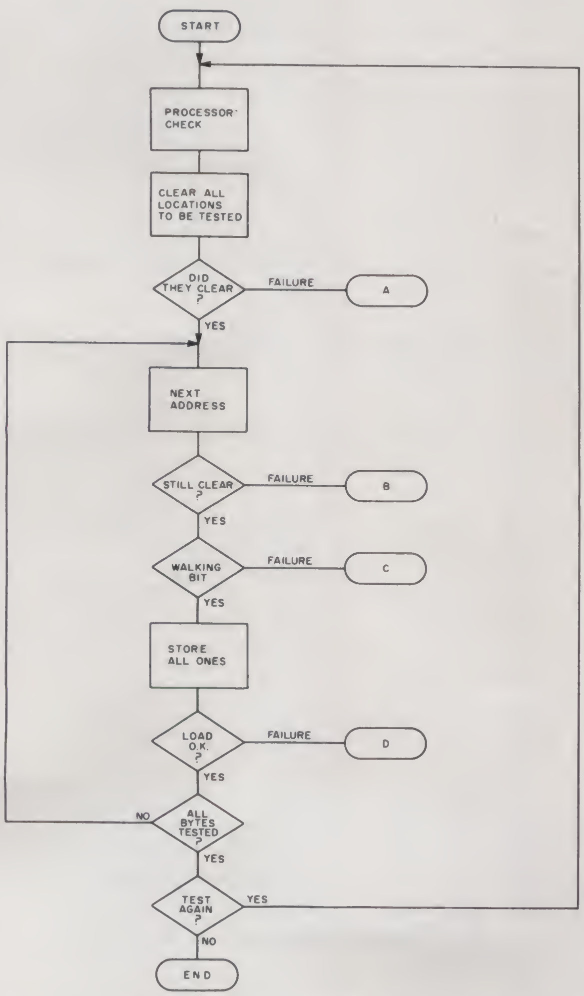

Fig. 1. The flowchart that started it all. Memory Monitor III was inspired and written from this chart. Using this basic information, a program could be written to run on any microprocessor.

```
B0004 B0005 B0006 B0007 B0008 B0009 B000A B000B
B0014 B0015 B0016 B0017 B0018 B0019 B001A B001B
B0024 B0025 B0026 B0027 B0028 B0029 B002A B002B
B0034 B0035 B0036 B0037 B0038 B0039 B003A B003B
B0044 B0045 B0046 B0047 B0048 B0049 B004A B004B
```

Fig. 2a. This printout is the result of a short between address lines A3 and A4 while the first 256 bytes on an 8K board were being tested. Every time A3 goes high the errors start.

```
C0C00 D0C00 C0C01 D0C01 C0C02 D0C02 C0C03 D0C03
This continues to:
C0FFC D0FFC C0FFD D0FFD C0FFE D0FFE C0FFF D0FFF
```

Fig. 2b. This printout is the result of an open data lead, D7, in the fourth kilobyte of an 8K board. Every location in this kilobyte failed both the C and D branches.

```
B0040 B0041 B0042 B0043 B0044 B0045 B0046 B0047
B0048 B0049 B004A B004B B004C B004D B004E B004F
This continues for a long ways
```

Fig. 2c. This printout is the result of an open address line, A6, on a 2102 in the first kilobyte on an 8K board. Note that the printout starts at 0040, the first address in which the address line A6 would go high. A good troubleshooting clue!

determine how many bytes will be tested. In this case, 0000H is the starting point for the memory test, and 1FFFH (8K) will be tested.

Do not attempt to test areas that contain this or other programs in RAM or ROM. The RAM will be erased and the ROM will indicate a complete failure, as will areas that do not contain any memory.

If the only memory that you have is on the memory board you want to test, locate MM III at 0000H and set up the stack at 007FH. Start the test at 0080H and test as many bytes as you have left on the board.

As indicated in Cook's article, if the program is located in defective memory, you will have trouble determining if the problem is in the memory or the processor. Try locating MM III in different places and compare the results.

C90B to C917 will load zeros into all locations chosen above; C918 to C92C will check to see that these zeros are actually loaded. Any location that fails will branch out at C920 (CNZ C980) to failure-indication subroutine Branch A, which was written for the SOL. You can replace this call nonzero instruction with a CNZ or JNZ to a halt or other indicator. The trouble with a halt is that you must examine the registers to find out where and how you failed. As Cook suggests, let's let the computer do most of the work and print the information for us.

Starting at C92D, we are going to check if each location still contains all zeros. Although this may seem to be a duplication of the previous test, we are now looking for any location that we know contained a zero, but that may have been changed while we were testing other locations. Shorted address lines could cause this fault. A failure here branches to failure-indication subroutine Branch B (C935). Again, you can call or jump to whatever you choose.

Lines C938 to C942 comprise the walking-bit routine. A failure at C93B takes us to failure Branch C. C943 to C949 loads all ones and then checks them. The final failure branch, D, is at C947. Lines C94A to C954 increment the address counter, decrement the byte counter, and check to see if all desired locations have been tested. If not, a jump back to C933 is made; otherwise, we go on to C955.

C955 (Call C99C) will call the print subroutine to put a distinctive character (ASCIIΩ) on the screen. This character will appear as many times as the test is run and will help separate test results on the screen.

The number of times we wanted the entire test to run was loaded at C900 into the C regis-

```
ADDRESS   OP CODE    ASSEMBLY        REMARKS
                     LANGUAGE

C900      0E 01      MVI C 01        Load repeat counter
C902      31 30 CB   LXI SP CB30     Locate stack
C905      21 00 00   LXI H 0000      Load start address
C908      11 FF 1F   LXI D 1FFF      Load total bytes
C90B      AF         XRA             Clear A register
C90C      36 00      MVI M 00        clear test  address
C90E      1B         DCX D           Count bytes
C90F      23         INX H           Increase address
C910      BA         CMP D                all loaded?
C911      C2 0B C9   JNZ C90B             if not, do
C914      BB         CMP E                next address
C915      C2 0B C9   JNZ C90B
C918      21 00 00   LXI H 0000      Load start address
C91B      11 FF 1F   LXI D 1FFF      Load total bytes
C91E      AF         XRA             Clear A register
C91F      BE         CMP M           Location clear?
C920      C4 80 C9   CNZ C980        Failed? Call Print A
C923      1B         DCX D           Count bytes
C924      23         INX H           Increase address
C925      BA         CMP D                All loaded?
C926      C2 1E C9   JNZ C91E             If not, do
C929      BB         CMP E                next address
C92A      C2 1E C9   JNZ C91E
C92D      21 00 00   LXI H 0000      Load start address
C930      11 FF 1F   LXI D 1FFF      Load total bytes
C933      AF         XRA             Clear A register
C934      BE         CMP M           Location clear?
C935      C4 85 C9   CNZ C985        Failed? Call Print B
C938      3E 01      MVI A 01        Load 0000 0001 in A
C93A      77         MOV M A         Move to test  address
C93B      BE         CMP M           Load OK?
C93C      C4 8A C9   CNZ C98A        Failed? Call Print C
C93F      17         RAL             Rotate bit left
C940      D2 3A C9   JNC C93A        8 bits checked?
C943      3E FF      MVI A FF        Load 1111 1111 in A
C945      77         MOV M A         Move to test address
C946      BE         CMP M           Load OK?
C947      C4 8F C9   CNZ C98F        Failed? Call Print D
C94A      1B         DCX D           Count bytes
C94B      23         INX H           Increase address
C94C      AF         XRA             Clear A register
C94D      BA         CMP D                All loaded?
C94E      C2 33 C9   JNZ C933             If not, do
C951      BB         CMP E                next address
C952      C2 33 C9   JNZ C933
C955      CD 9C C9   Call C99C       Call print Ω
C958      0D         DCR C           Count repeats
C959      AF         XRA             Clear A register
C95A      B9         CMP C           All repeats done?
C95B      C2 02 C9   JNZ C902        If not, do again
C95E      C3 04 C0   JMP C004        Jump to SOL monitor
```

Program A. Memory Monitor III—a memory diagnostic program written for SOL System users. See text for modifications to make this fit other machines.

```
ADDRESS     OP CODE     ASSEMBLY       REMARKS
                        LANGUAGE

C98Ø        Ø6 41       MVI B 41       Load "A"
C982        C3 91 C9    JMP C991       Go to print
C985        Ø6 42       MVI B 42       Load "B"
C987        C3 91 C9    JMP C991       Go to print
C98A        Ø6 43       MVI B 43       Load "C"
C98C        C3 91 C9    JMP C991       Go to print
C98F        Ø6 44       MVI B 44       Load "D"
C991        C5          PUSH B         Save repeat count
C992        E5          PUSH H         Save address
C993        CD 8A CØ    CALL CØ8A      Print character
C996        E1          POP H          Restore address
C997        CD D7 C2    CALL C2D7      Print address
C99A        C1          POP B          Restore repeat count
C99B        C9          RET            Go back to MM III
C99C        E5          PUSH H         Save address
C99D        C5          PUSH B         Save repeat count
C99E        Ø6 Ø7       MVI B Ø7       Load Ω
C9AØ        CD 8A CØ    CALL CØ8A      Print character
C9A3        C1          POP B          Restore repeat Count
C9A4        E1          POP H          Restore address
C9A5        C9          RET            Go back to MM III
```

Program B. A failure-indication print subroutine based on the SOL System-Consol, or SOLOS, personality module. This is not usable on other computers since the print subroutines are not located at the same addresses or configured the same as the SOL.

ter. Now we decrement C (C958 DCR C) and go back to the beginning if another test is called for or exit at C95F. C95F is a return to the monitor mode in the SOL. You can substitute whatever fits your machine.

After a board indicates that it's 100 percent trouble free on a single test run, I set the test to run 256 times; the string of 256Ωs gives me confidence that I don't have any intermittent troubles. 256 test runs on an 8K board take eight minutes and 17 seconds, or 1.9 seconds per test. After this, if I still have a problem with a specific program, I am sure that the trouble is with the program or is a processing error.

Program B will only be of direct interest to SOL users, but it might help you to implement a similar subroutine on other computers. An entry at C980 will print an "A" and then the address where failure occurred; entry at C985 will print "B" plus the address; entry at C98A will print "C" plus address; entry at C98F will print "D" plus address; and entry at C99C will print the ASCII character "Ω."

The Push and Pop H and B instructions save the test address and repeat count while the screen-print subroutine is operating so that we can return to MM III and continue the test.

MM III has found defects that I had previously been unable to find. It has also given me confidence in my memory boards. I agree with Charles Cook that this is the kind of program manufacturers should supply with their hardware. They would probably see fewer boards returned for repair and might even sell more boards.

I hope that Memory Monitor III will help to fill the need for microprocessor diagnostic programs.■

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Eliminating Finger Blisters

If you, like the author, have reservations about the S-100 front panel, read this article to learn about a replacement.

Peter W. Sargent
4209 Knoxville Ave.
Lakewood CA 90713

Steve R. Tuenge

From the beginning it was obvious that the many switches on the front of the Altair 8800, although very impressive, left a lot to be desired when it came to entering programs. My first attempt to rectify this situation was to use a Bowmar Brain keypad (an old four banger) and a few ICs, which allowed octal address and data entry. This primitive system still relied on the front panel for many of the necessary functions.

My next step on the road to replacing the front panel was a full DMA (direct memory access) that handled all commands from an ASCII keyboard; of course, the 60 ICs needed to implement the system made it all a bit bulky. Although a definite improvement, the new system still didn't work effectively.

Next I incorporated an EPROM from Godbout Electronics with an automatic jump to the EPROM, which then contained a small 8080 monitor that did most of what a front panel could do. It contained hassle-free software and required only a handful of ICs. The monitor-in-PROM system worked quite well for a while; then Processor Technology finally delivered my VDM-1 and I decided to start all over again!

The new system is flexible (not dependent on minor hardware changes) and not tied to the hardware design of the front panel (i.e., changes can be made without all-night rewiring sessions). The final result is not only simple, but requires so few ICs that four I/O ports fit on the same prototype board with plenty of room for further expansion.

The heart of the new system is its reliance on two 8223 field programmable PROMs. The versatility of this method allows you to change from Tarbell cassette tape to Tarbell disk operating systems simply by replacing one PROM. The secret behind the final success is that the system bootstraps in a Small Operating System (designated S-4), then loads any user program (e.g., BASIC). This allows a great deal of flexibility since each tape can be loaded from a cold start allowing untrained operators to operate the computer.

The system described here functions as follows:

1. Autostart feature. Upon power on clear, or manual reset, the computer jumps to PROM A (see Listing 1). PROM A clears the screen.
2. PROM A jumps to PROM B (see Listing 2). PROM B contains a Tarbell cassette bootstrap loader, which, when completed, loads the main body of System S-4 and then loads any desired program such as BASIC or Processor Tech Software #1.
3. The software commands are listed in Table 1.
4. Provides two parallel input ports and two parallel output ports.
5. Extra space is provided for hardware additions, such as a UART for serial I/O.
6. By replacing PROM B with PROM C upon reset, the computer will boot in the Tarbell disk operating system (see Listing 3).

By examining the circuits separately we can analyze the function of each and the sequence of actions. To begin with, all the address and data lines from the bus are buffered, using 8T97s (almost any TTL noninverting gate will do, but at the start I didn't know just what the final loading would be). Figs. 1, 2 and 3 detail the wiring and circuitry involved.

The heart of the system is the

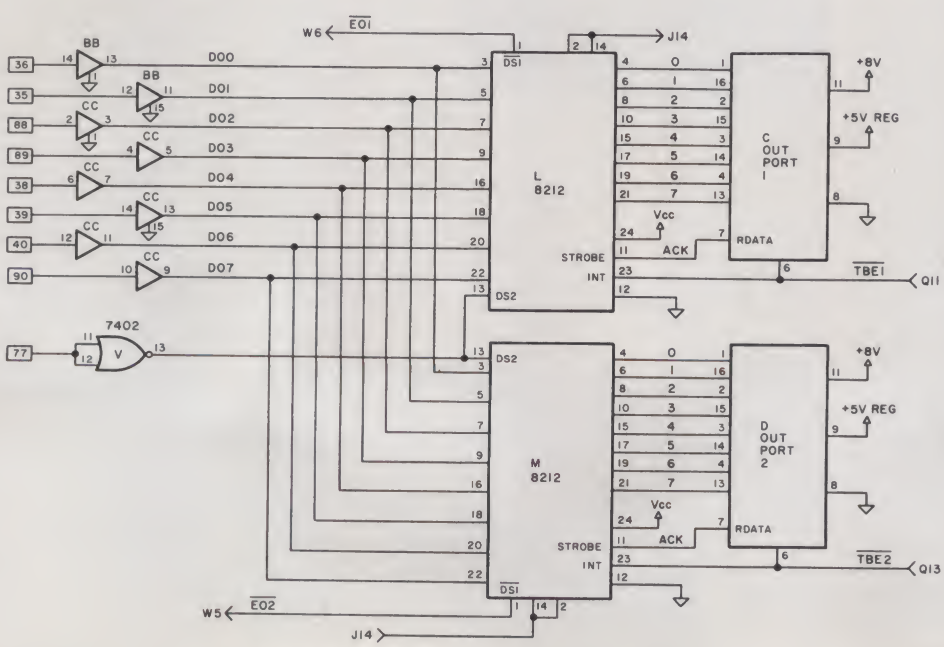


Fig. 1. System S-4 schematic output ports.

autostart and bootstrap section (see Fig. 3). An RS (reset-set) flip-flop made up of two gates of IC-G is set by an active low signal ($\overline{PRESET}$, which also resets the CPU) on pin 5. The low-going output at pin 3 disables the data-input buffers on the CPU, thereby disconnecting the CPU from the data bus.

The high-going output from pin 6 of IC-G is NANDed with PDBIN (data in strobe) to provide a chip enable ($\overline{CEA}$) for IC-H, PROM A. IC-H is a 32-byte PROM and uses the lower five address lines.

The data from H is fed by way of a cable (à la Altair) directly to the CPU. If a memory board with a phantom line is used in the lower portion of memory, the cable may be dispensed with; the output from H can be paralleled with that of PROM B, IC-GG; and the output from pin 8 of IC-G (now the active low phantom line) is connected to the appropriate bus pin.

PROM A clears the screen and then jumps to PROM B, which contains the Tarbell loader. The chip enable for PROM B uses the top eight bits of the address and PDBIN, so the following restrictions apply:

1. Although the PROM is only 32 bytes long, the remainder of the page (256 bytes) may not be

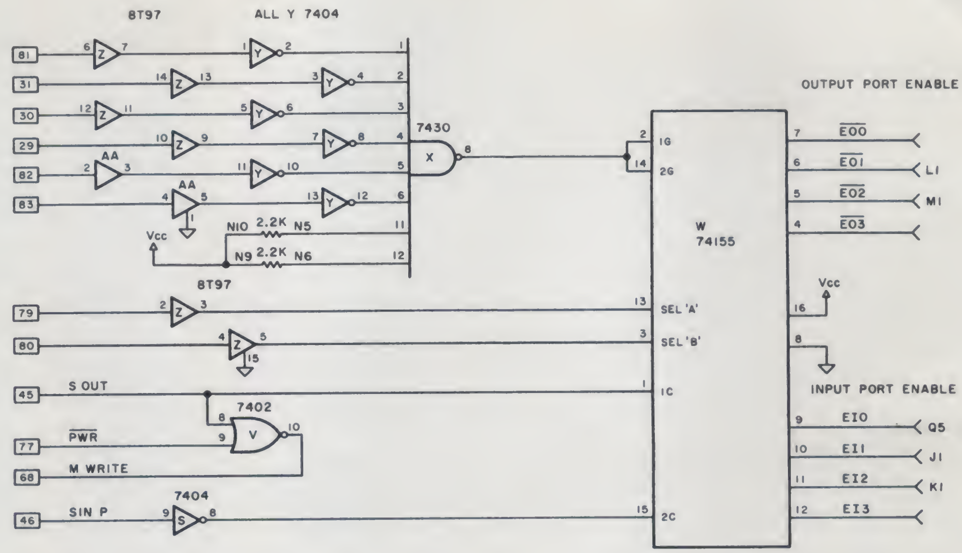


Fig. 2. System S-4 schematic port select.

```
0000  3E00          MVI   A,0      ;RESET THE VDM TO DISPLAY
0002  D3C8          OUT   0C8H     ;ALL SIXTEEN LINES, BEGINNING
                                   WITH 0
0004  3E0D          MVI   A,0DH    ;END OF MEMORY
0006  0E20          MVI   C,20H    ;BLANK CHARACTER
0008  21CC00        LXI   H,0CCH   ;POINT TO BEGINNING VDM
                                   MEMORY
000B  71     LOOP   MOV   M,C      ;BLANK A BYTE
000C  23            INX   H        ;BUMP POINTER
000D  BC            CMP   H        ;END OF VDM MEMORY?
000E  C20B00        JNZ   LOOP     ;AGAIN IF NOT
0011                DS    12       ;NOT USED YET
001D  C300C3        JMP   BOOT     ;EXIT TO PROM 'B'
C300  =      BOOT   EQU   0C300H
```

Listing 1. Software listing for PROM A.

```
C300  3E10        MVI   A,10H      ;RESET CASSETTE INTERFACE
C302  D363        OUT   6EH
C304  2113C3      LXI   H,0C313H   ;SET UP 'RETURN'
C307  AF          XRA   A
C308  5F          MOV   E,A
C309  DB6E  LOOP  IN    6EH        ;MAIN INPUT ROUTINE
C30B  E610        ANI   10H
C30D  C209C3      JNZ   LOOP
C310  DB6F        IN    6FH
C312  E9          PCHL
C313  57          MOV   D,A        ;SET LOAD ADDRESS
C314  2E19        MVI   L,19H      ;NEW RETURN
C316  C309C3      JMP   LOOP
C319  12          STAX  D          ;LOAD ROUTINE
C31A  1C          INR   E
C31B  C209C3      JNZ   LOOP       ;DONE?
C31B  EB          XCHG
C31F  E9          PCHL             ;EXIT TO LOADED PROGRAM
```

Listing 2. Software listing for PROM B.

W is write command. You may type W followed by the beginning address of the data you wish to record and the block length (in even ¼K (256) byte segments). For example, to write the VDM driver on tape you would type W 360 000 002. Be sure to have cassette tape running before you type the last part of the block length. After write command is finished, W will appear indicating good write.

R is read command. You may type in an R followed by the beginning address of the data to be loaded into memory and then the block length (in even ¼K byte segments). For example, to read back the tape of the VDM driver, type R 360 000 002. The computer will respond with G, indicating good load, or E, indicating bad load.

D is dump command. Type D and the to and from dump-memory address in octal. With D000 000 to 000 377, the first 377 bytes will be displayed.

L is load command. Type L and beginning address of load. Computer will echo the address and you may begin entering data in octal. Any illegal character will terminate load. L 000 000, 000 041 022, etc., loads data at beginning of memory.

M is move command. Type in M followed by the beginning address of data source, then beginning address of data destination, and length of data transfer. For example, M (from) 360 000 (to) 000 000 (length) 001 000.

C is copy. The C command will generate an exact copy of this and any additional data that is in the last 4K of memory onto the cassette. *Be sure* to have the cassette recorder running in record mode before you press the C.

Z is zero memory. Type the beginning address, ending address and ASCII value to be loaded. Command begins at the last keystroke. Z 000 000 (from) 000 377 (to) 001 (value to be loaded).

S is sync generator. It generates a continuous sync stream of E6 hex for making a Tarbell test sync tape. Be sure to have recorder running in record mode before you press the S.

V is view command. Type in V and beginning address of memory to be viewed. This command enables you to look at what is in memory as displayed ASCII characters. Space bar moves 1 line at a time (64) bytes. Shift O or back arrow moves 1 line backwards. CR moves forward ½ page at a time.

Q escape enables you to terminate any command.

The control commands for the VDM are: Control A = clear the screen; D = new speed; B = cursor on or off. Any illegal character entered will terminate operation.

Table 1. S-4 software operating commands.

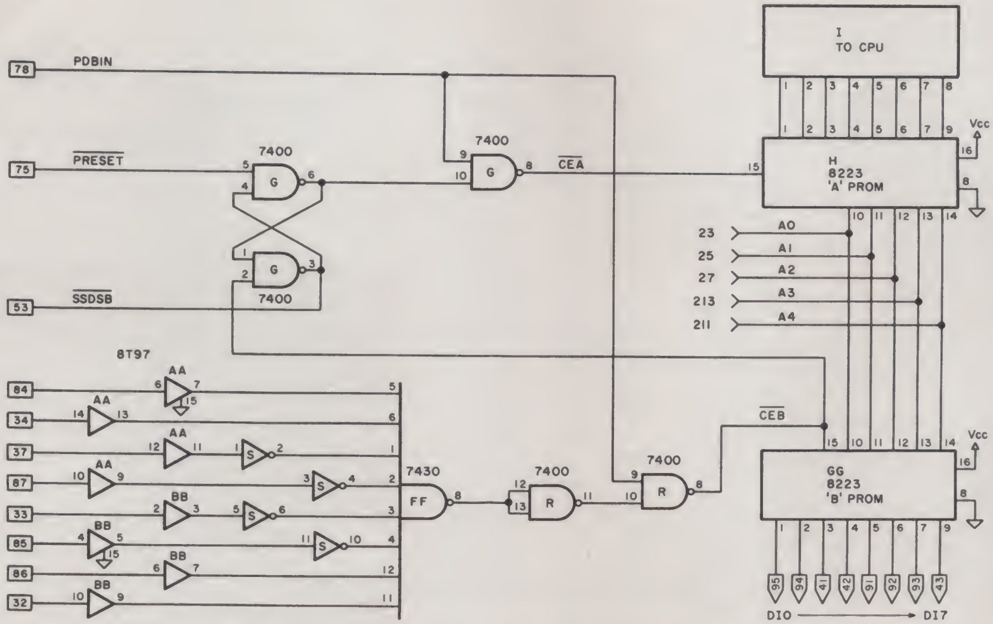


Fig. 3. System S-4 schematic PROM addressing select.

used for anything else.

2. Since neither SMER (status line indicating that the current machine cycle will access memory) nor SINP (same as SMEM but for input from port) are used, input port C3 (hex) may not be implemented.

The first chip enable for the second PROM ($\overline{\text{CEB}}$) also resets the RS flip-flop, IC-G, and restores the computer to normal operation. Listing 2 gives the program for the second PROM to use with the Tarbell cassette interface board.

The program as shown will read the first byte on the tape and interpret it as the high-order byte of the load address (zero is assumed as the low-order address). It then loads the remainder of the page from the tape and commences execution at the beginning of the loaded program.

Input/Output Circuitry

The basic I/O decoding is all done in one chip, IC-W, a 74155 (see Fig. 2). The inverted address lines provided by IC-Y are NANDed in IC-X to enable the 74155 whenever address lines A2 through A7 are all low; this decodes the lowest block of four ports, both input and output (ports 0-3). The data on address lines A0 and A1 are used to drive the select A and select B input on the 74155 to determine which one of the four possible ports is to be accessed.

Finally, SINP and SOUT are used as the 2C and 1C inputs to the 74155 to determine which set of outputs is to be enabled (whether an input or output port enable line is to go low). Thus, one special chip and eight support gates provide all the decoding to give an active low signal for enabling four input and four output ports.

To date, only three input ports and two output ports have been implemented. Input port zero is used for handshaking with the other ports, so there are more input than output ports. Input port zero (IC-T in Fig. 4) is an 8T97 gated by the enable for port zero (EI0 from IC-W, Fig. 2) and PDBIN by way of a NAND gate (pins 4, 5 and 6 of IC-R).

Since my system was originally set up using the Processor Technology VDM-1 port assignments, the active low $\overline{\text{TBE}}$ (transmitter buffer empty) and $\overline{\text{DAV}}$ (data available) are inverted by ICs Q and S before being gated onto the computer's input bus.

When using the Tarbell disk system with PROM C, it is necessary to change the $\overline{\text{DAVI}}$ to bit zero by adding the change as noted on Fig. 4. Connect the dotted line as shown from pin 9 of IC-Q to pin 12 of IC-T and change the output of T from pin 42 on the bus to pin 95.

The input ports are 8212s wired according to the Intel data sheets (see Fig. 5). Since no hobby standard exists for a 16-pin DIP header, the system used by Oliver Audio Engineering's OP-80 paper-tape reader was copied. The only changes have been to provide both 8 V (unregulated) and 5 V (regulated) to the connected peripheral device (see Fig. 6).

With the mode input connected to ground, the 8212 is set up as an input port—a high-going input on the strobe input (pin 11) clocks the data into the internal latches and sets the output of pin 23 ($\overline{\text{DAV}}$) to its active low state. Whenever DS1 (device select one, active low) is pulled low by the port decoding circuitry and PDBIN goes

C3 00	DB FC	INPUT WAIT
C3 02	AF	XRA
C3 03	6F	MOV L,A
C3 04	67	MOV H,A
C3 05	3C	INR A
C3 06	D3 FA	OUT SECT
C3 08	3E 8C	MVI A, 8 CH
C3 0A	D3 F8	OUT, D COM
C3 0C	DB FC	IN WAIT R LOOP
C3 0E	B7	ORA,A
C3 0F	F2 19 00	JP R DONE
C3 12	DB FB	IN D DATA
C3 14	77	MOV M,A
C3 15	23	INX H
C3 16	C3 0C 00	JMP R R LOOP
C3 19	DB F8	IND D STAT R DONE
C3 13	B7	ORA A
C3 1C	CA 7D 00	JZ 07 DH
C3 1F	76	HLT

Listing 3. Software listing for PROM C.

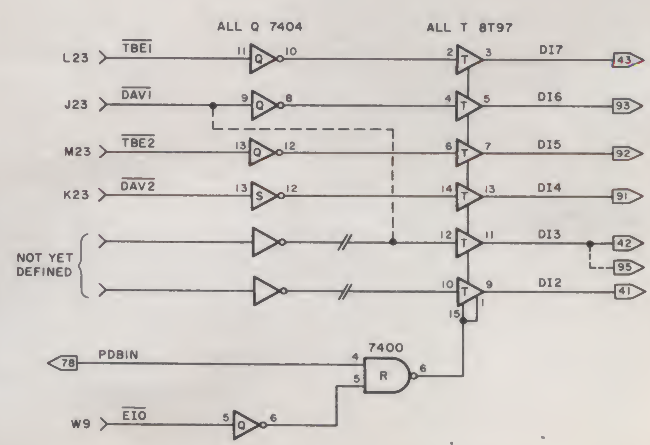
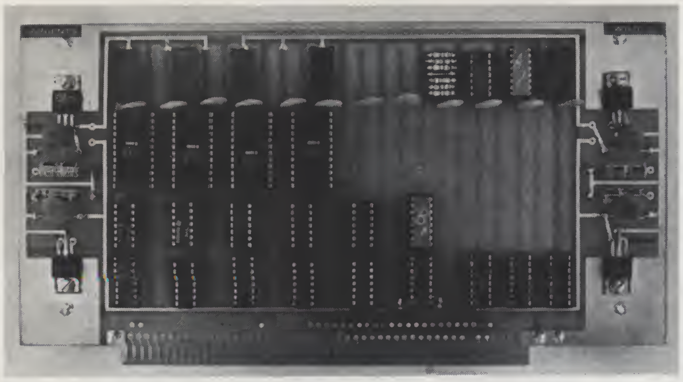


Fig. 4. System S-4 schematic status port.



The assembled S-4 front-panel board.

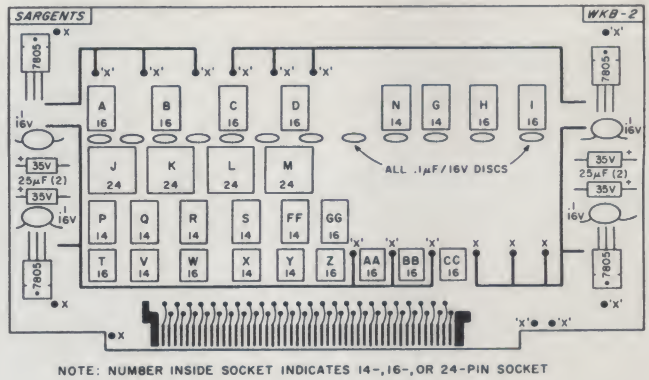


Fig. 8. Top view system S-4 parts layout.

high (signifying that the CPU is ready for data), the outputs of the 8212 assume the values of the internal latches. Since the outputs are Tri-stated, except when the device select lines assume their active state, the outputs may be connected directly to the data-input bus. Reading the port automatically resets the internal interrupt latch, making $\overline{DAV}$ go high.

Thus, an input routine that checks for bit 6 of port zero high, then reads input port one, will input only valid new data. For port 2, check bit 4. As mentioned earlier, any standard may be assumed by wiring port zero differently.

The 8212 is really a handy device—merely changing the input on pin 2 (MODE) from ground to 5 V (through a pull-up resistor) changes it from an input port to an output port as shown in Fig. 1. Again the data flow is straight through, except now the data is always valid instead of being Tri-stated when not in use. Device select one is still driven by the I/O decoding circuitry, but now the active low $\overline{PWR}$ (signifying that the CPU has valid data on the data out bus) is inverted by one gate of IC-V pins 11, 12, 13 to provide DS 2 (see Fig. 1).

The result of the changes is that the INT of the 8212 now acts as a strobe for the connected device. The strobe output of the 8212 is available at pin 7 of the output ports as a reception of data signal for full handshaking (see Fig. 7).

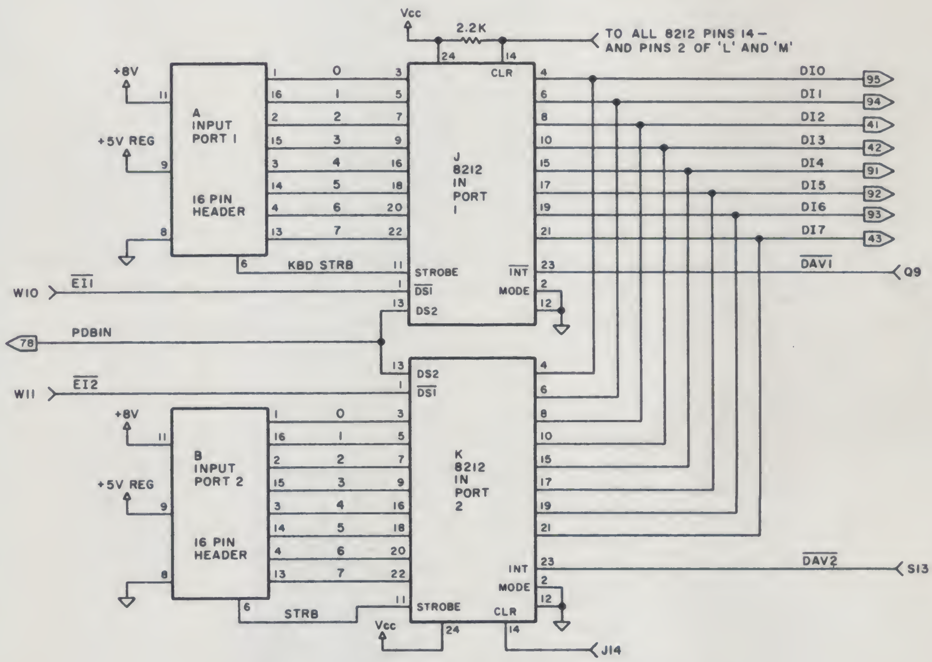


Fig. 5. System S-4 schematic input ports.

Construction

Neither layout nor wiring is critical. A typical layout is shown in Fig. 8, which shows a top view of the system. The circuitry can be laid out on any S-100 prototype board. Although four 7805 regulators are shown, only two are required.

If you desire to add additional circuits later, you can compress the IC sockets all at one end of the board. A completed System S-4 board is shown in the photo.

Checkout

After construction and checkout of all wiring, you can insert the cassette tape, turn on the computer and push reset. The computer will clear the screen, sign on with an initialization message and present you with * and G for good load. If you get an E, you have error. Reload, and if problems still exist, consult your Tarbell manual.

Once a good load is achieved and the computer prompts with G, you may proceed with either S-4 software or whichever program you have loaded. The software commands for S-4 are listed in Table 1.

If you are using PROM C with

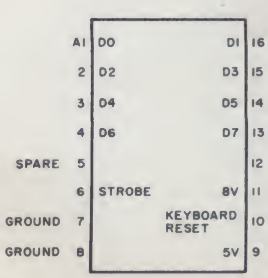


Fig. 6. Input port pin-outs for 16-pin DIP header.

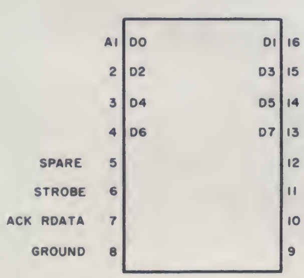


Fig. 7. Output port pin-outs for 16-pin DIP header.

the Tarbell disk-operating system, resetting the computer with the disk running cold boots in the CPM operating software.

The system as described here has been in operation with several computers for some time. It is used with the Imsai, Solid State Music VB-1 video board, various memory boards and home-brew systems. It has proven fully reliable and provides an inexpensive way to tie your system together.

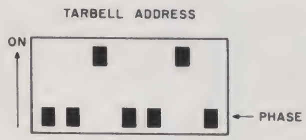


Fig. 9. Tarbell addressing and phase settings.

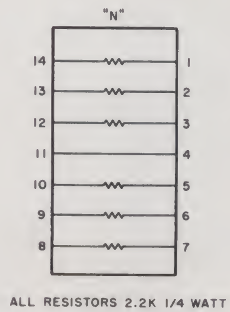


Fig. 10. N 14-pin header, resistor locations.

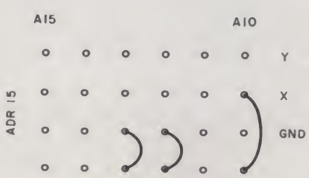


Fig. 11. Processor Technology VDM-1 addressing.

Although run, stop and single-step functions may be added according to either Imsai or Altair schematics, so far the only external switch used (besides the power on/off) has been a simple, normally open, single-pole, single-throw, momentary-contact keyboard push button that supplies the reset ground to pin 75 of the bus.

Starting up the computer is much simpler and quicker by just starting the tape and pushing a button, instead of entering data by front-panel switches for five to ten minutes. It not only saves time, but allows untrained operators, including children, to operate the computer.

Table 2 details the parts used. Fig. 9 details the only resistors used for pull-ups (wired on a 14-pin header); Fig. 10 shows the Tarbell addressing and phasing we use; and Fig. 11 illustrates the VDM-1 standard address assignments.

For those who don't want to work from schematics, a complete layout of the board and step-by-step wire list is available. All correspondence regarding the front-panel replacement should be directed to the source for the kits and boards as listed in Table 3.■

1. Prototype board
2. Four LM 340T or 7805 regulators
3. Four 25 uF at 35 V
4. Sixteen .1 uF at 20 V disk
5. Four 24-pin w/w sockets
6. Ten 14-pin w/w sockets
7. Thirteen 16-pin w/w sockets
8. Forty w/w dummy pins
9. Two 8223 PROMS (instructions preburned in) ICs-GG, A
10. Two 7400 ICs-G, R
11. Four 8212 ICs-J, K, L, M
12. Two 7430 ICs-FF, X
13. One 74155 IC-W
14. Five 8T97 ICs-AA, BB, CC, Z, T
15. Four 7404 ICs-S, Q, P, Y
16. One 7402 IC-V
17. Six 2.2k ¼ W resistors
18. One 14-pin header socket (N)
19. One instruction set
20. Cassette with software

Table 2. System S-4 parts list.

S-100 wire-wrap prototype card.	$20
S-100 mini proto kit. Includes board, 16 .1 bypass caps, four 25 uF caps, four 7805 regulators, and 25 bus pins.	$30
S-100 System 4 start-up front-panel replacement kit, featuring two parallel inports, two parallel outports, PROM auto load and 12 command 8080 monitor on Tarbell Cassette tape, and either PROM B or C.	Assem $95 Kit $80
S-100 System 4 plan set.	$7.50
One set preprogrammed PROMs 8223 for S-4.	$5.00
PROM C special PROM to boot in Tarbell Disk System.	$2.50
S-4 small system software on Tarbell cassette.	$7.50

Parts, etc., can be purchased from Sargents Distributing Co., 4209 Knoxville Ave., Lakewood CA 90713.

Table 3. Price list and parts source.

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Home-Brew Z-80 System (Part 2)

Last month's article discussed the front panel for this system. This concluding portion of the article discusses construction of the CPU and memory board.

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In last month's issue, I described the construction of a front panel that, when combined with memory and an S-100 compatible Z-80 CPU card, provides an operating computer system. In this article a simpler Z-80 circuit is presented, along with an expandable memory configuration. These designs are directly compatible with the front panel and provide a self-contained Z-80 computer system. Also, with one modification and 250 ns access-time memory, the system could be used with the 4 MHz Z-80 at full speed without wait states.

Description

CPU. Fig. 1 is the schematic for the CPU. It is very simple and consists of a clock, the Z-80 MPU and appropriate gating/buffering for interface and control. All the essential bus signals are provided. Don't be misled by the S-100 bus numbering—many S-100 signals are not provided, and no attempt at bus compatibility with that system is made.

Fig. 1 shows the first three sections of IC2 employed as an oscillator/buffer with a 4 MHz crystal. This 4 MHz square wave is binary-divided by the D flip-flop IC3; the 2 MHz clock is applied to the Z-80 clock input i. The 330 Ohm pull-up resistor is required to raise the positive voltage level required by the MPU. If 4 MHz operation is desired, simply omit the flip-flop and run the pin 8 connection of IC2 directly to pin 6 of IC1. The 330 Ohm pull-up resistor must still be used as before.

All lines into, and out of, the MPU are buffered to protect and provide proper loading for the Z-80 chip. In particular, the two data buses and address bus are buffered with Tri-state devices. ICs 8 and 9 do not have high load requirements and may be 74LS367 packages, although the 8097 and 8T97 are pin-for-pin alternatives. The Data Out and Address buses are disabled by $\overline{\text{ADDRDSB}}$, which is a front-panel signal used to permit the front panel to control these buses.

In keeping with the structure of the front panel, Z-80 signals are converted to appropriate bus signals. Thus, gates are used to buffer the MPU and generate needed logic. In this manner, $\overline{\text{M1}}$ is converted to SM1; $\overline{\text{MEMRQ}}$ and $\overline{\text{RD}}$ combine to produce SMEMR; $\overline{\text{RD}}$ and $\overline{\text{IORQ}}$ are NORed to produce SINP (PORT IN); $\overline{\text{IORQ}}$ and $\overline{\text{WR}}$ are NORed to generate SOUT (PORT OUT); $\overline{\text{WR}}$ is buffered to give $\overline{\text{PWR}}$. All of these bus sig-

CPU

ICs	
IC1	Z-80 MPU (Z-80A for 4 MHz operation)
IC2	7400
IC3	7474
IC4	7437
IC5	7404
IC6	74LS02
IC7, IC10-13	8T97
IC8, IC9, IC14	74LS367

Miscellaneous

1	4 MHz crystal
1	circuit board of choice
1	edge connector for circuit board
14	2.2K Ohm, ¼ W 10% resistors
1	10 Ohm, ¼ W 5% resistor
3	470 Ohm, ¼ W 5% resistors
1	330 Ohm, ¼ W 10% resistor
1	1k Ohm, ¼ W 5% reistor
1	6.8k Ohm, ¼ W 5% resistor
8	4.7k Ohm, ¼ W 5% resistors
1	100 uF, 15 V electrolytic capacitor
	0.1 uF, 10 V disk capacitors for bypass (see text)

MEMORY

ICs	
IC1	74LS86
IC2	74LS02
IC3	74LS00
IC4	74LS42
IC5-8	8T97
IC9	74LS367
IC10-41	21L02-1 (250 ns access time 2102s if 4 MHz desired)

Miscellaneous

1	circuit board of choice
1	edge connector for circuit board
4	2.2K Ohm, ¼ W 10% resistors
1	DIP switch with four SPST switches—S1, S2, S3, S4
	0.1 uF, 10 V disk capacitors for bypass

Parts list.

nals can be disabled by front-panel signal SDSBL, which allows front-panel control in front-panel operation.

Buffers are provided for Z-80 interrupt pins $\overline{\text{INT}}$ and $\overline{\text{NMI}}$. These pins must not be left floating or they will act like tiny antennae, picking up stray signals to generate interrupts where none exist. This will result in erratic operation. So, at least tie these pins high even if you don't intend to use them.

In my previous article, it was noted that DMAG or PHLDA acknowledges the DMA request. This signal is derived by inverting the Z-80 $\overline{\text{BUSAK}}$ with IC4. The front-panel DMA request signal, PHOLD, is applied to the Z-80 $\overline{\text{BUSRQ}}$ pin through a buffer. Similarly, $\overline{\text{PRDY}}$ is applied to $\overline{\text{WAIT}}$ on the MPU. This command permits either single-step operation with the front panel or the use of slow memory requiring wait states.

A Schmitt Trigger circuit is used to generate a bounceless $\overline{\text{RESET}}$ command causing the MPU to set its program counter to 0000_{16}. The need for debouncing this command became apparent when I interfaced this system with a TVT. When I hit the RESET switch, a whole string of ASCII character prompts were printed as each bounce of the switch caused program execution.

The Z-80 output pins have very limited drive capability, so loading should be held to about one standard TTL load. For this reason, IC6 should be a low-power Schottky device.

Memory. Fig. 2 depicts the memory circuit. Again, circuitry is straightforward and does the job. A handy feature is the use of the DIP switches, which recently have become widely available. With these switches, memory addressing of each 4K block is switch selectable to any of 16 possible sectors covering all directly addressable memory.

The four high-order address bits, A12 through A15, are used to select the 4K block to which the memory will respond. If the block is addressed and this is not an I/O operation (i.e., SINP and SOUT are not true), then the subsector decoder, a 74LS42, is enabled, and ad-

The author's system.

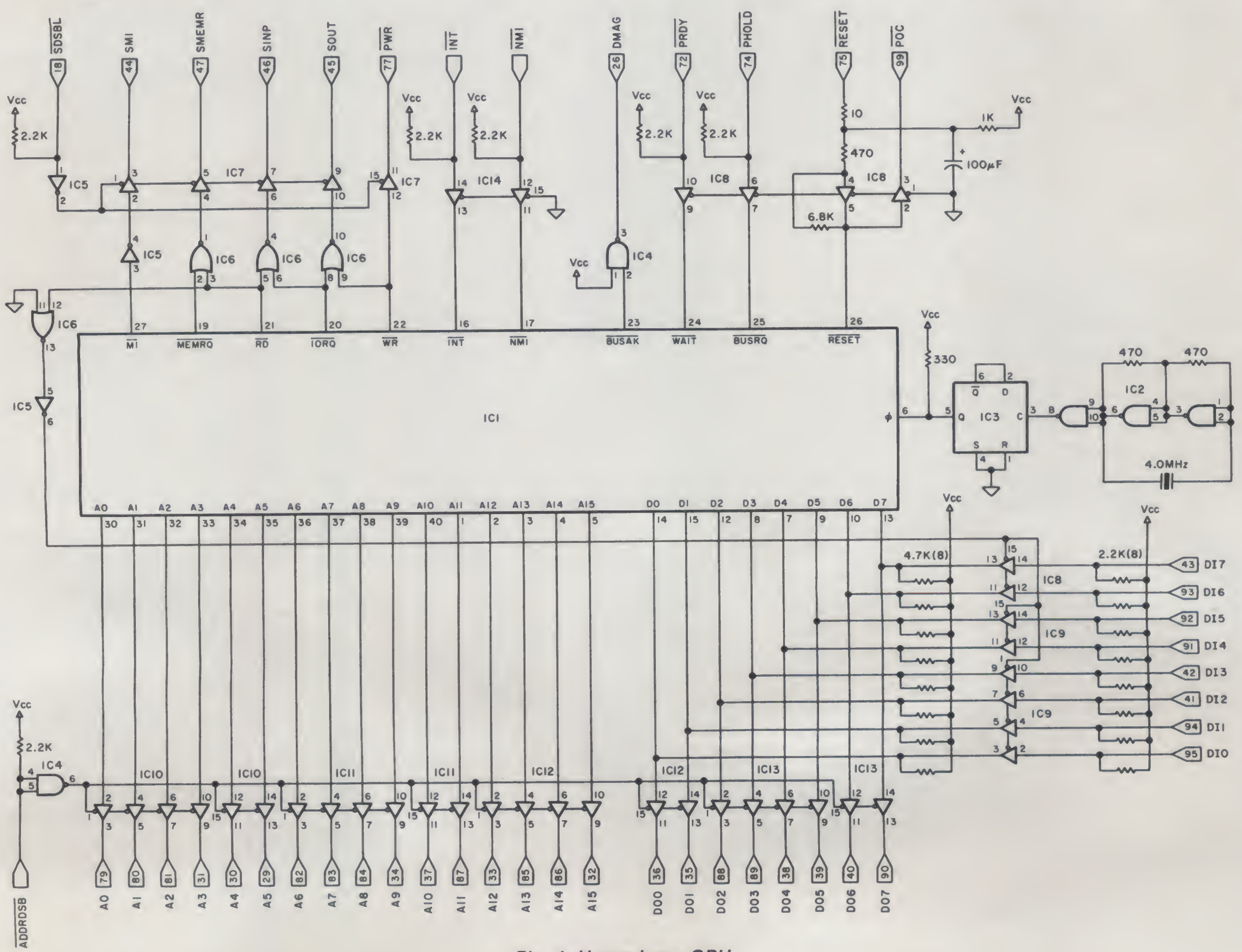

Fig. 1. Home-brew CPU.

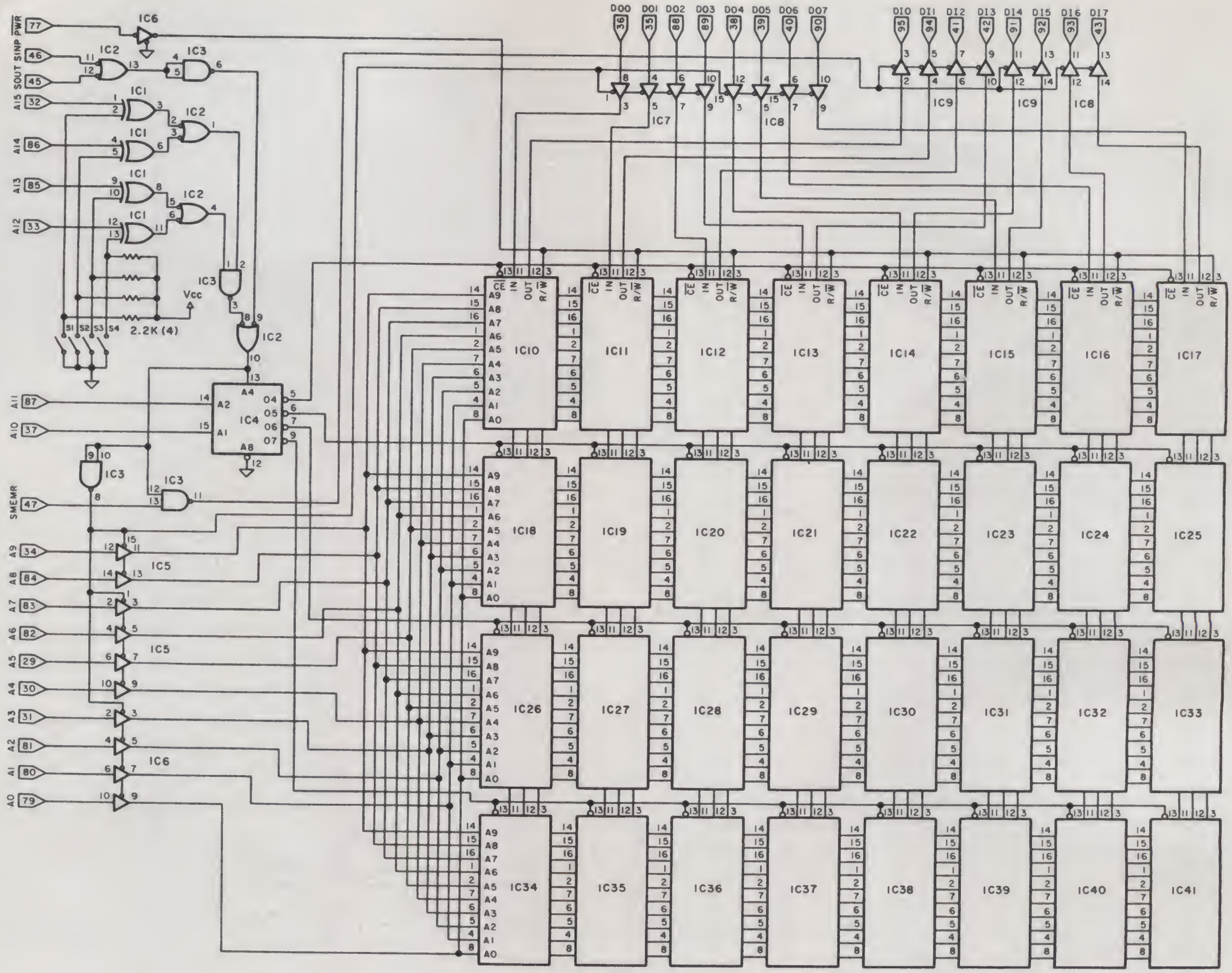

Fig. 2. 4K memory block.

dress bit A10 and A11 determine which of four 1K subsectors is actually accessed. Address bits A0 through A9 are applied to the address pins of the 2102 memory chips to select the single byte desired. Table 1 gives the scheme for mapping 4K sectors in memory.

This is a fully decoded address technique that allows expansion to a full 64K if desired. Again, data buses, as well as the low-order address bits, are buffered with Tri-state devices. High-order address bits present low-power Schottky loads to the drivers so as not to compromise the ability for full expansion.

If the operation is a memory write, $\overline{PWR}$ will provide the necessary active low signal only after memory addresses have settled. In a read operation, SMEMR is gated to enable the memory output onto the Data In bus provided this memory block has been addressed.

For the hobby-computer enthusiast on a tight budget, memory can be expanded 1K at a time. With 1K available at about $12 per 8 2102s, this is a distinct advantage. For the computer hot-rodder, 250 ns 2102s give a memory usable with the 4 MHz Z-80 without wait states.

S1	S2	S3	S4	Starting Address	Ending Address
0	0	0	0	0000	0FFF
0	0	0	1	1000	1FFF
.					
.					
.					
1	1	1	1	F000	FFFF

Table 1. Scheme for mapping 4K sectors in memory.

Construction

As was discussed in my front-panel article, some sort of plug-in prototype board would be advantageous for flexibility. Mounting edge connectors on the top of a plain old aluminum chassis is a quick, easy and sound method. Refer to the photograph for the method actually used in the prototype.

Bypass capacitors are not critical in the front panel. However, they are important in both the CPU and memory because of the high-speed operation with numerous switching transients. One 0.1 uF disk cap per four gate packages or per two MSI packages is the minimum recommendation. Good, wide buses with adequate filtering are also recommended. Use 50 or 100 uF electrolytics at the points where power enters the circuit boards.

Operation

Operation is identical to that described in my front-panel article. I refer you to that article for a simple program to check out system operation. This system seems to work well and I have now interfaced a home-brew TVT as mentioned earlier. If anybody out there develops a good monitor routine using this system, I'll be happy to hear from you. ■

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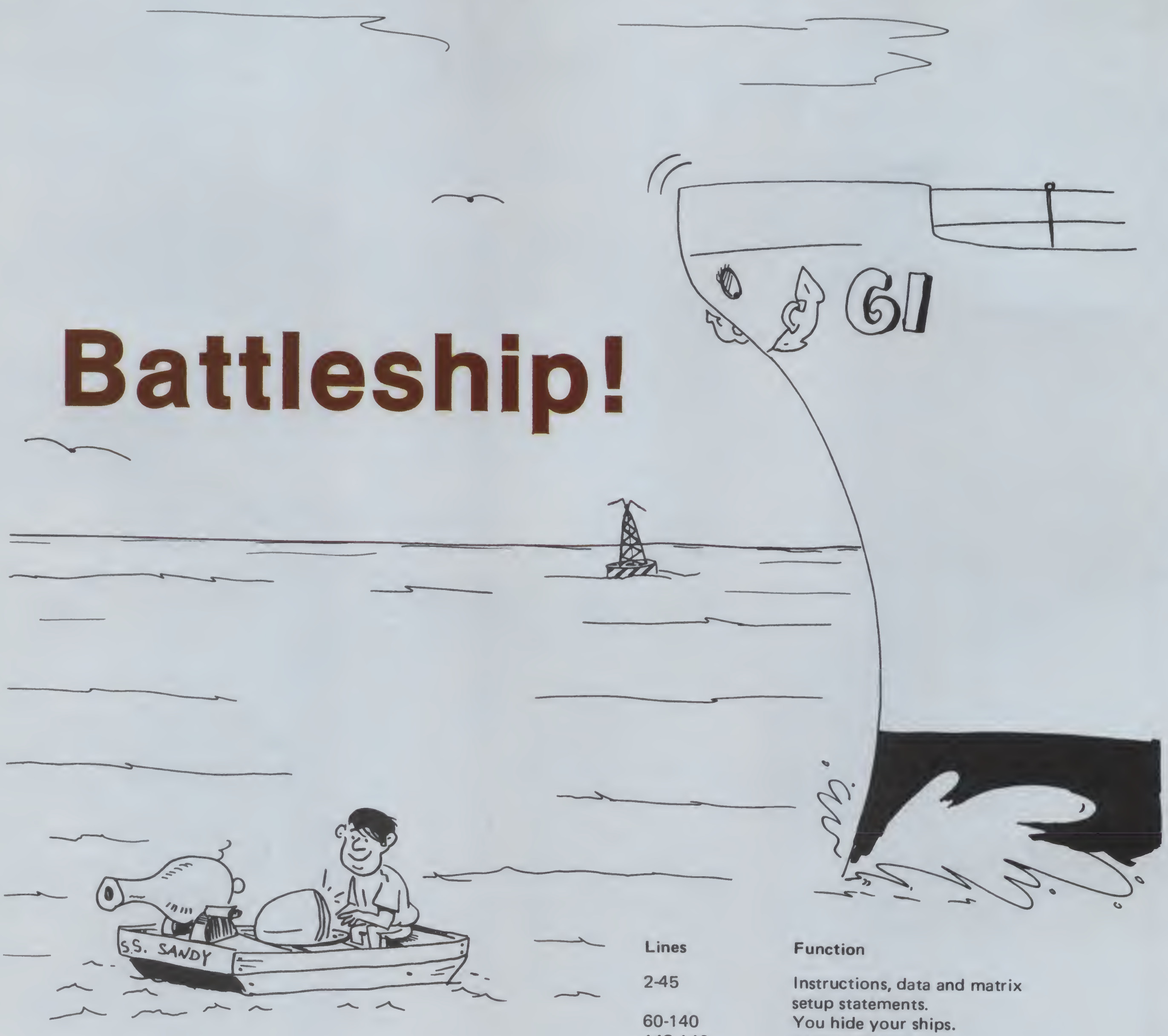
Battleship!



Harley Dyk
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The classic game of Battleship has been around for years. I can recall playing the pencil-and-paper version in the 1950s, and fancy peg versions are still available in stores.

The game is for 2 players; each hides five ships on his 10 x 10 grid (which his opponent cannot see). The grid columns are numbered from 1 to 10 and the rows lettered from A to J. The ships and their lengths are shown in Table 1. Ships may be placed vertically or horizontally; no diagonal placements are allowed.

The game is played by the players taking turns calling off coordinates of suspected enemy-ship positions. G-9, for example, would indicate

Ship	Length
Aircraft carrier	5
Battleship	4
Cruiser	3
Submarine	3
PT boat	2

Table 1.

Lines	Function
2-45	Instructions, data and matrix setup statements.
60-140	You hide your ships.
142-146	Attack strategy.
150-240	Computer hides ships.
251-253	Won-lost check.
255-270	Your shot.
290	Routes action to search for Hit 1, 2, or 3, 4, and/or 5, if necessary.
300-308	Routine to check if ships were hit when sinking another ship.
310-390	Search for Hit 1 on a ship.
400-502	Search for Hit 2 on ship.
510-590	Search for Hits 3, 4, and/or 5, if necessary.
600	Play again?
700-701	Subroutine to print out hidden ships if you lose.
800-898	Subroutine to check if there is room for certain ship's length at a certain location or orientation.
900-906	Subroutine to go left, right, up or down, after Hit 1 on ship.
950-954	Subroutine to continue searching for more of ship in direction of last hit for Hits 4 and 5, if necessary.
1000-1050	Grid printout subroutine.

Table 2.

Program listing.

```
2 PRINT"WELCOME TO THE CLASSIC GAME OF 'BATTLESHIP'.  YOU AND THE"
3 PRINT"COMPUTER WILL TRY TO FIND EACH OTHER'S 5 SHIPS HIDDEN IN A"
4 PRINT"10 X 10 GRID.  POINTS ON THE GRIDS ARE IDENTIFIED BY ROW AND"
5 PRINT"COLUMN.  6,7 FOR EXAMPLE SPECIFIES THE POINT WHERE ROW 6 AND"
6 PRINT"COLUMN 7 CROSS.  YOU WILL NOW HIDE YOUR SHIPS.  GOOD LUCK!"
7 CLEAR10:RUN10
10 DIMA$(5),S(5),L$(5),M$(11,11),C$(10,10),H$(11,11),X(4),Y(4),S$(4)
20 FORI=1TO5:READA$(I),S(I),L$(I):NEXT
30 DATA AIRCRAFT CARRIER,4,A,BATTLESHIP,3,B,CRUISER,2,C
31 DATA SUBMARINE,2,S,PT BOAT,1,P
33 FORI=0TO11:FORJ=0TO11:M$(I,J)=" ":H$(I,J)=".":NEXTJ,I
35 FORI=1TO10:FORJ=1TO10:M$(I,J)=".":C$(I,J)=".":NEXTJ,I
36 FORI=1TO4:S$(I)=" ":NEXT
40 PRINT"ENTER THE ENDPOINTS OF YOUR SHIPS, TOP TO BOTTOM OR LEFT TO"
45 PRINT"RIGHT, THE NUMBER INDICATES THE LENGTH OF THE SHIP."
60 FORI=1TO5:GOSUB1000
65 PRINTA$(I);S(I)+1;:INPUTX1,Y1,X2,Y2
70 IFX1>10ORX2>10ORY1>10ORY2>10THENPRINT"YOU GOOFED":GOTO65
80 IFX1<>X2ANDY1<>Y2ORX1<1ORX2<1ORY1<1ORY2<1THENPRINT"YOU GOOFED":GOTO65
99 IFX2-X1<>S(I)ANDY2-Y1<>S(I)THENPRINT"YOU GOOFED":GOTO65
101 FORJ=X1TOX2:FORK=Y1TOY2
110 IFM$(J,K)<>"."THENPRINT"2 SHIPS CANNOT OCCUPY THE SAME SPOT":GOTO65
120 NEXTK,J
130 FORJ=X1TOX2:FORK=Y1TOY2:M$(J,K)=L$(I):NEXTK,J
140 NEXTI:GOSUB1000:PRINT:PRINT"I WILL NOW HIDE MY SHIPS."
142 CD=INT(RND(1)*3+1):IFCD=1THENC1=2:C2=1:C3=3:C4=2:C5=1:C6=3
144 IFCD=2THENC1=1:C2=1:C3=2:C4=2:C5=3:C6=3
146 IFCD=3THENC1=3:C2=1:C3=1:C4=2:C5=2:C6=3
150 FORI=1TO5
160 Z=RND(1)
170 IFZ>.5THENX1=INT(RND(1)*(10-S(I))+1):Y1=INT(RND(1)*10+1):Y2=Y1
180 IFZ>.5THENX2=X1+S(I):GOTO200
190 Y1=INT(RND(1)*(10-S(I))+1):X1=INT(RND(1)*10+1):X2=X1:Y2=Y1+S(I)
200 FORJ=X1TOX2:FORK=Y1TOY2:IFRND(1)>.85GOTO212
210 IFH$(J,K+1)<>"."ORH$(J+1,K)<>"."ORH$(J-1,K)<>"."GOTO160
212 IFH$(J,K)<>"."ORH$(J,K-1)<>"."THEN160
215 NEXTK,J
220 FORJ=X1TOX2:FORK=Y1TOY2:H$(J,K)=L$(I):NEXTK,J
240 NEXTI:PRINT:PRINT"OK, LET'S PLAY"
251 IFCC=17THENPRINT:PRINT"YOU WON!!":GOTO600
252 IFCM=17THENPRINT"YOU LOST, CHECK THE"17-CC"HIT(S) YOU FAILED TO MAKE
253 IFCM=17THENGOSUB700:GOTO600
255 INPUT"YOUR SHOT";A,B
257 IFA>10ORB>10ORA<1ORB<1THENPRINT"YOU GOOFED":GOTO255
260 IFH$(A,B)<>"."THENC$(A,B)=H$(A,B)ELSEC$(A,B)="*"
270 IFH$(A,B)<>"."THENCC=CC+1:H$(A,B)="."
290 ONHGOTO400,510,510,510
300 IFS$(1)=" "ANDS$(2)=" "ANDS$(3)=" "THENR=0:GOTO310
302 FORQI=1TO4:IFS$(QI)<>" "THEN305
303 NEXTQI
305 FORI=1TO5:IFS$(QI)=L$(I)GOTO308
306 NEXTI
308 S$(QI)=" ":H=1:X=X(QI):Y=Y(QI):GOTO400
310 A=INT(RND(1)*10+1):B=INT(RND(1)*10+1):IFCM=15ANDGF=1THEN325
312 BS=B:AS=A
314 IFB>3THENB=B-3:GOTO314
316 IFA>3THENA=A-3:GOTO316
317 IFCM=15THENCG=CG+1:IFCG=50THENGF=1
318 IFA=C1ANDB=C2ORA=C3ANDB=C4ORA=C5ANDB=C6THEN320ELSE310
320 A=AS:B=BS
325 IFM$(A,B)="H"ORM$(A,B)="*"GOTO310
330 IFCM>=12ANDPX=1ORCM=15THENGOSUB800:IFSP<SLTHEN310
350 IFM$(A,B)="."THENM$(A,B)="*":GOSUB1000:H=0:CG=0:GOTO251
360 H=1:X=A:Y=B:FORI=1TO5:IFM$(A,B)=L$(I)GOTO390
370 NEXTI
390 M$(A,B)="H":CM=CM+1:GOSUB1000:GOTO251
400 Z=INT(RND(1)*4+1):ONZGOSUB902,900,906,904
450 IFM$(X+P,Y+Q)="H"ORM$(X+P,Y+Q)="*"ORM$(X+P,Y+Q)=" "THEN400
452 SL=0:SP=1:A=X:B=Y:ONZGOSUB810,810,872,872:IFSP>=S(I)+1GOTO460ELSE400
460 IFM$(X+P,Y+Q)="."THENM$(X+P,Y+Q)="*":GOSUB1000:GOTO251
470 IFM$(X+P,Y+Q)<>L$(I)THENR=R+1:S$(R)=M$(X+P,Y+Q):M$(X+P,Y+Q)="H"
480 IFM$(X+P,Y+Q)<>L$(I)THENCM=CM+1:GOSUB1000:X(R)=X+P:Y(R)=Y+Q:GOTO251
490 M$(X+P,Y+Q)="H":CM=CM+1:H=2:GOSUB1000:P=P*2:Q=Q*2
500 IFH=S(I)+1THENH=0:PRINTCHR$(7)"SUNK!! GURGLE,GURGLE,GOODBYE "A$(I)
501 IFI=5THENPX=1
502 GOTO251
510 IFM$(X+P,Y+Q)="."THENM$(X+P,Y+Q)="*":GOTO530
520 GOTO540
530 ONZGOSUB900,902,904,906:GOSUB1000:GOTO251
540 IFM$(X+P,Y+Q)="*"ORM$(X+P,Y+Q)=" "THENCK=1:ONZGOSUB900,902,904,906
542 IFCK=1THEN550
544 IFM$(X+P,Y+Q)="H"THENONZGOSUB900,902,904,906
550 CK=0:IFM$(X+P,Y+Q)<>L$(I)THENR=R+1:S$(R)=M$(X+P,Y+Q):M$(X+P,Y+Q)="H"
560 IFM$(X+P,Y+Q)<>L$(I)THENCM=CM+1:X(R)=X+P:Y(R)=Y+Q:GOSUB1000:GOTO251
570 M$(X+P,Y+Q)="H":CM=CM+1:H=H+1:GOSUB1000:GOSUB950
580 IFH=S(I)+1THENH=0:PRINTCHR$(7)"SUNK!! GURGLE,GURGLE,GOODBYE "A$(I)
590 GOTO251
600 PRINT:INPUT"WOULD YOU LIKE TO PLAY AGAIN";F$:IFF$="YES"GOTO7ELSEEND
700 FORHH=1TO10:FORYY=1TO10:PRINT" "H$(HH,YY);:NEXT:PRINTTAB(34)
701 FORYY=1TO10:PRINT" "C$(HH,YY);:NEXT:PRINT:NEXT:RETURN
800 SL=17-CM:SP=1
810 FORF=A+1TOA+4:IFF>10THEN860
```

```
830 IFM$(F,B)<>"H"ANDM$(F,B)<>"*"THENSP=SP+1:GOTO850
840 GOTO860
850 NEXTF
860 FORF=A-1TOA-4STEP-1:IFF<1THEN870
864 IFM$(F,B)<>"H"ANDM$(F,B)<>"*"THENSP=SP+1:GOTO868
866 GOTO870
868 NEXTF
870 IFSP>=SLTHENRETURN
872 SP=1:FORF=B+1TOB+4:IFF>10GOTO880
874 IFM$(A,F)<>"H"ANDM$(A,F)<>"*"THENSP=SP+1:GOTO878
876 GOTO880
878 NEXTF
880 FORF=B-1TOB-4STEP-1:IFF<1THEN898
892 IFM$(A,F)<>"H"ANDM$(A,F)<>"*"THENSP=SP+1:GOTO896
894 GOTO898
896 NEXTF
898 RETURN
900 P=-1:Q=0:RETURN
902 P=1:Q=0:RETURN
904 P=0:Q=-1:RETURN
906 P=0:Q=1:RETURN
950 IFP>0THENP=P+1
951 IFP<0THENP=P-1
952 IFQ>0THENQ=Q+1
953 IFQ<0THENQ=Q-1
954 RETURN
1000 PRINT:PRINTTAB(4)"1 2 3 4 5 6 7 8 9 10";
1010 PRINTTAB(34)"1 2 3 4 5 6 7 8 9 10":PRINT
1020 FORIL=1TO10:PRINTILTAB(4);
1030 FORIC=1TO10:PRINTM$(IL,IC);:PRINT" ";:NEXTIC
1040 PRINTTAB(30)IL;TAB(34);:FORIC=1TO10:PRINTC$(IL,IC);:PRINT" ";
1050 NEXTIC:PRINT:NEXTIL:PRINT:PRINT:PRINT:RETURN
OK
```

```
RUN
WELCOME TO THE CLASSIC GAME OF 'BATTLESHIP'. YOU
AND THE COMPUTER WILL TRY TO FIND EACH OTHER'S 5
SHIPS HIDDEN IN A 10 × 10 GRID. POINTS ON THE GRIDS
ARE IDENTIFIED BY ROW AND COLUMN. 6,7 FOR EXAMPLE
SPECIFIES THE POINT WHERE ROW 6 AND COLUMN 7
CROSS. YOU WILL NOW HIDE YOUR SHIPS. GOOD LUCK!
ENTER THE ENDPOINTS OF YOUR SHIPS, TOP TO BOTTOM
OR LEFT TO RIGHT, THE NUMBER INDICATES THE
LENGTH OF THE SHIP.

    1 2 3 4 5 6 7 8 9 10         1 2 3 4 5 6 7 8 9 10
 1  • • • • • • • • • •       1  • • • • • • • • • •
 2  • • • • • • • • • •       2  • • • • • • • • • •
 3  • • • • • • • • • •       3  • • • • • • • • • •
 4  • • • • • • • • • •       4  • • • • • • • • • •
 5  • • • • • • • • • •       5  • • • • • • • • • •
 6  • • • • • • • • • •       6  • • • • • • • • • •
 7  • • • • • • • • • •       7  • • • • • • • • • •
 8  • • • • • • • • • •       8  • • • • • • • • • •
 9  • • • • • • • • • •       9  • • • • • • • • • •
10  • • • • • • • • • •      10  • • • • • • • • • •

AIRCRAFT CARRIER 5 ? 2,7,6,7

    1 2 3 4 5 6 7 8 9 10         1 2 3 4 5 6 7 8 9 10
 1  • • • • • • • • • •       1  • • • • • • • • • •
 2  • • • • • • A • • •       2  • • • • • • • • • •
 3  • • • • • • A • • •       3  • • • • • • • • • •
 4  • • • • • • A • • •       4  • • • • • • • • • •
 5  • • • • • • A • • •       5  • • • • • • • • • •
 6  • • • • • • A • • •       6  • • • • • • • • • •
 7  • • • • • • • • • •       7  • • • • • • • • • •
 8  • • • • • • • • • •       8  • • • • • • • • • •
 9  • • • • • • • • • •       9  • • • • • • • • • •
10  • • • • • • • • • •      10  • • • • • • • • • •

BATTLESHIP 4 ?
```

Opening instructions and grid display, followed by a sample placement of the aircraft carrier.

the point in row G, column 9. A player must also give the name of the opposing ship hit in that event. The game continues until one of the players has destroyed all 17 points of his opponent's ships.

A computer program allowing 2 people to play Battleship against each other would be a good challenge, but to get the computer to play intelligently and competently seemed more challenging. Games like Star Trek and Hangman are excellent, and specify what the player must do in a certain number of steps, but do not actually pit the player against the computer (and its program). This is possible in games such as Ticktacktoe, Checkers, Chess and Battleship.

A program listing and some typical output follows. To conserve memory, REM statements were not used in the program, but Table 2 gives a summary statement of the functions of various sections of the program.

The program follows the traditional rules; the only difference is how the coordinates are called. To name C, 6, for example, I used 3, 6 simply numbering the rows rather than using letters. The program instructions are rather short due to memory limitations; but if you read this article and look at the sample output, you should have no trouble getting started.

The program is written in Mits Extended BASIC; however, only lines 260, 318, 452 and 600 would have to have their if-then-else instructions changed to conform to 8K BASIC. As usual, the program expanded to fill the available memory, and just resides and runs in the 6084 bytes I have available. The game was not designed to be played on a teletypewriter unless the player has an hour or two and surplus paper. At 9600 baud on a CRT, one can play game in five minutes (once accustomed to the program).

Although the computer "knows" where your ships are, at no time does it use this information to play more intelligently. My experience indicates that the computer's luck runs in streaks. When I perfected the version of the game shown here, the computer beat me the first three times. After that put-down, I became more serious and have become a better player; I now win three or four games out of five.

You will probably have to play at least ten games to get a good idea of your ability against the computer and its ability against you. You should win some easy ones, have some close victories and lose occasionally.

If you want to make the program easier (or harder), you must consider lines 312-320, as they are a key part of the attack strategy. If they are removed, the game will be much easier. They can also be revised to make the game slightly easier. To trim the ego of someone who wins regularly, change the 5 at the end of line 150 to a 4. This makes it impossible to win.

Another possible change is the .85 in line 200. Making this number smaller increases the probability that the computer will hide ships next to each other. This makes things trickier — especially if the player assumes that ships are never adjacent.

Since the computer plays somewhat intelligently and systematically, it may need to "think" longer as the game progresses before it picks a point. Occasional thinking delays of 10 or 15 seconds near the end of the game are normal, so don't be too impatient with your computer. The BASIC language does not yet have the long awaited HUNCH statement available (this statement will give the computer extrasensory perception and mind-reading ability when playing games). Happy sinking! ■

(A paper tape copy of the program is available from the author for $4.00.)

```
PT BOAT 2 ? 2,10,3,10

     1 2 3 4 5 6 7 8 9 10          1 2 3 4 5 6 7 8 9 10
  1  ● ● ● ● ● ● ● ● ● ●        1  ● ● ● ● ● ● ● ● ● ●
  2  ● ● ● ● ● ● A ● ● P        2  ● ● ● ● ● ● ● ● ● ●
  3  ● ● S ● ● ● A ● ● P        3  ● ● ● ● ● ● ● ● ● ●
  4  ● ● S ● ● ● A ● ● ●        4  ● ● ● ● ● ● ● ● ● ●
  5  ● ● S ● ● ● A ● ● ●        5  ● ● ● ● ● ● ● ● ● ●
  6  ● ● ● ● ● ● A ● ● ●        6  ● ● ● ● ● ● ● ● ● ●
  7  ● ● ● ● ● ● ● ● ● ●        7  ● ● ● ● ● ● ● ● ● ●
  8  ● C C C ● ● ● ● ● ●        8  ● ● ● ● ● ● ● ● ● ●
  9  ● ● ● ● ● ● B B B B        9  ● ● ● ● ● ● ● ● ● ●
 10  ● ● ● ● ● ● ● ● ● ●       10  ● ● ● ● ● ● ● ● ● ●

I WILL NOW HIDE MY SHIPS.

OK, LET'S PLAY
YOUR SHOT? 2,1

     1 2 3 4 5 6 7 8 9 10          1 2 3 4 5 6 7 8 9 10
  1  ● ● ● ● ● ● ● ● ● ●        1  ● ● ● ● ● ● ● ● ● ●
  2  ● ● ● ● ● ● A ● ● P        2  * ● ● ● ● ● ● ● ● ●
  3  ● ● S ● ● ● A ● ● P        3  ● ● ● ● ● ● ● ● ● ●
  4  ● ● S ● ● * A ● ● ●        4  ● ● ● ● ● ● ● ● ● ●
  5  ● ● S ● ● ● A ● ● ●        5  ● ● ● ● ● ● ● ● ● ●
  6  ● ● ● ● ● ● A ● ● ●        6  ● ● ● ● ● ● ● ● ● ●
  7  ● ● ● ● ● ● ● ● ● ●        7  ● ● ● ● ● ● ● ● ● ●
  8  ● C C C ● ● ● ● ● ●        8  ● ● ● ● ● ● ● ● ● ●
  9  ● ● ● ● ● ● B B B B        9  ● ● ● ● ● ● ● ● ● ●
 10  ● ● ● ● ● ● ● ● ● ●       10  ● ● ● ● ● ● ● ● ● ●

YOUR SHOT?
```

The final ship being hidden, followed by the opening shots of the game by the computer and player.)

```
     1 2 3 4 5 6 7 8 9 10          1 2 3 4 5 6 7 8 9 10
  1  ● ● * ● ● * ● ● ● ●        1  ● A A ● ● ● ● ● ● ●
  2  ● ● ● ● ● ● A ● ● P        2  * ● ● ● ● ● ● ● ● ●
  3  ● ● S ● * ● A ● ● P        3  ● * * ● ● ● ● ● ● ●
  4  ● ● S ● ● * A ● * ●        4  B B B B * ● ● ● ● ●
  5  * ● S * ● ● H ● ● ●        5  ● ● * ● ● ● ● ● ● ●
  6  ● * ● ● * ● H ● ● ●        6  ● ● ● P P * ● ● ● ●
  7  ● ● ● ● ● * ● ● ● ●        7  ● ● ● ● * * ● ● ● ●
  8  ● C C C ● ● ● * ● *        8  ● ● ● ● ● ● * ● ● ●
  9  ● ● ● ● ● ● H H H H        9  ● ● ● ● ● ● * * ● ●
 10  ● ● * ● ● * ● ● * ●       10  ● ● ● ● ● ● * ● * ●

YOUR SHOT? 1,4

     1 2 3 4 5 6 7 8 9 10          1 2 3 4 5 6 7 8 9 10
  1  ● ● * ● ● * ● ● ● ●        1  ● A A A ● ● ● ● ● ●
  2  ● ● ● ● ● ● A ● ● P        2  * ● ● ● ● ● ● ● ● ●
  3  ● ● S ● * ● A ● ● P        3  ● * * ● ● ● ● ● ● ●
  4  ● ● S ● ● * A ● * ●        4  B B B B * ● ● ● ● ●
  5  * ● S * ● ● H ● ● ●        5  ● ● * ● ● ● ● ● ● ●
  6  ● * ● ● * ● H ● ● ●        6  ● ● ● P P * ● ● ● ●
  7  ● ● ● ● ● * * ● ● ●        7  ● ● ● ● * * ● ● ● ●
  8  ● C C C ● ● ● * ● *        8  ● ● ● ● ● ● * ● ● ●
  9  ● ● ● ● ● ● H H H H        9  ● ● ● ● ● ● * * ● ●
 10  ● ● * ● ● * ● ● * ●       10  ● ● ● ● ● ● * ● * ●

YOUR SHOT?
```

Typical mid-game action. On the left grid, hits by the computer show up as Hs, misses as asterisks. As you discover the computer's ships on the right, the first letters of the ships will show.

Improvements Make the Difference: SWTP's New System

Outwardly, the new 6800/2 from Southwest Technical Products doesn't look much different than their previous models . . . but who cares about looks?

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One of the first, and still very successful, computer systems around is the 6800 system from Southwest Technical Products Corp. Just recently, SWTP introduced a new version of the old standby.

Though outwardly similar to the original, still available, 6800 computer, the new 6800/2 differs from the old in several ways. It still runs the same programs, though, and older 6800 systems can be updated without too much expense. For this reason, the new 6800/2 will be of interest not only to new purchasers, but also to owners of the 6800. Here is the rundown on the improvements and changes.

CPU Board

The older system came with the MP-A CPU board, while the new system has the MP-A2 CPU board. The major difference between the two is that the A2 board has four sockets that will accept 2716 EPROMs.

Each of these EPROMs is 2K x 8 bits, so the four ICs together will provide 8K of memory. (This is in addition to the 1K ROM monitor and the 128 words of RAM storage, which are on both boards.) The additional 8K of EPROM has address decoding on the CPU board, and can be addressed either as addresses C000 through DFFF, or as E000 through FFFF.

Although SWTP has not yet announced it, I suspect they will offer a ROM BASIC and perhaps other programs that might be stored in EPROM. In the meantime, they offer the MP-R EPROM programmer board for $45 if you want to program your own.

In addition to the sockets for the 2716 EPROMs, the new A2 CPU board contains a DIP switch that allows a great deal of addressing flexibility. For example, this switch selects the addressing of the EPROM. If it is placed between addresses C000 and DFFF, then it can be used in addition to the standard ROM monitor.

On the other hand, if the EPROM is addressed from E000 through FFFF, then it can replace the monitor. Thus, you could write your own monitor, which would automatically be brought into action when you pressed the Reset button or turned on the system. The DIP switch also allows the insertion of just 4K of EPROM, rather than the entire 8K.

Another part of the DIP switch disables the 128 word RAM on the CPU board so that it can be replaced by an external 4K or 8K memory board. Part of this new RAM would still be used by the monitor as the original 128 words were, but the rest would be available for *user* programs.

In fact, the new A2 board has more complete address decoding so that 16K of RAM can be added to the 32K which could

Pete sent us a picture of himself using the 6800/2, but he also sent this one of Pat Layman with the suggestion that we use whichever looked better. Guess which one we picked? With the exception of black trim instead of aluminum trim, the 6800/2 looks just like the older 6800 system from the outside.

be used on the older system. As a result, the new system can support as much as 48K of RAM and 8K of PROM, while the older system could only support 32K of RAM.

The MP-A2 CPU board is a plug-in replacement for the older CPU board and costs $145 if purchased separately. On the other hand, most of the parts on the new board are the same as those on the old board.

If you use sockets for the ICs on the original CPU board, then the total cost for converting to the new board is about $30. This includes $14.50 for a blank SWTP CPU board, about $10 for new integrated circuits, and the rest for some sockets and a few other components.

The only new integrated circuits are an MC6875 clock driver, two 74LS55 AND-OR-INVERT gates, a 74S139 decoder and a 7404 hex inverter. The first of these is kind of hard to get, but it is used in the new ET-3400 microprocessor trainer from Heath and should be available from them as a replacement part.

ROM Monitor

The older SWTP systems were supplied with Motorola's MIKBUG ROM. This is actually an MC6830 mask-programmed 1K ROM, of which only one half is used for the monitor system. The 6800/2 computer is supplied with SWTP's own monitor ROM, which they call SWTBUG.

The SWTBUG is also an MC6830, but by using the entire 1K it has many more functions than MIKBUG. It has been specially written to be compatible with MIKBUG, and its subroutine entry points are the same. Thus, most older programs that work with MIKBUG will also run with SWTBUG.

SWTBUG differs from MIKBUG in several ways. In addition to the older memory examine functions, program start, input-output subroutines, and the like, SWTBUG also has facilities for inserting breakpoints into a program being debugged, adding an end-of-tape record at the end of paper or cassette tape output, finding specified characters in memory, jumping to RAM or ROM programs without first having to load the starting address into memory, and bootstrapping the SWTP disk system (although I have been told that the disk bootstrap has a bug). Perhaps the most important is SWTBUG's ability to support two different kinds of serial interfaces (more on that in a moment).

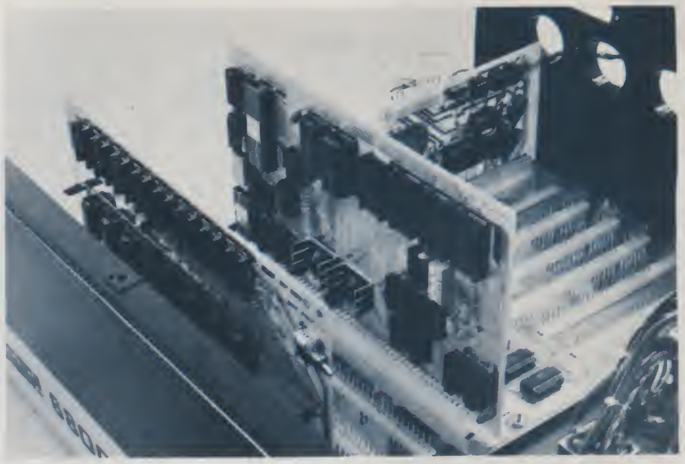
The SWTBUG ROM can be used on older systems as well; it is available separately for $20, and is worth every penny. Its additional functions are extremely useful. Since it uses twice as much memory as MIKBUG, a simple wiring change must be made to use SWTBUG. On the older CPU board this is done by cutting one trace and adding a jumper; on the newer CPU board this change is handled by the DIP switch, so that both MIKBUG and SWTBUG can be used.

Serial Interface

Since the SWTP computer does not have a control panel, it requires the use of a serial terminal (either a teleprinter or CRT) as a control device. Hence, the computer is supplied with a serial interface as part of the basic cost. This is where a big difference exists between the old and the new.

When Motorola designed the 6800 system and developed the MIKBUG monitor, they chose to use a parallel-type IC, the PIA (peripheral interface adapter), to provide the serial interface. Since this is a parallel chip, the conversion between parallel and serial is done in software; specifically, it is done by MIKBUG. Since this conversion is built into MIKBUG, every 6800 system using it has to use the PIA. This has the disadvantage of being slower, since the conversion to and from serial takes up some CPU time.

Thus, the original SWTP system had a special serial interface, the MP-C Control Interface, which used a PIA and was compatible with MIKBUG. If you wanted to add more serial interfaces, then a different serial interface—the MP-S, which uses an ACIA (asynchronous communication interface adapter)—had to be used; this is an IC similar to a UART that does the conversion to and from serial in hardware. This interface is faster and requires less programming; but it is not compatible with MIKBUG and cannot be used for the main or control terminal.



An interior view of the system. The front board, just behind the front panel, is the new 8K memory board; the top eight sockets are empty since the system is supplied with only 4K of ICs. The toggle switch near the top of the memory board is for write protection. Behind the memory board is the new MP-A2 CPU board, which has four free sockets at the top right for four optional 2716 ROMs. The new CPU board also has two regulators instead of one. The small board in the rear corner is the MP-S serial terminal interface.

SWTBUG, on the other hand, had been written so that either the PIA-type control interface or the ACIA-type serial interface can be used. In fact, SWTBUG will support one of each. In this way, the control terminal can be connected to one interface and a cassette system to the other, so they can be operated independently and at different speeds.

As a result, the 6800/2 system is supplied with an ACIA-type serial interface, rather than the older PIA-type control interface, on the theory that the serial interface is faster. This is true, as it can be operated as fast as 9600 baud, whereas the older interface was designed for operation up to only 300 baud, although it has been used faster.

In practice, though, I have a feeling that the older control interface is preferable. In the first place, whether it is really practical to run the terminal much faster than 300 baud is debatable, since it becomes harder to read as the speed Increases. Second, since the Kansas City cassette interface operates at 300 baud, running the terminal at the same speed makes it easy to switch from tape to terminal with just one interface. Although SWTBUG will support two separate interfaces for cassette and terminal, the assembler and BASIC interpreter won't. Third, the control interface automatically echoes the input back to the output, whereas the serial interface only does so under some circumstances.

But the serial interface has an even bigger disadvantage—it is locked into single-speed operation because of its hardware. Specifically, my own system uses an ACI-33 cassette interface made by Personal Computing Company, rather than SWTP's own AC-30 cassette interface. The ACI-33 interface is compatible with the AC-30, since both read and write standard Kansas City tapes. But the ACI-33 is supplied with an additional program, which allows the cassette to run at 2400 baud instead of 300 baud. This speed change is done strictly by software; there are no changes to the hardware.

However, 2400-baud operation is only possible with the PIA-type control interface; the ACIA-type serial interface cannot be used in this mode at all. This slows things down because loading BASIC at 2400 baud takes only about 30 seconds, as compared with about five minutes at 300 baud. This could be remedied by adding another PIA-type interface, but this creates other problems.

The PIA has one more advantage: Since only one half of it is actually used for running the terminal, the other half is available with some programming. Specifically, SWTBUG controls the other half to provide on and off control signals for tape reader and tape punch, which can be used to control two cassette recorder motors.

Memory

Both the 6800 system and the 6800/2 system come with 4K of RAM memory as standard, but on different boards. The 6800 system is supplied with an MP-M 4K board, which contains 32 21L02 1K x 1 integrated circuits. The 6800/2 system is supplied in the form of eight TMS4044 4K x 1 ICs.

A set of eight more ICs is available for $100 to extend the board to the full 8K. This is the same price as adding a complete 4K board, but the advantage is that the new 8K board takes only half as much power as two 4K boards. (By the way, SWTP will soon offer a $400 16K board, which can be expanded to 32K by the addition of more ICs.) The TMS4044 ICs are the same as those in the Heath computer system's 8K board.

Cabinet

Somewhere along the way, SWTP changed the cabinet design in going to the new computer system, although it is possible that they will offer the same cabinet with the standard 6800 system, too. The major difference is the addition of four cutouts on the rear panel to mount four 25-pin connectors of the type used for EIA RS-232C interfaces. The connectors themselves are not supplied.

Price

Surprisingly, the 6800/2 is not much more expensive than the standard 6800 system. The kit price of the 6800 system is $395, while the kit price of the 6800/2 is $439, a $44 difference. Considering that this includes a new $20 ROM and facilities for the new EPROMs, it is worth the extra cost.

Also, the use of an 8K board instead of the 4K board is also worth the price difference; SWTP prices an 8K board at $250, while two 4K boards go for only $200. Hence, in theory at least, $44 buys a lot more.

Even more interesting is that the 6800/2 is available wired for $495; this is a departure for SWTP, which has only offered kits in the past. It's obvious that they are aiming more at the industrial and business user than they have in the past. This is especially visible in some of the literature accompanying the new CPU board, which describes the EPROM sockets as useful when the system functions without a terminal if an operator is not needed; this is the case in industrial control applications.

All in all, the 6800/2 system from Southwest Technical Products shows some interesting new concepts. But most welcome is SWTP's pricing structure. As usual, they have priced their new system at a very competitive level, and give you a lot of equipment for the price. Even their policy of providing update kits and bare boards at reasonable prices shows concern, since it allows owners of older 6800 systems to update to the 6800/2 with just a modest outlay.

I would like to express my thanks to Tom Quay of Lehigh Computer Works, 1132-2 Tilghman, Allentown PA, who supplied much of the information comparing the two systems. I got my own SWTP system from Tom, who has been an excellent source of help and advice.■

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Simple and Low-Cost PROM Programmer

With a minimum of hardware you can add this programmer to a 6800 system. Just remember that errors are not allowed . . . this is PROM, not EPROM.

Commercial, bipolar PROM programmers are expensive—they range in price from $1000 to over $2000. Most of us are not interested at those prices, especially when you can put together a good, complete computer system for that much. Here is a PROM programmer that you can build for less than $25.

This PROM programmer is completely under software control, thus eliminating a lot of hardware and making it flexible and simple to use. It is designed around the Harris Semiconductor 7600 line of PROMs, specifically the 7641-5 and 7681-5. These are organized as 512 x 8 and 1024 x 8 words, respectively, and are TTL compatible requiring a single +5 volt power supply.

The software is written for a 6800 system with one PIA (peripheral interface adapter) available for I/O; however, after reading this article, you should be able to adapt it to any micro system. You will need two parallel eight-bit ports and an additional two I/O bits for some control signals. The 6820 PIA is used with most 6800 systems. It is a memory-mapped type I/O device (i.e., it occupies regular memory-address positions in memory; any memory-addressed instructions can be used with the I/O ports).

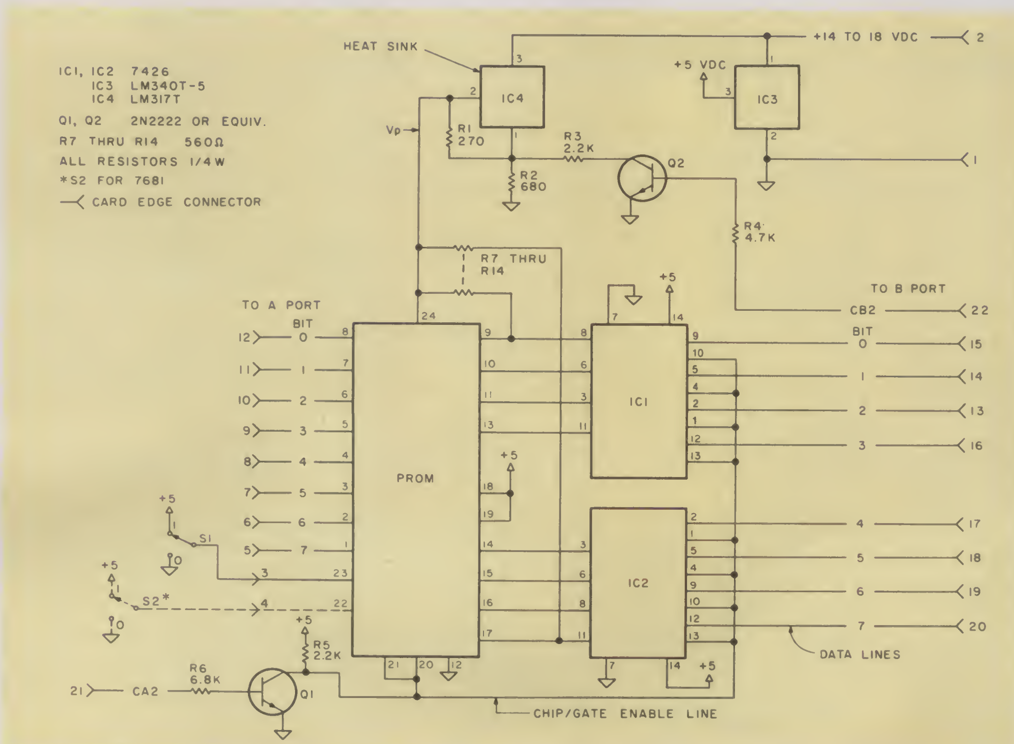


Fig. 1. The hardware for the programmer is very simple. IC4 should be mounted on a small-board-type heat sink. Keep wiring neat and lead lengths as short as possible.

About PROM Programming

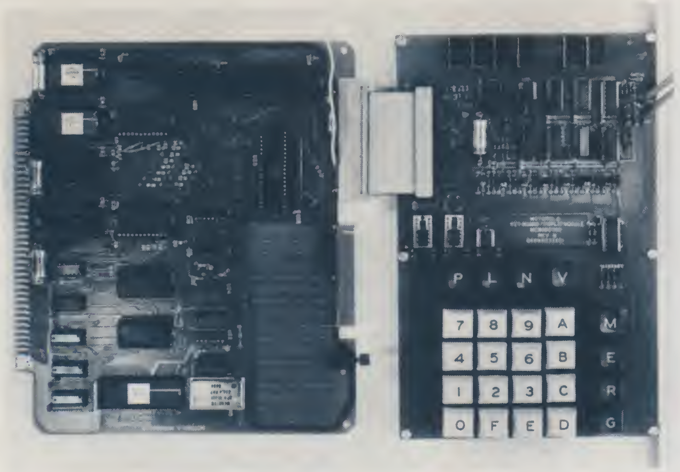
There are almost as many signal-level and timing requirements necessary to burn PROMs in general as there are PROM type numbers. Some require three different voltage levels; others need plus and minus voltages. Setting up the hardware and software for some types can be a real task.

The Harris 7600 line has several pluses: The voltage level and signal-timing requirements are easy to generate, and every PROM in the 7600 series is programmed by the same procedure. This is an advantage because once you have the hardware and software designed, any device in the line may be programmed with only a slight modification, such as a socket change.

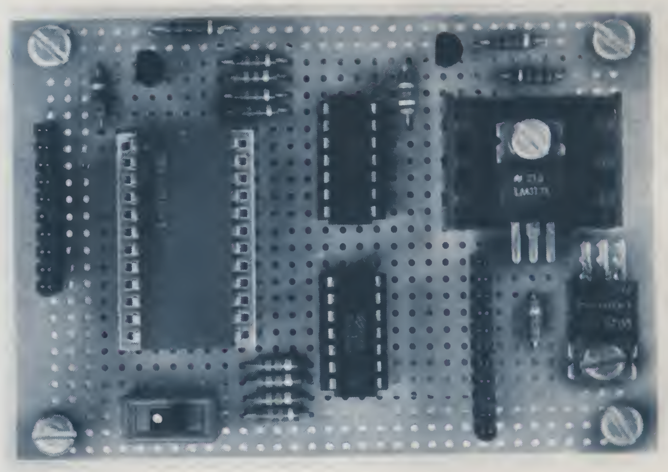
The 7641-5 comes with logic 1 in all bit positions. If a logic 0 is required in a given bit position, that bit must be burned. In the case of the 7600 series, burning is equivalent to blowing a fusible link on the IC chip. Once this is done, you can no longer get a logic 1 in that location.

The Hardware

The schematic for the hard-



The author's prototype was constructed on perfboard. For clarity the interconnecting cables are not shown. They plug in to the in-line PC type connectors on the board. The small-board-type heat sink can be seen on IC4. Switch S1 is located near the PROM in the 24-pin socket. *(Photo by Al Spiroff)*



The Motorola 6800 D2 kit is a versatile unit. It is complete with a well-thought-out 1K monitor, keyboard, LED display and Kansas City tape interface. *(Photo by Al Spiroff)*

ware is shown in Fig. 1: two regulator ICs and two TTL gates; it's that simple. The two TTL gates, IC1 and IC2, gate the data to be programmed from the I/O port to the PROM.

When the Chip/Gate Enable line is a logic 1 and a data input is a logic 0, the output of the DATA gate is a logic 1. This causes the programming current to flow through the corresponding 560 Ohm limiting resistor into the PROM output, blowing the fusible link. Regulator IC3 supplies +5 volts for the TLL gates.

I/O bit CA2 drives the base of transistor Q1, which controls the Chip/Gate Enable line. If CA2 is a logic 1, no programming can take place; but when CA2 is logic 0, the Chip/Gate Enable line is in the programming mode.

Programmable regulator IC4 controls the PROM program voltage. Bit CB2 controls the programming voltage through transistor Q2 and IC4. When CB2 is a logic 1, transistor Q2 conducts and shorts R3 to ground, which causes a 4 volt regulator output. A logic 0 from CB2 cuts off Q2, causing the regulator output to rise to the programming level of 12 volts; this higher voltage is necessary for blowing the PROM fusible links.

The PROM Programming Procedure

As mentioned previously, PROM programming requires that certain voltage levels and data be present and in proper sequence at specific times. Fig. 2 shows the timing requirements for the 7600 series points referenced on the schematic (Fig. 1). The tolerance for the timing relationships appears in Table 2.

To program an eight-bit word into the PROM, we must first set the PROM address to the desired location by simply presenting the proper logic levels to the address lines of the PROM. The MSB (most significant bit) is A8 and the LSB (least significant bit) is A0. Next, the Chip/Gate Enable line is set to a logic 1. Then V_p, the output of IC4, is raised from 4 volts to the 12-volt programming level.

After a delay (t_d) of 10 to 100 us, the first bit to be programmed is entered by placing a logic 0 on the respective DATA line. Up to this time all the DATA lines were at a logic 1. Only one bit at a time may be programmed, so all DATA lines, except the bit being programmed, must be at a logic 1. The logic 0 is held for 100 to 200 us, then returned to a logic 1. This bit is now programmed. This pulse is the programming pulse, t_p, in Fig. 2.

After another delay (t_d) the next bit to be burned may be programmed with a data pulse (t_p) exactly as above. This sequence is repeated until all the logic 0 bits in the word you are programming have been burned into their respective locations in the PROM.

Following the last bit to be programmed in a word, another t_d must be generated before V_p is lowered to 4 volts. Finally, the Chip/Gate Enable line is set to a logic 0. Now we can advance the PROM address to the next location.

Before starting on the next byte, we have to let the PROM cool for 10 to 15 ms. The reason for this is that blowing the fusible links causes some heat generation on the chip. If this heat Is allowed to build up, failure of the PROM can result.

A000—Delay counter in DLOOP (line 36).		
A001—Starting address in PROM for data (line 2).		
A002—High-order byte	Starting address in RAM of	
A003—Low-order byte	program to be burned (line 4).	
A004—High-order byte	Ending address +1 in RAM of	
A005—Low-order byte	program to be burned (line 32).	

Table 1. Six RAM storage locations.

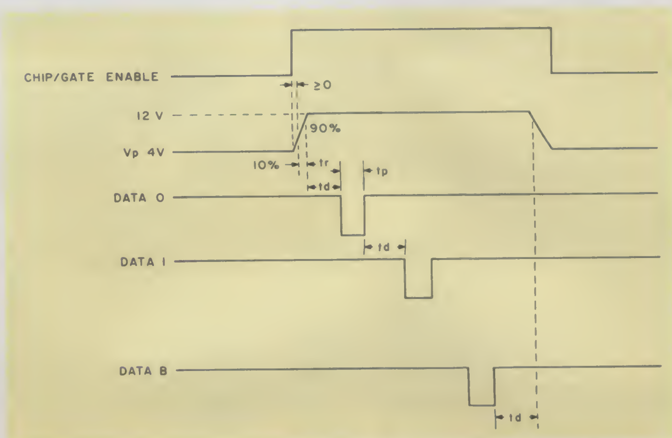


Fig. 2. Waveforms and timing. These timing relationships are necessary for proper PROM programming. The waveforms refer to points on the schematic with the same labels. Table 2 shows the tolerance for t_r, t_d and t_p.

Parameter	Symbol	Min	Recommend	Max	Units
Rise time	t_r	1	1	10	us
Programming delay	t_d	10	10	100	us
Programming pulse	t_p	100	100	200	us

Table 2. Timing tolerances. The recommended values are generated by the PROM burn program.

```
0000  86 FF            LDA   FF
0001  B7 8004          STA         Set ports A and B to be outputs
0002  B7 8006          STA
0003  86 3C            LDA   3C
0004  B7 8005          STA         Set bits CA2 and CB2 HI
0005  B7 8007          STA
0006  B6 8004          LDA         False read of A and B ports to
0007  B6 8006          LDA         clear interrupt bits
0008  4F               CLR
0009  B7 8004          STA         Set all address lines (A port) LO
0010  43               COM
0011  B7 8006          STA         Set all DATA lines (B port) HI
0012  3F               SWI         Stop.
```

Program A. PIA initialization routine.

```
0001  7F A000          CLR           Clear delay counter.
0002  B6 A001          LDA           Set PROM address to starting point.
0003  B7 8004          STA
0004  FE A002          LDX           Load beginning address of program to
                                     be burned.
0005  C6 34    START   LDA   34
0006  F7 8005          STA           Set CA2 LO; disable PROM.
0007  F7 8007          STA           Set CB2 LO; program voltage to 12 V.
0008  C6 01            LDA   01      Initialize mask enable bit.
0009  17       BSTART  TBA
0010  63 00            COM   0,X     Use mask to strip off a bit and
0011  A4 00            AND   0,X     test it for a zero to burn.
0012  43               COM
0013  81 FF            CMP   FF
0014  27 0D            BEQ   SHIFT   Go to SHIFT if no bit to burn.
0015  B7 8006          STA           Get bit to burn to DATA input lines.
0016  86 0C            LDA   0C      Start delay for bit burn.
0017  4A       PDELAY  DEC           Hold for 100 to 200 us.
0018  26 FD            BNE   PDELAY
0019  86 FF            LDA   FF      End delay pulse.
0020  B7 8006          STA           Restore all DATA lines to HI.
0021  58       SHIFT   ASL           Shift mask enable bit left.
```

Now we can go and repeat the steps until all data is programmed.

The Software

Generating all these critical timing and control signals with hardware is an ambitious undertaking. Fortunately, we have a tool to make it easy and flexible—software! Let's take a look at the program to see how it handles this.

The first section, PIA initialization, sets the eight-bit parallel ports A and B, and bit CA2 and CB2 as outputs. Also, port A is initialized to 00 (hex), port B to FF (hex), CA2 and CB2 to a logic 1. The PROM gets its address from port A, while port B is the data to be burned into the PROM. As stated before, bits CA2 and CB2 control the Chip/Gate Enable line and programming voltage, respectively. Even if you are not using a 6800 system or a 6820 PIA, you should be able to initialize your system from this description.

We will need six locations in RAM to store some information for the PROM burn program. I used A000 through A005 (hex), but any locations in RAM may be used as long as you replace their locations in the program with the respective addresses. These six locations and their uses are shown in Table 1.

Program lines 1 through 4 clear the delay counter, set the PROM starting address, and load the index register with the starting address of the program to be burned into the PROM. In lines 5 through 7, the PROM is disabled and the DATA gates enabled by setting CA2 to a logic 0. The program voltage is raised to 12 volts by setting CB2 to a logic 0. Now we've set up the first two conditions of the steps shown in Fig. 2.

Next, a mask bit is initialized and the LSB, DATA 1, of the first byte to be programmed is stripped off and tested for a 0 to burn. We've now used enough time to satisfy the first delay (t_d).

If no 0 is found to program, a branch is made to shift the mask bit to the next MSB in the byte and we go through the loop again, testing for a 0 bit to

program. This happens in lines 8 through 14. When a 0 is found, it is loaded into the DATA port in the proper position while maintaining logic 1 on the other seven DATA bits.

Now the data pulse in this bit position is at a logic 0 and must remain there for 100 to 200 us until a delay loop, PDELAY, is generated. Finally, the data pulse is terminated by loading the DATA port with FF (hex). Lines 15 through 20 perform this task.

We burned a bit! Now we have to spend some time doing something else in order to generate the next delay before going on to another bit. Let's shift the mask bit to the next MSB and test to see if all eight bits in the byte have been searched. If we're not finished with the byte, we'll branch back to BSTART and get ready to test the next bit for a 0. Lines 21 through 24 accomplish this, causing an interbit delay (t_d).

When we have finished a byte, the PROM must be allowed to cool. CB2 goes to a

```
0022  63 00              COM   0,X
0023  5D                 TST          Test for word complete.
0024  26 E3              BNE   BSTART Go to BSTART if word not finished.
0025  C6 3C              LDA   3C
0026  F7 8007            STA          Set CB2 LO; program voltage to 4 V.
0027  F7 8005            STA          Set CA2 LO; enable PROM.
0028  7C A001            INC
0029  B6 A001            LDA          Increment PROM address.
0030  B7 8004            STA
0031  08                 INX          Increment pointer to next word in
                                      RAM to be programmed.
0032  BC A004            CPX          Test for end; all words programmed.
0033  26 01              BNE   DELAY  Go to DELAY if not finished.
0034  3F                 SWI          Stop.  All finished.
0035  86 03     DELAY    LDA   03     Load multiplier for delay DLOOP.
0036  7C A000   DLOOP    INC          Increment duty cycle delay counter.
0037  7D A000            TST          Test counter for zero content.
0038  26 F8              BNE          Go to DLOOP if not zero.
0039  4A                 DEC          Decrement loop multiplier.
0040  26 F5              BNE   DLOOP  Go to DLOOP if not zero.
0041  20 B2              BRA   START  After duty cycle delay go to START
                                      for next word.
```

Program B. PROM burn program. Line numbers given are decimal and for reference only. The program may be located any place in memory following the one precaution given in the text.

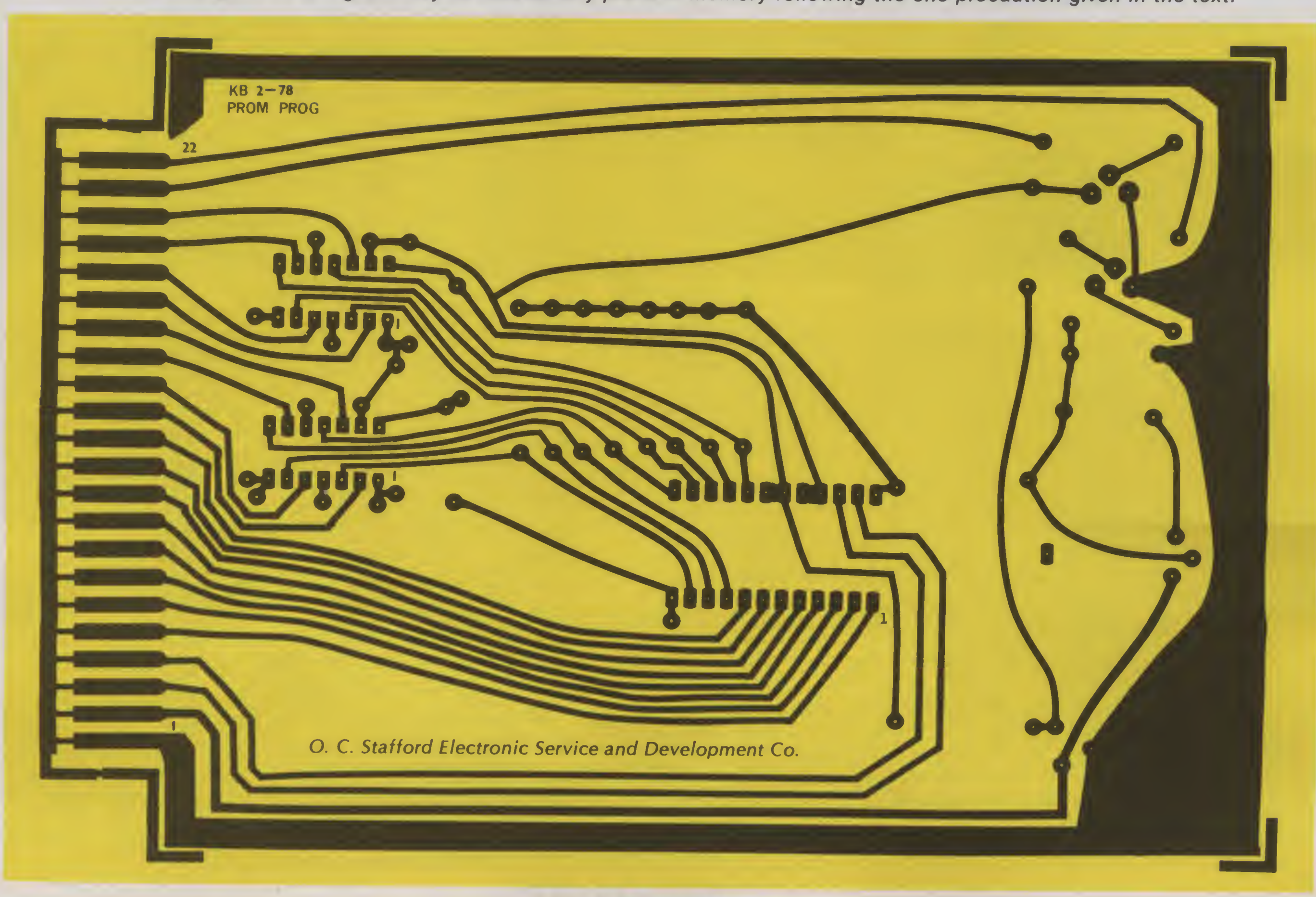


Fig. 3. PC board layout.

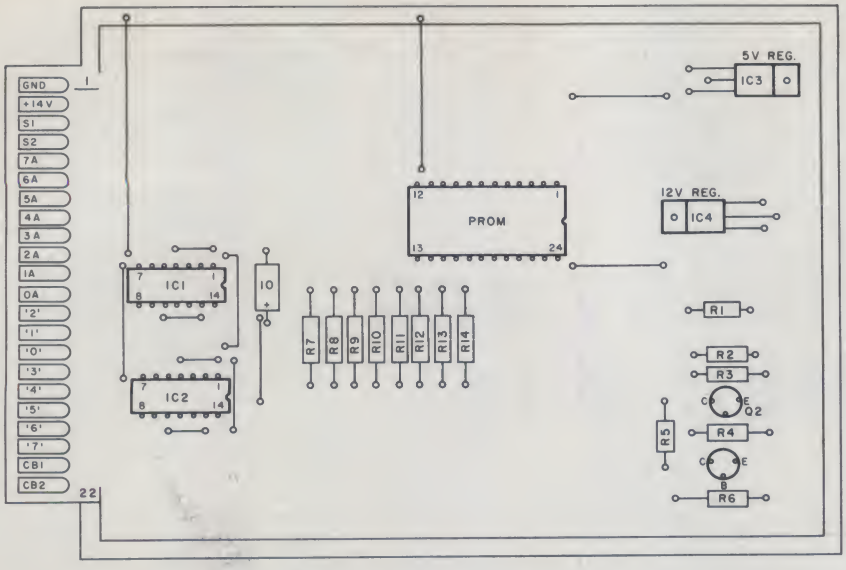


Fig. 4 Component placement diagram.

logic 1, dropping the programming voltage to 4 volts. Next, CA2 goes to a logic 1, enabling the PROM and disabling the DATA gates. Here's where the PROM starts its 10 to 15 ms cooldown.

We can take advantage of this time to do some other things that have to be done. We can increment the address of the PROM and set the pointer to the next location in RAM, then test to see if we are finished with all the bytes to be burned in the PROM. We still have plenty of time to kill so we have to set up a delay loop.

Load a loop multiplier, DELAY, and start incrementing the loop counter, DLOOP. Test the loop counter for 0. If it is not equal to zero, go back to DLOOP; if it is zero go decrement the loop multiplier and do everything again until we've finished our 10 to 15 ms delay.

Now it's time to go all the way back to START (without collecting $200 for passing GO) and loop through the program again until all bytes are programmed. The remainder of the program, lines 26 through 41, handles this chore.

Wow, that took a long time! —actually, about three seconds for each 256 words. Yes, I said 256 words. Remember, we are only using eight bits to address the PROM. That only covers 256 words. Here's where S1 comes into the picture.

S1 controls A8, the highest address bit of the PROM, switching it to a logic 0 or logic 1. We can address the lower or upper 256 words of the PROM, depending on whether S1 is set to 0 or 1, respectively. This should not present any problems because our programming is under software control.

If your program is longer than 256 words, just load the starting address into A002, A003 (hex), then determine what address in the program is 256 words from the beginning and load that address +1 into A004, A005 (hex). Run the program and burn that much. Then load A002, A003 (hex) with the next address and A004, A005 (hex) with the ending address +1. Flip S1 from 0 to 1 and burn the rest of the program.

The optional switch, S2, will allow you to use the Harris 7681-5 without any hardware or software modifications. The combination of S1 and S2 will allow programming the 7681-5 by selecting the address of the PROM in 256 word blocks.

Programming Procedure

When you're ready to program your PROM, the lines may be plugged into the I/O ports. Do not apply power to the programmer board, however. Load the PIA initialization routine and the PROM burn program. The program that you want to burn in the PROM can be either loaded now, or prior to this; but run it and make sure it works the way it's supposed to. Once it's burned in PROM it's too late.

Run the initialization routine, then load A001 through A005 with the proper data. Make sure that S1 (or S1 and S2) is in the right position to address the designated section of the PROM. Turn on the power to the PROM programming board, then run the program.

As soon as the program is finished, shut down the power to the programming board. Now you can plug the PROM into its intended location and verify the contents. If there are any bits that did not program, you can repeat the process several times. If there is still a problem, the PROM could be defective and should be returned. I have yet to find a bad one.

Modifications

If you have some spare I/O, you could modify the program and use these bits to control A8 and A9 to eliminate S1 and S2. A good place to put the steps in the program in order not to upset any timing is between lines 27 and 33. Also, if you have a 1 MHz system clock, change the loop multiplier, 03 (hex), in line 35 to 05 (hex). The clock in my system is 614.4 kHz.

Conclusion

It might be nice to burn the initialization routine and the PROM burn program into PROM so you don't have to load it each time. The hardware takes up very little space and could become a permanent part of your system for future convenient use. I have burned several programs with this system, but one of the most useful is a memory dump to CRT. A memory-test routine would also be nice to have in PROM. By now I'm sure you have many of your own uses lined up for this programmer, so burn those PROMs! ■

The PC-board artwork and component-placement diagrams are shown in Figs. 3 and 4 for you "do-it-yourselfers." All others may order the board and/or kit from O. C. Stafford at the following prices:

Drilled board $7.50
Undrilled board 5.80
Negative or positive 3.00
Parts kit (no board) 27.00

PROMs:
1024 x 8 . . . . $39.50
512 x 8 . . . . 15.00

The board is 4.5 x 6.5 inches, single sided, 22-pin card-edge connector with 0.156-inch spacing. A "zero-force socket" should be used to hold the PROM. (For any, and all, parts or kits, specify KB 2-78.)

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Or call, day or night, (919) 274-9917.

Bill Fuller
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Grand Prairie TX 75051

Compatibility and the Altair Bus

A lot can be said for buying all your S-100 system from one vendor. If you already have, you probably don't need this article. If not . . .

In a previous article, "Beware the Altair Bus" (*Kilobaud* No. 10), I detailed some of the various functions used on Altair bus pins 12 through 15 and 55 through 67. My focus in that article was, and in this one is, to detail functions appearing on those undefined pins.

Since that article appeared, I have found that opinions about the bus are as volatile as discussions on structured programming. Without question, arguments may start just at the mention of Altair or the electrical structure of the bus. Some people desire to maintain the "purity" of the Altair bus both in name and design; others want to call it the S-100, 100-pin or Hobbyist Standard.

For purposes of this article, having no preference for or prejudice against any of the above names, I will refer to the bus as the Altair-mod (modified) bus. This implies that it encompasses the original Altair bus designations as defined by Mits as well as the new functions on the undefined pins referenced in my previous article.

Now that a name has been agreed upon, some background material may be presented. Essentially, this article is the result of a six-month survey of over 150 manufacturers of systems, kits and boards for the Altair-mod bus. Of those manufacturers queried, 45 responded with various bits of information about their equipment. Some were exceedingly helpful in providing additional information and explanation of their bus signal functions. Others, in the process of design, requested any information I had on the undefined pins. A couple supplied almost unprintable comments about the bus itself.

Some Results

Obtaining the information was easy compared to compiling the data into some meaningful form. Although the original intent was to consider only the undefined pins, it became apparent that something should be said about products that are compatible with the basic Altair bus. Another question arose when a few manufacturers redefined some of the original Altair bus functions. What about them? The resultant approach was to include all the information. Thus, three tables categorize the data.

Table 1 specifically lists only the products using the undefined pins (and leaves a few empty columns for boards that might be discovered by readers in the future). Table 2 is self-explanatory. It does not imply that the boards are necessarily compatible with the Altair-mod bus. Finally, Table 3 is a listing of boards or systems that fall into a nebulous category. More about each table later.

Before detailed comments about the contents of the tables are provided, it should be noted that the tables are not a complete listing of every system, kit or board available on the market. Only those products which I could verify were listed—the result of writing, inquiries to manufacturers, leafing through manuals in various computer stores, talking to the reps at NCC, among other means. Thus, if you notice a product missing from the table and you, as a manufacturer or user, feel slighted, that was not the intent; I was simply unable to obtain the data. Possibly, in some cases, the data or product does not exist. A near-final account indicates about 70 manufacturers represented in the tables.

Undefined Pin Comments

Table 1 is an update of my previous article, but is restructured to list only the 19 undefined pins. Additionally, the table contains previously unavailable information. The manufacturer's name, beginning first with systems, followed by CPU and memory boards, and finally, miscellaneous items, appears across the top of the table. Every attempt was made to maintain consistency in name for signals that performed the same function; however, in some cases, the information was lacking or unclear.

It's obvious from Table 1 that either caution was used to select certain pins or a severe lack of communication exists among the manufacturers. For example, pins 12, 13 and 67 are used for six or seven uniquely different signals. Lack of communication could have been the problem a year ago, but that doesn't explain later entrants into the market assigning a new function to a defined pin already in use. Perhaps the clearest example of this is the Phantom signal on pin 67.

Historically (about two long years ago), it was generally known that Processor Technology and Cromemco differed over the use of pin 67. Processor Technology used the pin for Phantom, while Cromemco defined the pin for DMA usage with the Dazzler. (It is rumored that Cromemco has since abandoned usage of that function on pin 67.) So, the question arises, why contribute to the conflict with NMI, RFSH, SCLK?

From a different angle, it may be interesting to see how many of the *same* functions appear on different pins.

NMI apprears in Table 1 a total of seven times and is distributed among four pins. The different CPUs for NMI are: Z-80, three on pin 12, two on pin 67; 6502, one on pin 15, one on pin 17; 6800, one on pin 12. Discussion of electrical compatibility between different CPUs with similiar signals *will be left* as the subject of a yet-to-be-written book.

Compatible Systems/Boards

Table 2 lists those manufacturers who have indicated by survey or in their literature that pins 12 through 17 and 55 through 67 are not used in their product. Going one step further, I eliminated any product from the table that redefined existing Altair bus functions. You should be able to confidently select any of the

Table 1. Products using the undefined pins.

Pin No.	Mnemonic	Function	ALTAIR 8800B SYSTEM	COMPUTER POWER & LIGHT COMPAL 8 SYSTEM	CROMEMCO Z-2 SYSTEM	CENTRAL DATA 2650 SYSTEM	DATA HANDLER 6502 SYSTEM	FORETHOUGHT-KIMSI 6502 SYSTEM	IMSAI SYSTEM	NORTH STAR HORIZON SYSTEM	POLYMORPHIC SYSTEM	TECHNICAL DESIGN LABS (TDL) Z-80 SYSTEM	PROCESSOR TECHNOLOGY SYSTEM	VECTOR GRAPHIC MAINFRAME SYSTEM	ALPHA MICROSYSTEMS AM-100 (16-BIT) CPU	BASE 2 Z-80 CPU	ITHACA AUDIO Z-80 CPU	KENT-MOORE Z-80 CPU	MRS M6800 CPU	S.D. SALES Z-80 CPU	BISI CCD MEMORY	DRC ELECTRONICS 8K RAM	CREA/COMP SYSTEMS 16/32K MEMORY	EXTENSYS 16K RAM	ITHACA AUDIO 8K MEMORY	SEALS 8K MEMORY	TDL MEMORY MANAGEMENT	TDL 16K MEMORY	MICRODESIGN MR8 PROM	VECTOR GRAPHIC 16K RAM	MINITERM MERLIN	COMPTEK CL2400	CURTIS ELECTRO DEVICES, INC. HAM-S100	ENVIRONMENTAL INTERFACES
12	XRDY 2	EXTERNAL READY 2	●								●																							
	NMI	NONMASKABLE INTERRUPT			●					●		●					●		●															
	—	BATTERY BACKUP (+ 12V)																								●								
13	IRQ	INTERRUPT REQUEST																	●															
	CK3	PHASE 3 SHIFT CLOCK																			●													
	STDBY	STANDBY POWER																							●									
	—	BANK SELECT 8																						●										
	PAUSE	—				●																												
14	RDS BL/L	—										●																						
	Ø1	M6800 Ø1 CLOCK																	●															
	CK1	PHASE 1 SHIFT CLOCK																			●													
	STDBY	STANDBY POWER																							●	●								
	—	BANK SELECT 9																						●										
	OPREQ	—				●																												
15	Ø2	M6800 Ø2 CLOCK																	●															
	BWE	WRITE ENABLE ANDED WITH WRITE																			●													
	NMI	NONMASKABLE INTERRUPT					●																											
	—	BATTERY BACKUP																																
	—	BANK SELECT 10/ADDRESS 18																						●										
	STOP CLK	—				●																												
16	R/W	M6800 READ/WRITE																	●															
	LDM	LOAD MEDIUM ADDRESS BYTE																			●													
	—	BANK SELECT 11/ADDRESS 16																						●										
	INTAK	—				●																												
17	BDSEL	ACKNOWLEDGE SIGNAL FROM ADDRESSED STORAGE BOARD																			●													
	NMI	NONMASKABLE INTERRUPT						●																										
	BGNT +	CPU BUS GRANT		●							●																							
	—	BANK SELECT 12/ADDRESS 17																						●										

products in Table 2 for complete compatibility with the Altair bus. This will not necessarily be true for the S-100/Imsai/Hobbyist Standard/Altair-mod bus. Why this restriction exists will be discussed later in the article.

Miscellaneous Compatibilities

Table 3 lists those boards and systems that either redefined some of the Altair/Altair-mod bus functions, were known to have some strange pin assignments or did not generate some of the required signals. This table is not complete; other products most likely should appear here, but the main purpose of this article is to show that various levels of compatibility exist, not just the distinctions arbitrarily selected for Tables 1 through 3.

PolyMorphic, ComPAL-80 and Central Data are listed primarily because, as systems, they do not provide some of the defined bus functions required for some boards. The CGRS MPU, also listed, is not compatible due to redefinition of some of the basic pin functions. The MICRONICS BBT uses pins 12 through 17 for interrupt-type functions and is not completely compatible. For the remaining products, see the referenced articles and Table 3.

Now! About Compatibility

What can you expect when you buy a board or kit? Will it work with other boards in your system? If all you had to do was compare your board's signals with those in Tables 1 through 3 and had reasonable assurance that they would play together, your compatibility problem would be solved. *However*, there are always some problems.

So what can you hope for in the continuing saga of the incompatibles? Well, you could play it safe by buying boards and systems from the same manufacturer. Of course, then you miss out on some fine pieces being offered by others. You could also buy a ready-to-go system that required only a wall socket to get started. But this would be too easy; you would no longer spend sleepless nights debugging programs or experience the exhilaration and joy of "getting it to work." Essentially, there is no single answer to each individual situation, but the information contained in the tables and the following paragraphs should help you explore the possibilities of creating your own unique combination.

Playing Together

Although Tables 1 and 3 indicate that certain products just won't play together, there is hope. Many manufacturers have had the foresight to anticipate the problem and do something about it. The first approach was to provide jumper options for the new function; you do not have to cut traces, but must decide where to jump. In some cases, information provided in the supplied equipment handbook makes you aware of potential problems with other products. But this approach is the *exception* rather than the rule.

While it is presently next to impossible to cover compatible combinations of the over 200 boards available, some potential problems can be identified. Let's look at a few.

Since the Phantom seems to be the most used of the new functions, it gets first consideration. Basically, the Phantom disables memory and I/O data output buffers during initialization of the system. This allows the PROM board access

Table 1. (continued)

Pin No.	Mnemonic	Function	ALTAIR 8800B SYSTEM	COMPUTER POWER & LIGHT COMPAL 8 SYSTEM	CROMEMCO Z-2 SYSTEM	CENTRAL DATA 2650 SYSTEM	DATA HANDLER 6502 SYSTEM	FORETHOUGHT-KIMSI 6502 SYSTEM	IMSAI SYSTEM	NORTH STAR HORIZON SYSTEM	POLYMORPHIC SYSTEM	TECHNICAL DESIGN LABS (TDL) Z-80 SYSTEM	PROCESSOR TECHNOLOGY SYSTEM	VECTOR GRAPHIC MAINFRAME SYSTEM	ALPHA MICROSYSTEMS AM-100 (16-BIT) CPU	BASE 2 Z-80 CPU	ITHACA AUDIO Z-80 CPU	KENT-MOORE Z-80 CPU	MRS M6800 CPU	S.D. SALES Z-80 CPU
55	RTC	REAL TIME CLOCK	●	●							●									
	GND	GROUND						●	●			●		●						
56	$\overline{STSTB}$	STATUS STROBE	●																	
	DMAGR7	DMA GRANT 7													●					
	Vcc	STANDBY		●							●									
57	$\overline{DIG1}$	DATA INPUT GATE 1	●										●							
	DMAGR6	DMA GRANT 6													●					
58	FRDY	FRONT PANEL READY	●																	
	DMAGR5	DMA GRANT 5													●					
59	DMAGR4	DMA GRANT 4													●					
	CW	CONDITIONAL MEMORY WRITE										●								
	---	MEMORY DISABLE (PHANTOM)																		
	EXINHØ	BANK SELECT 0 (?)																		
	$\overline{INH}$	SHADOW MEMORY																		
60	DMAGR3	DMA GRANT 3													●					
	$\overline{ABX}$	NOT ALTERNATE BANK X (A16)										●								
	---	MEMORY BANK SELECT																		
	---	BANK SELECT 1																		
61	A17	ADDRESS 17										●								
	DMAGR2	DMA GRANT 2													●					
	KRDY	KIMSI READY						●												
	---	BANK SELECT 2																		
	GND	GROUND								●										
62	DMAGR1	DMA GRANT 1													●					
	CK4	PHASE 4 SHIFT CLOCK																		
	KØ2	KIMSI Ø2 CLOCK						●												
	---	BANK SELECT 3																		
	A18	ADDRESS 18										●								
63	DMAGR0	DMA GRANT 0													●					
	CK2	PHASE 2 SHIFT CLOCK																		
	$\overline{KHOLD}$	KIMSI HOLD						●												
	---	BANK SELECT 4																		
	A19	ADDRESS 19										●								
64	$\overline{DMA\ RCVD}$	DMA GRANT FLAG													●					
	BCE	CHIP ENABLE																		
	RTC	REAL TIME CLOCK (60 HZ)																		
	---	BANK SELECT 5																		
	RDSBL/H	---										●								
65	$\overline{MREQ}$	MEMORY REQUEST			●					●						●	●	●		
	$\overline{WRITE}$	WRITE ENABLE																		
	---	BANK SELECT 6																		
66	$\overline{RFSH}$	REFRESH			●					●								●		●
	LDH	LOAD HIGH ADDRESS BYTE																		
	CMCLK	VARIABLE VIDEO CLOCK																		
	---	BANK SELECT 7																		
	8/16	---																		
67	$\overline{PHANTOM}$	PHANTOM DISABLE			●					●		●	●	●						
	$\overline{NMI}$	NONMASKABLE INTERRUPT																●		●
	$\overline{RFSHDSBL}$	REFRESH DISABLE			●															
	$\overline{MDSBL}$	MEMORY DISABLE																		
	BBSY +	(PHANTOM -active low?-)		●							●									
	RFSH	REFRESH														●	●			
	SCLK	CLOCK (VIDEO SAMPLE)																		
	A19	ADDRESS 19 OR PHANTOM																		

Pin No.	Mnemonic	Function	BISI CCD MEMORY	DRC ELECTRONICS 8K RAM	CREA/COMP SYSTEMS 16/32K MEMORY	EXTENSYS 16K RAM	ITHACA AUDIO 8K MEMORY	SEALS 8K MEMORY	TDL MEMORY MANAGEMENT	TDL 16K MEMORY	MICRODESIGN MR8 PROM	VECTOR GRAPHIC 16K RAM	MINITERM MERLIN	COMPTEK CL2400	CURTIS ELECTRO DEVICES, INC. HAM-S100	ENVIRONMENTAL INTERFACES
55	RTC	REAL TIME CLOCK														
	GND	GROUND														
56	$\overline{STSTB}$	STATUS STROBE														
	DMAGR7	DMA GRANT 7														
	Vcc	STANDBY														
57	$\overline{DIG1}$	DATA INPUT GATE 1													●	
	DMAGR6	DMA GRANT 6														
58	FRDY	FRONT PANEL READY														
	DMAGR5	DMA GRANT 5														
59	DMAGR4	DMA GRANT 4														
	CW	CONDITIONAL MEMORY WRITE														
	---	MEMORY DISABLE (PHANTOM)							●	●						
	EXINHØ	BANK SELECT 0 (?)				●										
	$\overline{INH}$	SHADOW MEMORY				●										
60	DMAGR3	DMA GRANT 3														
	$\overline{ABX}$	NOT ALTERNATE BANK X (A16)														
	---	MEMORY BANK SELECT											●			
	---	BANK SELECT 1				●										
61	A17	ADDRESS 17														
	DMAGR2	DMA GRANT 2														
	KRDY	KIMSI READY														
	---	BANK SELECT 2				●										
	GND	GROUND														
62	DMAGR1	DMA GRANT 1														
	CK4	PHASE 4 SHIFT CLOCK	●													
	KØ2	KIMSI Ø2 CLOCK														
	---	BANK SELECT 3				●										
	A18	ADDRESS 18														
63	DMAGR0	DMA GRANT 0														
	CK2	PHASE 2 SHIFT CLOCK	●													
	$\overline{KHOLD}$	KIMSI HOLD														
	---	BANK SELECT 4				●										
	A19	ADDRESS 19														
64	$\overline{DMA\ RCVD}$	DMA GRANT FLAG														
	BCE	CHIP ENABLE	●													
	RTC	REAL TIME CLOCK (60 HZ)												●		
	---	BANK SELECT 5				●										
	RDSBL/H	---														
65	$\overline{MREQ}$	MEMORY REQUEST														
	$\overline{WRITE}$	WRITE ENABLE														
	---	BANK SELECT 6				●										
66	$\overline{RFSH}$	REFRESH														
	LDH	LOAD HIGH ADDRESS BYTE	●													
	CMCLK	VARIABLE VIDEO CLOCK														●
	---	BANK SELECT 7				●										
	8/16	---										●				
67	$\overline{PHANTOM}$	PHANTOM DISABLE		●	●						●	●	●		●	
	$\overline{NMI}$	NONMASKABLE INTERRUPT														
	$\overline{RFSHDSBL}$	REFRESH DISABLE														
	$\overline{MDSBL}$	MEMORY DISABLE														
	BBSY +	(PHANTOM -active low?-)														
	RFSH	REFRESH														
	SCLK	CLOCK (VIDEO SAMPLE)														●
	A19	ADDRESS 19 OR PHANTOM				●										

to the data bus. Now consider these questions: What memory and I/O need to be disabled? How? Why? Where does Phantom come from? Are my boards properly equipped? Most of the answers can be obtained from Jack Regula's article, "Using an Invisible PROM" (*Kilobaud* No. 9). The essentials will be given here to illustrate where the problem comes into play.

Any memory board or I/O in the same address location as the PROM board needs to be disabled during initialization of the system (usually at Reset and shortly thereafter). The data bus output drivers are disabled to prevent data from appearing on the bus while the PROM board has access to the bus. Since not all memory boards are created equal, they may not contain the circuitry to allow the Phantom to do its job. In this case, either modify the memory board or make sure no RAM memory exists in the same memory space as the PROM memory.

To modify the memory board, disable the output bus driver enable signal, which is usually a combination of SMEMR, DBIN and Address Decode. Phantom should be combined with this enable signal so a positive level appears on the bus driver enable pin while Phantom is operating. One could swear off using Phantom, but most front-panel-less systems now use it in one form or

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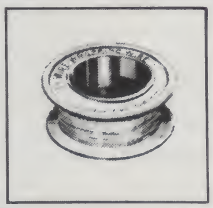
For AWG 26-28	BW-2628

Bit for AWG 30	BT-30
Bit for AWG 26-28	BT-2628

*USE "C" SIZE NI-CAD BATTERIES (NOT INCLUDED)



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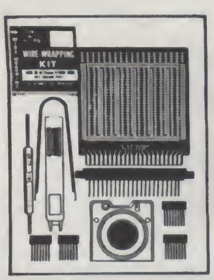

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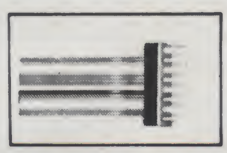

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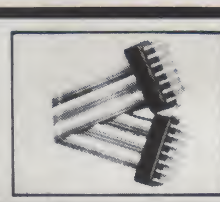
With 14 Pin Dip Plug 24" Long (609mm)	SE14-24
With 16 Pin Dip Plug 24" Long (609mm)	SE16-24



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With 14 Pin Dip Plug - 4" Long	DE 14-4
With 14 Pin Dip Plug - 8" Long	DE 14-8
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With 16 Pin Dip Plug - 8" Long	DE 16-8

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Billings Computer Corp.—Data-Byte System 1.
Canada—PC 3200 AC Controller Interface.
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Digital Systems—HB-1.3 Floppy-Disk Interface.
DRC—16K PROM.
Dutronic—8K RAM.
Dynabyte, Inc.—16K RAM.
EMA Industries—PLRAM Memory.
GNAT—8005 Hardware Multiply/Divide.
Godbout—memory boards (various).
Heuristics—Speechlab.
IBEX—16K PROM.
Imsai—I/O Boards (various).
Integrand Research Corp.—Mainframe/Motherboard.
IOR—VDS2K Video, 6-Port I/O Controller.
Ithaca Audio—16K PROM.
Lincoln Semiconductor—uCT-1 Clock.
Matrox Electronic Systems—ALT-2480 Video Interface.
MECA—Digital Cassette Interface.
MK Enterprises—MK-11 DTMF Transceiver.
Micropolis Corp.—1071 Disk Controller Interface.
Morrow—Cassette Interface.
Mountain Hardware—PROROM.
NEWTECH Computer Systems, Inc.—Model 6 Music Board.
North Star—Micro Disk Controller & Floating Point Boards.
Percom—CI-812 Cassette Interface.
Peripheral Vision, Inc.—PV1001 Floppy-Disk Controller, PV1002 I/O.
Phonics, Inc.—SR 18 Speech Recognizer.
Pickles & Trout—BDPIO.
PolyMorphic Systems—I/O Idea Board.
Processor Applications Ltd.—FDC-1016.
Processor Technology Corp.—3P + S I/O, VDM, Cuts Audio, Music System.
Seattle Computer Prod.—Model 24-101 16K RAM.
Solid State Music—VB-1 Video, Memory (various).
Speech Technology—M188 Voice Generator.
Szerlip Enterprises—PROM Setter.
Tarbell—#1011 Floppy-Disk Interface. Cassette Interface.
Vector Graphic, Inc.—8080 CPU.
Vandenberg Data Products—16K RAM.
WAMECO, Inc.—QM-1 Motherboard.
XITEX—SCT-100 Video Terminal.

Table 2. Products compatible with the Altair bus.

another.

The Phantom function may be generated from either the CPU board, the PROM board or both. Combinations can exist that will put the two sources in conflict to cause some strange system results and fighting bus drivers. The solution is to make sure only one source of Phantom is available.

The next signal that can cause havoc—MWRITE (pin 68)—is not a new function. It has recently become a problem due to elimination of the front panel. Mits originally designed this function into the front-panel board, and Imsai followed suit. Assuming you wanted a system without the blinking lights and the multitude of switches, where would you obtain the MWRITE signal? Well, you could obtain it from some of the reset-and-go-type PROM boards similar to the Vector Graphic board. It is also available from a few CPU boards—Ithaca Audio, for example. In another example, the Vandenberg 16K RAM board contains the function as an option. The ultimate problem would occur in an Altair 8800A or Imsai front-panel system containing a Vector Graphic Reset and Go PROM board, a Vandenberg 16K RAM board and an Ithaca Audio Z-80 CPU board—all with MWRITE enabled.

The New CPUs

With the influx of the Z-80, 6502, 6800 and other CPUs onto the Altair-mod bus, a whole new set of incompatibilities is anticipated. Table 1 Indicates that many are already here.

Not to be overlooked is the simulation of the basic Altair bus signals by these newer CPUs. The problem is that the Altair bus was designed for an 8080 CPU, and the majority of boards depend upon 8080-type signals to function properly. A Z-80 or 6502 requires that certain 8080-type signals be simulated faithfully, i.e., with the same specifications (timing, phase and voltage).

Some things to watch out for with the newer CPU boards are how they handle I/O and whether PSYNC and Ø2 are generated. The 8080 generates the I/O device address on both the upper and lower address lines (0-7 and 8-15) during an I/O instruction, but other CPUs handle I/O differently. If you have the Solid State Music Universal I/O board and your CPU only generates a device address on the lower address, you have problems. The Solid State Music board is etch-committed to the upper address.

Memory boards generally use the PSYNC and Ø2 to develop wait-state selection for slow memory. One would have thought that the wait-state circuitry could be eliminated with the availability of faster memory ICs. However, as the CPUs get faster, the older memory boards that didn't use the wait circuitry may find that implementation is necessary. Thus, it may be necessary to evaluate the CPU board with this in mind.

Besides the above-mentioned CPU-generated signals, the non-8080 CPU board or system should be inspected for certain other signals (e.g., DBIN, SINP, SOUT, SMEMR). Most RAM memory boards use these signals.

The majority of non-8080 CPU boards have been proven in some type of Altair-mod bus system. But, it remains to be seen if they will function with the innumerable combinations

Byte Shop Byt-8 (also Olsen Electronics) (Protect grounded).
Central Data 2650 System*.
CGRS Microtech, Inc.—6502 MPU**.
Computer Power & Light—COMPAL-80* (same bus as Poly-88).
Western Data Systems Data Handler 6502 (does not generate SINP, MEMR and redefines pins 45, 47, 72).
Extensys 16K Memory (redefines pins 18 through 20 to Bank Select 13-15).***
Micronics BBT (uses pins 12-17 as interrupts)
MiniMicroMart—Numerous boards (generally follow TDL and P.T. Corp.)*.
PolyMorphic* system and boards.
S.D. Sales* Z-8800, Z-80.

*See *Kilobaud*, October 1977, "Beware the Altair Bus."
**See *Interface Age*, June 1977, "Introducing The S-100" by W.M. Goble.
***See *Electronic Design*, November 8, 1977, "Break the 65-K byte address barrier."

Table 3. Products not completely compatible.

possible. Some examples are: S.D. Sales Z-80, Solid State Music PROM board, two Mits dynamic RAM memory boards, the Percom cassette interface and a Solid State Music motherboard. Together, they don't work in this combination; yet, if the combination (less the motherboard) is put into another essentially identical system, they work. To complicate the situation, the combination originally worked at one time—when the ambient temperature was higher. One could speculate that the problem is temperature-related, but why does it work in another system? The next guess is that the motherboard is the problem.

Conclusions

My intent was not to paint a bleak picture for the Altair-mod bus or to imply that it is next to impossible to get a working combination. There are too many working systems now in existence to disprove that position. Most of the problems I cited may be unheard of in other parts of the country. Also, my purpose was not to make certain manufacturers look bad by mentioning their names with an associated problem. Generally, the majority of boards and kits available are of good quality.

The main point is to become aware of the possible problems by evaluating what is meant by "Altair/Imsal/S-100/Hobby Standard/100-pin/Altair-mod" compatible. Each manufacturer, computer store and hobbyist means something different when talking about the Altair bus.

Recommendations

1. Support the Central Standards Library (ALF Computer Products, Inc.) in defining a standard. It seems to be the only organization willing to take on the task seriously.
2. Report your combination, problems and solution via national media.
3. Demand bus information and clarification of signal specification, especially with the simulated 8080 signals.
4. Communicate nationally. ■

References:

Kilobaud, September and October, 1977.

Interface Age, June 1977.

Electronic Design, November 8, 1977.

NNJACC Newsletter, July 1977. (Reprinted in *ACGNJ News*, September 1977, of The Amateur Computer Group of New Jersey.)

S-100 Computer Kits List by Robert Elliott Purser, PO Box 466, El Dorado CA 95623.

ALF Products, Inc.,
128 S. Taft,
Lakewood CO 80228.

Manufacturers' manuals and literature.

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Heath H8, 16K; H9, cassette; ext BASIC. Up & run. 1 ship, $1450. A. Thornburg, RR2, Thompsonville IL 62890. (618) 627-2166.

Checking Account Program for SWTPC 6800 with AC30. Runs in 6K. Good up to $99,999. Cassette tape and documentation, $5, send SASE for more information. Russell Duncan, 254 Scotts Manor Dr., Glen Burnie MD 21061.

MIKBUG/SWTBUG users: Clever memory dump program. Dumps both ASCII and hex on same line. Fully relocatable, with full documentation. Send $5 to: Howard Heid, 3930 Paseo Dorado, Tucson AZ 85711.

TRS-80 software on cassette or diskette. Lowest cost. Free newsletter. Poi Pow, 96 Dothan St., Arlington MA 02174.

BASIC Coding Forms! Special design allows for 32, 40 or 64 character line. First 40 sheets, $2; each additional 50 sheets, $2. Send SASE for list of well documented TRS-80 programs. J. J. DeMita, 53 Fenimore St., Lynbrook NY 11563.

RCA COSMAC VIP Owners: Backgammon against computer. Fantastic!! Also: Vegas Blackjack & Craps, Pinball, Star Wars and much more. Send SASE to: SVS, N. Hollywood CA 91601.

TRS-80 Level 1 cassettes: Starfleet game; 2 players maneuver and attack with 11 ships each. 16K, $10. Star Trek; fast playing, but difficult. 4K, $5. G. W. Scheil, #118-1638 Bushman Dr., Kansas City MO 64110.

Disassemble 6800 programs directly from object tapes w/o loading into memory. Gives branch destination addresses and uses vectored I/O. Fully commented listing. $7.50. M. Virkus, 9925 Broadmoor #2, Overland MO 63114.

For Sale: E&L Inst. MMD1-K, assembled. Kit price, $422.60; ass., $600.00. Must sell for $500 or best offer. John Musgrove (713) 466-3486.

PET users need info? Getting started with your PET workbook, $4. Workbook has helpful info, sample programs, exercises and fundamental features of PET BASIC. Send SASE for details. D. Smith, Box 921, Los Alamos MN 87544.

TRS-80—BASIC I. Array manipulations on tape. Resolves DIM problems. Matrix read, add, multiply, inverse & print. Gauss-Jordan elimination solves simultaneous equations. Great for games and business. Commentary on flip side, $5. G. Austin, Box 258, Pinehurst ID 83850.

All prime, 100% guaranteed, in tubes. CD4030—25/$7.50, CA3079—25/$12, 74S112—25/$10, 74116—15/$15. A. Khan, 2355 Burch Cir. N.E., Atlanta GA 30319.

TRS-80 Sort: in BASIC I, 4K min. Sorts recs in memory on 1 or 2 numeric fields in asc. or desc. seq. Input from tape, k.b. or both. Output to tape or video. Can be subroutine. $10 on tape w/doc. To: Software, Box 6153, Syracuse NY 13217.

GE opto-isolators H11A2, all prime. 100% guaranteed. With spec. 2/$1, 100/$40. A. Khan, 2355 Burch Cir. N.E., Atlanta GA 30319.

CIRCLE CHESS instruction book by Alphonso, used in Circle Chess software development. $5, Stanonis, Box 63, Des Plaines IL 60017.

TRS-80 users: Software routine allows display of double-sided letters/numbers (32 characters per line instead of 64). Uses Level I BASIC routines. No modifications to TRS-80 needed. Enter/run programs from keyboard. Send $2.95 to Project Philip, Box 498, California PA 15419, for complete instructions.

TRS-80 Level 1 prgs. on cassette. 4K: Lunar/Martian Lander, ($8); 16K: Star Trek w/graphics, ($10); Oklahoma-Texas Football, ($12); Carrier Battle, ($6). R. Fitzgerald, 3338 Sheila Ln. 292, Dallas TX 75220.

We had replacement panels made for our Altair 8800s. They're blue against a white background and really look nice! We'll sell the extras for $16 each. D. L. Tibbetts, 520 Schoolhouse Ln., Willow Grove PA 19090.

APPLE II ham radio software—send & rcv in Morse, Baudot or ASCII. Variable-size text buffer; 3-field screen display; stored messages & more features. Uses game I/O; req 8K. On cassette, $18. C. H. Galfo, 602 Orange St., Charlottesville VA 22901.

APPLE II Game of LIFE—high speed: 180 gens/min for 36 x 36 cell matrix. Variable-size color display & many features using game paddles & keyboard. Req. 8K. On Apple cassette, $12. C. H. Galfo, 602 Orange St., Charlottesville VA 22901.

PET Owners: Test your system before trying Las Vegas. Blackjack, Baccarat, Roulette, Craps. Full casino options for maximum reality. Screen graphics show cards, dice, wheel. Cassette tape, $25. CMS, 5115 Menefee, Dallas TX 75227.

Use the Classifieds

KB CALENDAR

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Dallas TX

The International Microcomputer Exposition in Dallas (Sept 29-Oct 1) will feature a unique panel of experts, which will consist of qualified experts in the fields of software, hardware and design. The panel will be located on the exhibit floor during all show hours and will field questions from attendees concerning all facets of microprocessing and small systems . . . pertaining to both industrial/business applications and personal computing—from simple to complex. There is no charge to attendees for this forum to discuss problems and design.

Washington DC

Amateur Computing 78 microcomputer festival will be held July 22-23 at the Sheraton National Motor Hotel, Columbia Pike and Washington Blvd., Arlington VA.

Registration at the door for two full days is $5 (spouse and children of ticket holder admitted free). Saturday night banquet tickets, if not sold out, are $14 per person if purchased at the show. To avoid delays and to save money, admission tickets are $4, and the banquet tickets are $12 per person, if ordered in advance by mail. Send check payable to AMRAD to: PO Box 682, McLean VA 22101.

Trenton NJ

Trenton State College is offering three microcomputer courses during the week of August 21: "Assembly Language Programming and Interfacing for the 8080/8085/Z-80" ($350), "Programming in BASIC" ($300), "Digital Logic Circuits" ($300).

All classes are limited to 20 participants. For more information, contact the Division of Continuing Adult Education, Trenton State College, Trenton NJ (609) 771-2255.

Philadelphia PA

Personal Computing '78 will move to a new location for this year's presentation: Philadelphia's centrally located Civic Center. The 1978 edition is slated to run four days, August 24 through 27.

In addition to the exhibits, other attractions will include an art show, music festival, computerized mouse maze and the Personal Computing College. The college will again include over 80 hours of free in-depth seminars conducted by some of the country's leading names in the computing field. Several sessions will be tailored to the needs of businesses that have seen the tremendous advantages of micro and minicomputer applications.

A Saturday night banquet, to be held at the Sheraton, will feature several guest speakers, including Dr. Adam Osborne. During the week, professional seminars featuring in-depth study will be conducted by companies such as Adam Osborne Associates, Sybex and Tychon, Inc., at the nearby Hilton Hotel.

For more information contact: Personal Computing '78, John H. Dilks III, Rt. 1, Box 242, Warf Rd., Mays Landing NJ 08330 (609) 653-1188.

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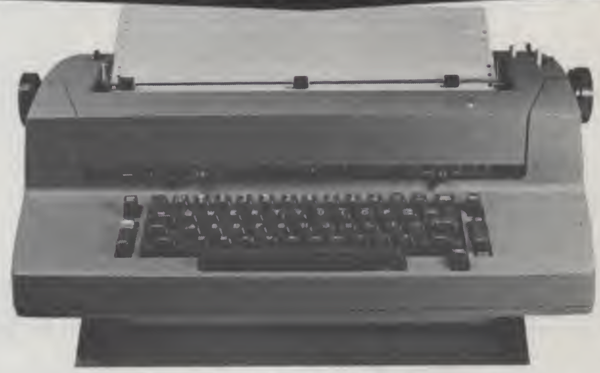

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Retail Pricing System

Here's a retail pricing system that's ready to be used for any small business . . . perhaps that should be very small businesses. (If the program doesn't interest you, maybe you'll want to buy some teas.)

Phil Hughes
PO Box 2847
Olympia WA 98507

bpt'z teas & spices

pob 503 OLYMPIA, WA 98507

January 17, 1978

The wholesale tea and spice prices fluctuate because teas and spices come from all different parts of the world. Remember the coffee frosts of last year? We still see the effect of that market loss in our coffee prices today. Same with teas and spices. Frosts on some markets and bumper crops on others force prices up and down.

I run my business mail-order. Because of this, I have to have updated price lists to send to my customers. My old system (which I like to call "Bury Bexa Under Reams of Paper") required a calculator, old price list, new price list, twelve to fourteen new sharp pencils, and a jumbo pink pearl eraser. Including I should mention, a typewriter that I typed the list on, until I got it right. The old method took about 4-5 hours. My new method is taking my new price list in my right hand, tracking over to Phil's and handing it to him. He takes it from there. Now I'm writing all the labels myself, but soon my bag labels will be printed by the computer also. My time saved is important, but relieving the headache involved seems more important when its time to update.

Bexa Peutz

Bexa Peutz

Build Program

1. LOAD and RUN program BUILD.
2. Enter Name/Description, cost pairs.
3. Terminate input by entering '.,0'.
4. Start output cassette recorder and enter '-return-'.
5. The same file may be re-saved by entering 'GOTO 400'.
6. Another file can be created by entering RUN and returning to step 2.

Report Program

1. LOAD program REPORT.
2. APPEND desired data file (or files).
3. Enter RUN.
4. Enter Title (up to 32 characters).
5. Enter effective date.
6. Position paper and enter '-return-'.

Update Program

1. LOAD program UPDATE.
2. APPEND data file to be updated.
3. Enter RUN.
4. In response to name, cost prompts, enter new cost, 0 for no change or -1 for delete.
5. Repeat step 4 until entire file is updated.
6. Start output cassette recorder and enter '-return-'.
7. Another file can be updated by returning to step 2.

Note: -return- signifies depressing the carriage return. All user input is terminated by -return-.

Fig. 1. User instructions.

This system is designed to generate resale price reports for herbs, teas and spices. The input consists of product names and wholesale costs per pound. Output consists of a retail price report for ¼- and one-pound quantities. Example 1 is a letter from the owner of bpt'z describing the problems of performing the pricing function manually and the advantages of going computerized.

The system facilitates an easy method of price updating and generation of retail price lists. It can also be adapted to any other product whose retail prices can be established as a function of wholesale prices.

The system consists of three BASIC programs plus data files. The programs are file build, file update and report. The *system* is designed to run on an SWTP computer system with AC-30 cassette interface, 12K of RAM and 8K BASIC, Version 2.0 or later. The data files are handled as BASIC DATA statements so the APPEND command can be used for file manipulation. Fig. 1 is a summary of the user instructions for all three programs.

The following information is common to all three programs.

- The DIGITS command is used to set the number of digits after the decimal point to two.
- Variable C1 is the maximum number of data records the program can handle.
- Variable D1 is set to the port used by the cassette interface.
- Variable S1 is set to the first DATA statement line number.
- Variable I1 is set to the line number increment between DATA statements.
- String variable L$ is set to five null characters.
- Each DATA statement has two pieces of information—product name/description and wholesale cost.

Build Program

The build program prompts the user for name and cost pairs. The name may consist of up to 32 characters. Any printable ASCII character, except comma, is permitted. (Comma is not permitted because it is the field delimiter for BASIC.) The wholesale cost is a numeric field.

When user input is complete (signified by the input of '.,0'), the build program waits for the user to ready the output cassette. At this point, entering a carriage return will start the output of the data file. The data file consists of a series of DATA statements that can be APPENDed to the update or report program for processing. Program A contains the listing and a sample run of the build program.

Report Program

The report program prompts for a title and effective date and then prints a report based on the data that has been appended to the program. The listing and a sample output are shown in Program B. Line 160 reads two strings so a date with an embedded comma (e.g., January 1,1978) can be entered.

The codes at lines 260 and 270 set the prices. Line 260 sets the ¼-pound retail price to one-half of the wholesale cost of one pound. Line 270 sets the retail price of one pound to 1.4 times the wholesale cost of one pound. These statements can be modified to reflect any desired markup.

Additionally, it may be desirable to set the retail price to a percentage of wholesale cost

```
READY
#LOAD B
B0001 REM BUILD [SSC] 1-5-78
0010 LINE= 80
0090 REM C1=TABLE SIZE
0091 REM S1=START LINE NUMBER
0092 REM I1=LINE NUMBER INCREMENT
0093 REM D1=OUTPUT PORT NUMBER
0100C1=80
0110S1=1000
0120L$=CHR$(0)+CHR$(0)+CHR$(0)+CHR$(0)+CHR$(0)
0130D1=1
0140I1=5
0150 DIM N$(C1),N(C1)
0160N$(C1)="."
0200 PRINT "TABLE BUILD -- VERSION 1.00"
0210 PRINT :PRINT"ENTER NAME,COST/LB."
0220 PRINT "'.,0' WILL TERMINATE INPUT MODE"
0230 FOR I=1 TO C1-1
0240 INPUT N$(I),N(I)
0245 IF N$(I)="." THEN 400
0250 NEXT I
0260 PRINT "************ TABLE FULL ***************"
0270I=I+1
0280 GOTO 400
0400 PRINT "PREPARE OUTPUT CASSETTE AND PRESS 'RETURN'";
0410 INPUT D$
0420 PRINT #D1,L$;L$;L$;L$;L$;L$
0500 FOR J=1 TO I
0510 PRINT #D1,CHR$(2);(J-1)*I1+S1;"DATA ";
0520 DIGITS= 2
0530 PRINT #D1,N$(J);",";N(J)
0540 DIGITS= 0
0545 NEXT J
0550 PRINT #D1,CHR$(3);L$;L$;L$;L$;CHR$(19);CHR$(20)
0600 PRINT "TO RE-OUTPUT ENTER 'GOTO 400'"
0999 END

READY
#RUN
TABLE BUILD -- VERSION 1.00

ENTER NAME,COST/LB.
'.,0' WILL TERMINATE INPUT MODE
? Darjeeling/Ceylon,3.35
? Earl Grey,3.25
? English Breakfast,2.50
? Irish Breakfast,2.65
? Russian Caravan,2.65
? .,0
PREPARE OUTPUT CASSETTE AND PRESS 'RETURN'?

1000 DATA Darjeeling/Ceylon,3.35
1005 DATA Earl Grey,3.25
1010 DATA English Breakfast,2.50
1015 DATA Irish Breakfast,2.65
1020 DATA Russian Caravan,2.65
1025 DATA .,0.00

TO RE-OUTPUT ENTER 'GOTO 400'
```

Program A. Build program.

```
READY
#LOAD R
R0001 REM REPORT [SSC] 1-4-1978
0010C1=80
0020 DIGITS= 2
0030 LINE= 80
0150 INPUT "ENTER TITLE",T$
0160 INPUT "ENTER A.O. DATE",A$,B$
0180 INPUT "POSITION PAPER AND HIT 'RETURN'",N$
0190 PRINT T$;TAB(40);A$;",";B$
0195 PRINT "DESCRIPTION";TAB(33);"1/4 lb.";TAB(45);"1 lb."
0197 PRINT
0200 FOR I=1 TO C1
0210 READ N$,N
0215 IF N$="." THEN 400
0220 REM N=COST PER POUND
0230 REM SET P1 TO SALES PRICE PER 1/4 POUND
0240 REM SET P2 TO SALES PRICE PER POUND
0260P1=N/2
0270P2=N*1.4
0300 PRINT N$;TAB(34);P1;TAB(45);P2
0390 NEXT I
0400 FOR I=1 TO 20:PRINT:NEXT I
0410 END
9999 DATA .,0

READY
#APPEND


1000 DATA Darjeeling/Ceylon,3.35
1005 DATA Earl Grey,3.25
1010 DATA English Breakfast,2.50
1015 DATA Irish Breakfast,2.65
1020 DATA Russian Caravan,2.65
1025 DATA .,0.00

READY
#RUN
ENTER TITLE? TRADITIONAL BLENDS
ENTER A.O. DATE? JANUARY 1,1978
POSITION PAPER AND HIT 'RETURN'?

TRADITIONAL BLENDS                             JANUARY 1,1978
DESCRIPTION                          1/4 lb.      1 lb.

Darjeeling/Ceylon                     1.67        4.69
Earl Grey                             1.62        4.55
English Breakfast                     1.25        3.50
Irish Breakfast                       1.32        3.71
Russian Caravan                       1.32        3.71
```

Program B. Report program.

plus a fixed amount. For example, P2 = 1.3*N + .25 would set the retail price for one pound equal to 1.3 times the wholesale cost plus 25 cents.

Changes to the data files can be made by loading the desired file using the LOAD command, modifying the file using the editing functions of BASIC and then saving the new file using the SAVE command. This is the easiest way to correct a spelling error, change a single wholesale cost or add a few new items. For an extensive cost revision, the update program should be used.

```
READY
#LOAD U
U0001 REM UPDATE [SSC] 1-5-78
0010 LINE= 80
0100C1=80
0110S1=1000
0120D1=1
0130I1=5
0150L$=CHR$(0)+CHR$(0)+CHR$(0)+CHR$(0)+CHR$(0)
0180 DIM P(C1)
0200 PRINT "TABLE UPDATE -- VERSION 1.00":PRINT
0210 FOR I=1 TO C1
0220 READ N$,N
0230 IF N$="." THEN 300
0240 PRINT N$;TAB(34);N;
0250 INPUT P(I)
0260 IF P(I)=0 THEN P(I)=N
0270 NEXT I
0280 PRINT "********** TABLE OVERFLOW **********"
0300 REM OUTPUT NEW FILE
0310 RESTORE
0320 PRINT "PREPARE OUTPUT CASSETTE AND PRESS 'RETURN'";
0330 INPUT D$
0340 PRINT #D1,L$;L$;L$;L$;L$;L$
0350 FOR J=1 TO I
0360 READ N$,N
0370 IF P(J)<0 THEN 410
0380 PRINT #D1,CHR$(2);(J-1)*I1+S1;"DATA ";
0390 DIGITS= 2
0400 PRINT #D1,N$;",";P(J)
0405 DIGITS= 0
0410 NEXT J
0420 PRINT #D1,CHR$(3);L$;L$;L$;L$;CHR$(19);CHR$(20)
0500 END
1000 DATA .,0

READY
#APPEND


1000 DATA Darjeeling/Ceylon,3.35
1005 DATA Earl Grey,3.25
1010 DATA English Breakfast,2.50
1015 DATA Irish Breakfast,2.65
1020 DATA Russian Caravan,2.65
1025 DATA .,0.00

READY
#RUN
TABLE UPDATE -- VERSION 1.00

Darjeeling/Ceylon                 3.35 ? 0
Earl Grey                         3.25 ? -1
English Breakfast                 2.5 ? 0
Irish Breakfast                   2.65 ? 2.88
Russian Caravan                   2.65 ? 2.47
PREPARE OUTPUT CASSETTE AND PRESS 'RETURN'?

1000 DATA Darjeeling/Ceylon,3.35
1010 DATA English Breakfast,2.50
1015 DATA Irish Breakfast,2.88
1020 DATA Russian Caravan,2.47
1025 DATA .,0.00
```

Program C. Update program.

HERB TEAS DESCRIPTION	JANUARY 1,1978 1/4 lb.	 1 lb.
Alfalfa Leaves	0.57	1.61
Chamomile Flowers	1.67	4.69
Chicory Root	0.80	2.24
Comfrey Leaves	0.85	2.38
Damiana Leaves	0.90	2.52
Eucalyptus Leaves	0.62	1.75
Goldenseal Root	6.75	18.90
Hibiscus Flowers	1.30	3.64
Lavendar Flowers	2.50	7.00
Lemon Grass (wh)	0.75	2.10
Lemon Grass (C&S)	0.80	2.24
Licorice Root	0.90	2.52
Pennyroyal	1.12	3.15
Peppermint Leaves	1.25	3.50
Raspberry Leaves	0.60	1.68
Rosehips (Seedless)	0.82	2.31
Sarsaparilla Root	1.00	2.80
Slippery Elm Bark	1.50	4.20
Spearmint Leaves	0.75	2.10
Yerba Mate	0.50	1.40

Fig. 2. Sample retail price report.

Update Program

The update program reads the data file that has been appended to it, prints current names and prices and prompts for price changes. The following user responses are permitted:

- Any positive number—enters this as the new cost.
- Any negative number—deletes this record.
- Zero—no change.

When the end of the input data file is reached, a new data file is output in the same manner as the build program. Program C contains the listing and sample run of the update program.

File merges can be performed by using the update program to change the starting line number of a file (by changing S1) and then performing multiple APPENDs. Fig. 2 is a sample of the finished product: an updated retail price report. ■

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Colors: Red, Blue, Green, Yellow, Black, Orange, White
Wire packaged in plastic bags. Add 25¢/length for tubes

	100	500	1000	5000
2½ in	.76	2.40	4.30/K	3.89/K
3 in.	.82	2.60	4.71/K	4.22/K
3½ in.	.86	2.80	5.12/K	4.55/K
4 in.	.90	3.00	5.52/K	4.86/K
4½ in.	.94	3.21	5.93/K	5.21/K
5 in.	.98	3.42	6.34/K	5.52/K
5½ in.	1.02	3.65	6.75/K	5.86/K
6 in.	1.06	3.65	7.16/K	6.19/K
6½ in.	1.15	4.05	7.57/K	6.52/K
7 in	1.20	4.25	7.98/K	6.85/K
7½ in.	1.25	4.45	6.39/K	7.16/K
8 in	1.29	4.65	8.80/K	7.53/K
8½ in.	1.32	4.85	9.21/K	7.84/K
9 in.	1.36	5.05	9.62/K	8.17/K
9½ in	1.40	5.25	10.03/K	8.50/K
10 in	1.45	5.51	10.44/K	8.83/K
Addl. in.	10	41	.82/K	.66/K

WIRE KITS

#1 $6.95

250	3"	100	4½"
250	3½"	100	5"
100	4"	100	6"

#2 $19.95

250	2½"	250	4½"	250	6"
500	3"	250	5"	100	6½"
500	3½"	100	5½"	100	7"
500	4"	1 250 ft Roll Bulk			

Choose One Color or Assortment

WIRE WRAP SOCKETS

	1-9	10-24	25-99	100-249	250-999	1K-5K
8 pin*	41	38	35	31	29	.27
14 pin*	.36	.34	.32	.30	.28	.27
16 pin*	.38	.36	.34	.32	.30	.29
18 pin*	63	58	.54	47	44	41
20 pin	84	78	71	63	59	54
22 pin*	.95	90	.85	.75	.72	.70
24 pin	91	84	.76	68	.64	59
28 pin	1.25	1.15	1.08	95	89	82
40 pin	1.65	1.55	1.42	1.25	1.15	1.09

Gold 3-level Closed Entry Sockets

* End & Side Stackable

All prices include gold

2-level sockets available

WIRE WRAP TOOLS

$34.95

HOBBY WRAP
Model BW 630
With Free Wire Kit 1
($6.95 Value)

Batteries & Charger	$11.00
WSU 30 Hand Wrap-Unwrap Strip Tool	5.95
WSU 30M, for Modified Wrap	6.95
BT 30 Extra Bit	2.95

INTERCONNECT CABLES

Ribbon cable connectors for connecting boards to front panels, or board to board

	SINGLE ENDED			DOUBLE ENDED		
	14 pin	16 pin	24 pin	14 pin	16 pin	24 pin
6"	1.24	1.34	2.05	2.24	2.45	3.37
12"	1.33	1.44	2.24	2.33	2.55	3.92
24"	1.52	1.65	2.63	2.52	2.76	4.31
48"	1.91	2.06	3.40	2.91	3.17	5.08

PAGE DIGITAL ELECTRONICS
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Ordering Information:

- Orders under $25 and COD's, add $2
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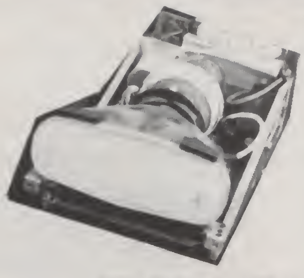
- For Blue Label (Air) or 1st Class, add $1
- We accept Visa & Mastercharge
- Most orders shipped same day

Dealer Inquiries Invited

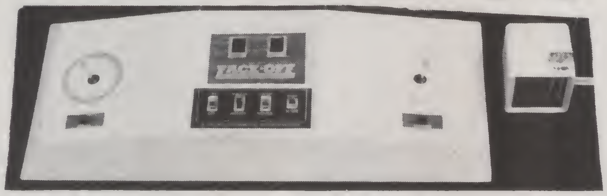


TYPESETTING MONITOR

We have acquired an unusual video monitor. It was originally designed for and used in the photo typesetting industry. As the typesetter composed his copy, the copy would appear on the screen. The tube is a flat type about 6½" x 2¼", since only one line of copy was scanned at a time. Most of the tubes have slight burn marks, but are still usable. We have all the circuitry, and will supply the circuitry with each order. We believe most of these units are in working order, since they were taken out of service when the equipment was upgraded. Looks like a good start to make into your own video monitor at giveaway prices. We have them with and without the CR tubes. Sold as is only.

STOCK No. 5603K Typesetter monitor with tube & circuit diagrams . . . . . . $22.50 ea. 2/$40.00
STOCK No. 5604K Typesetter monitor without tube, with circuit diagrams . $15.00 ea. 2$25.00

TV HOCKEY and SOCCER GAME plus VIDEOCUBE

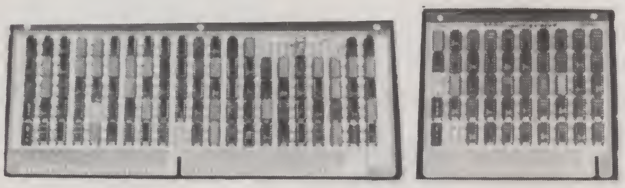


For some time we have been selling our VIDEOCUBE, the TV interface between computers, cameras, etc., and your TV set. We sold them in kit form, and to date we have sold over 3,000. We sold the complete VIDEOCUBE, when available, for $16.95.

We now have a limited number of Hockey-Soccer Video games, complete with VIDEOCUBE interface, at a new low price of $18.95; previously sold for $27.50 in kit form. This gives you two games, at two levels of skill, with LED readouts for scorekeeping. This game sold in Boston department stores for $79.50.

STOCK No. 5495K Complete VIDEO GAME & VIDEOCUBE $18.95 ea. 2/$35.00

WIRE WRAP BOARDS LOADED WITH 7400 SERIES ICs



Since last summer, we have been selling 2 wire wrap boards, Our Stock No. 6558K with approximately 100 sockets, and our Stock No. 6559K with approximately 45 sockets. These have been successful, based on your orders and reorders. We now have the same boards, but with the sockets still containing the original SN7400 series ICs that were used in the computer that these boards were designed for. We checked the value of these ICs, against the lowest price ICs in several Electronics magazine, and found that at the lowest possible surplus prices, the values of the ICs on the 100 socket board ran to over $40.00. A sample of some of the chips on the board we looked at are as f ollows: 74H87, 7486, 74107, 7451, 7400, 7404, 7495, 7493, 7492, 74193, 7489 and many others, to numerous to mention. Also on some boards, are a few linears, and phase locked loops. Not everyone needs every chip, but if you are working at all with TTL, this is a great opportunity to get an inventory of the most useful chips at a ridiculous price. We are selling the 100 socket board with about 100 chips, for $10.00 more than the board itself, and the 45 socket chip for $5.00 more than the board itself. We will also include with each board, 2 edge connectors with the 100 socket board, and 1 edge connector with the 45 socket board.

STOCK NO.6558K	75 to 100 socket board	$18.75 ea.	2/35.00
STOCK NO.6559K	45 to 50 socket board	$11.75	2/22.00
STOCK NO.6749K	75 to 100 socket wire wrap board with ICs and edge connectors	$28.75 ea.	2/55.00
STOCK NO.6750K	45 to 50 socket wire wrap board with ICs and edge connector	$16.75 ea.	2/32.00
STOCK NO.6603K	Edge connector for either board	$ 2.00 ea	3/5.00

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TRANSFORMER 1. Primary 115 V, Secondary 1, 30V @ 2 A.Secondary 2, 16.5 V @ 1.2 A. Secondary 3, 16 V @ 3.5 A. Secondary 4, 9.5 V @ 3.5 A.

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TRANSFORMER 3. Primary 115 V. Secondary 1, 12.6 V ct @ 1 A.Secondary 2, 33 V tapped at 13.1 V @ 1 Amp. Secondary 3, 140 V. @ 100 ma.

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Our promotional plans and show program strongly reflect these differences. We are the same team that proved last year in Chicago that the personal computer market is ready to reach out beyond the narrow confines given it by other shows. Based on our past, successful experiences with personal computer shows, we project a crowd of over 15,000 that could easily be 20,000 or more.

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16K OR 32K EPROM $49.95 W/OUT EPROM

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KIT FEATURES:

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2. Quality Plated through P.C. Board Including Solder Mask and Silk Screen
3. Selectable Unit States
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5. All Sockets Provided W/Board

WE CAN SUPPLY 450As 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

EXPANDORAM
THE ULTIMATE RAM BOARD
32K FOR $475.00

32K MODEL	
8K	$151.00
16K	259.00
24K	367.00
32K	475.00

64K MODEL	
16K	$281.00
32K	519.00
48K	757.00
64K	995.00

THE 32K VERSION USES THE MOSTEK MK4115 RAM AND HAS 8K BOUNDARIES AND PROTECTION & UTILIZES DIP SWITCHES. P. C. BOARD COMES WITH SOCKETS FOR 32K OPERATION

BUY A S100 COMPATIBLE RAM BOARD AND UPGRADE THE SAME BOARD TO A MAXIMUM OF 65K MEMORY IN STEPS OF EITHER 8K OR 16K AT YOUR OPTION BY MERELY PURCHASING MORE RAM CHIPS FROM SD COMPUTER PRODUCTS.

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LOOK AT THE FEATURES WE HAVE BUILT INTO THE EXPANDORAM!

- MEMORY ACCESS TIME IS 375 ns
- MEMORY CYCLE TIME IS 500 ns
- POWER REQUIREMENTS ARE:
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  18 VDC 400 MA DC
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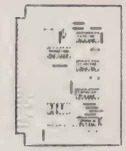
- CONTROL, DATA & ADDRESS INPUTS UTILIZE LOW POWER SCHOTTKY DEVICES
- DESIGNED TO WORK WITH Z-80, 8080, 8085, CPU's

ADD $50.00 TO ABOVE PRICES FOR FULLY ASSEMBLED AND TESTED BOARDS

Low Cost Cassette Interface Kit
$19.95



Features: Play and record K.C. Standard 2400/1200 Hz tapes, 300 Baud, TTL I/O Compatible, Phase Lock Loop, Both 22 Pin Connector and 8 Pin Molex Connector. Comes partially assembled. Oscillator and phase lock loop pre-tuned to K.C. Standard. Selector switch sends cassette data or auxiliary input data to microprocessor. LED indicates logic 1 level.

4K LOW POWER RAM KIT
The Whole Works - $79.95

Full Buffered - on board regulated - reduced power consumption utilizing low power 21L02-1 500ns RAMS - Sockets provided for all IC's. Quality plated through PC board.

*Add $10.00 for 250ns RAM operation.

8K LOW POWER RAM
$159.95

FULLY ASSEMBLED AND TESTED. NOT A KIT

Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select.

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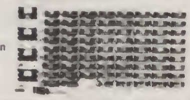
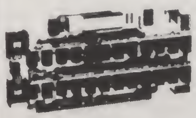


Z-80 CPU BOARD KIT
Complete Kit $139.



CHECK THE ADVANCED FEATURES OF OUR Z-80 CPU BOARD: Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus sockets provided for all IC's. *Add $10. extra for Z-80A chip which allows 4MHZ operation.

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"VERSAFLOPPY"™ KIT
THE VERSATILE FLOPPY DISK CONTROLLER
ONLY $149.00

FEATURES: IBM 3740 Soft Sectored Compatible. S-100 BUS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:

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FD 1771B-1 CHIP ALONE $39.95

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4011	19	4047	1.50
4013	32	4049	35
4016	32	4069	23
4017	95	4071	19
4020	97	4076	97
4022	97	14518	1.10
4024	75	14528	85
4027	39	14529	85

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- ★ Low Power
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- ★ Totally Buffered
- ★ Phantom
- ★ Battery Back-up
- ★ Address on 1K boundary
- ★ Requires no front panel
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KIT
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Bare PC Board w/Data **$21.95**
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"Special Offer" Buy (4) 8K 450ns. Kits $117.00 ea.

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- ★ On board 2708
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- ★ 2708 included (450ns.)
- ★ completely socketed

Assembled and tested $185.00
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TDL COMPATIBLE Z-80 CPU
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IMS 16K STATIC RAM
- ★ Memory mapping
- ★ Phantom
- ★ Address 16K Bound
- ★ Use with or w/o front panel
- ★ Power 2.1 amps typ.
- ★ Uses 2114

ASSEMBLED & TESTED ONLY
450ns. $439.95 250ns. $495.95

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S100 compatible with 8 level Vector Interrupt fully socketed.
Assembled & Tested $149.95
Kit .... $ 99.95
Bare PC Board w/data .... $ 34.95

S-100 32K STATIC RAM
- ★ Address 32K Boundary
- ★ Power 450ns. 2.8 amps typ.
- ★ No wait states on 2MHz
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- ★ Phantom can be added
- ★ 2114/TMS4045 or 9135

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TARBELL FLOPPY INTERFACE
★ S100 Compatible ★ Uses CPM
★ Jumper Selectable ★ Persci, Shugart, etc
Assembled and tested $269.95
Kit $179.95
Bare PC Board .... $ 39.95
NOTE: For CPM Add $70.00
Documentation Add $20.00

MICROBYTE 32K STATIC RAM
★ Phantom ★ TMS4044
★ Addressable 4K Blks ★ Independed reg.
ASSEMBLED & TESTED ONLY
450ns. $775.00
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(Special offer 16K version (expandable) 450ns. $435.00)

WMC REAL TIME CLOCK
- ★ S100 Compatible
- ★ Two interrupts
- ★ Software programmable
- ★ 1MHz Crystal Oscillator

Assembled and tested $179.95
Kit $124.95
Bare PC Board w/data .... $ 29.95

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★ Telephone/TWX ★ S-100 compatible
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Bare PC Board w/data .... $ 49.95

MICRODESIGN MR-16 2716 EPROM BOARD
- ★ Individual Prom Address
- ★ Uses Low cost 16K TI EPROMS
- ★ Optional 1K RAM ★ Phantom control

Assembled and Tested 174.95
Kit 99.50

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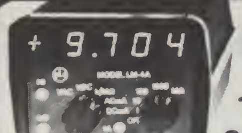

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- Rechargeable batteries and charger included
- Measures DC Volts, AC Volts, Ohms and Current
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Parts & labor guaranteed 1 year

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With Rechargeable Batteries & Charger Unit

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16 pin*	.43	.42	.39	.35	.32	.30
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Sockets purchased in multiples of 50 per type may be combined for best price

All sockets are GOLD 3 level closed entry *End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION

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1-4	5-9	10-24
$3.50	$3.25	$3.00

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1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-STN 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR and IMASI motherboards. NASGLO tin-nickel plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

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Other Popular Edge Connectors

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ATTN: OEM'S and Dealers, many other connectors available call or quotation.

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- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
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- Mounts 11 receptacles with 100 contacts (2 rows) on 125 centers with 250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active pull-up, or floating terminations
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- Fits in IMSAI 8080 microcomputer as expander board

Price: $29.50

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8800V

Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5 3" x 10" x 1/16

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8801-1

Same as 8800V except plain, less power buses & heat sink

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Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156

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Card Extender has 100 contacts-50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems. $25.00

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1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

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64P44	4.5x6.5"	$1.70	1.53
84P44	4.5x8.5"	$2.10	1.89
169P44	4.5x17"	$4.30	3.87
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Wraps insulated wire on .025" square posts

FOUR TIMES FASTER than regular manual wrap post tools

P180 with two 100' spools of 28 ga wire $24.50

P180-4T Includes charger, wire $75.00

NO PRE-STRIPPING*
NO PRE-CUTTING*
SPOOL-FED WIRE*

*The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation where it presses the square post corner. the bared copper is indented by the sharp edge (7 turns = 28 contacts)

Insulation is slit where wrapped but not between terminal posts when led straight out of the tool

"Daisy-chain" runs. Reliable and easy to use. Manual or power operation

SLIT-N-WRAP WIRE $2.75 Package

NO. 28 GAGE INSULATED WIRE, 100' SPOOLS

W28 2 A Pkg 3. Green — W28 2-C Pkg 3 Clear
W28 2 B Pkg 3. Red — W28 2 D-Pkg 3 Blue

2708 8K 450 ns EPROM

FACTORY PRIME

$10.00 EA.

25 + *Call For Price*

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14 - G3 100 for $30.00

16-G3 100 for $30.00

50 of each for $32.00

Sockets are End & Side stackable, closed entry

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

- For Auto, Home, Office
- Small in size (2x2½x½)
- Push button for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO, included.
- 2 MODELS AVAILABLE.

LCD-101, portable model runs on self-contained batteries for better than a year.

LCD-102, runs on 12 Volt system and is back-lighted.

- LCD-101 or LCD-102 your choice $34.95 ea.
- Clear desk stand for $2.00

LEDU MG 10A List $72

Perfectly balanced, fluorescent lighting with precision magnifier lens. For prot'l, techn'l & hobbist. Has die cast protective shade, inst start 3 diopter lens 42" reach $44.95

with T 9 fluorescent lamp (required) $49.95

colors Gray or Black Chocolate Brown 2 choices please

$44.95 SPECIAL

SC-5 With Rechargeable Batteries & Charger Unit $89

FM-7 With Rechargeable Batteries & Charger Unit $195

Features Include. • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7-digit resolution. • The FM-7 can be calibrated to an accuracy of 0 00001%. • The SC-5 is accurate to one part per million. • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1 9" H x 2 7" W x 3 9" D. • The units may be obtained separately or as a "Frequency Duo". • Parts & Labor guaranteed 1 year

Tilt stand option .... $ 3.50

Leather case $16.00

MICRO-KLIP

for .042 dia. holes (all boards on this page)

T42-1 pkg. 100 .... $ 1.50

T42-1 pkg. 1000 .... $11.00

P-149 hand installing tool .... $ 2.03

.8" LED ALARM CLOCK

12 hr LED Alarm Clock uses 3½ digit .8" LED Display with AM/PM indicators and colons. Direct drive, PIN to PIN interface with S1998A I.C. Just add switches, AC Supply, Alarm. Display and I.C. only.

$7.95 or 2/$15.00

Price Breakthrough! $17.50 MA1003 CAR CLOCK

Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.

SPECIAL

14CS2 100 for $14.00

16CS2 100 for $16.00

14 pin CS2 10 for $2.00

16 pin CS2 8 for $2.00

These low cost DIP sockets will accept both standard width plugs and chips. For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.

Vector WRAP POST

for .042 dia. holes (all boards on this page)

T-44 pkg. 100 .... $ 2.28

T-44 pkg. 1000. .... $14.00

A-13 hand installing tool .... $ 2.80

PRIORITY ONE ELECTRONICS ©

P21

10031C Woodley Ave. Sepulveda CA. 91343

Terms: VISA, MC, BAC, check, Money Order, C.O.D., U.S. Funds Only. CA residents add 6% sales tax. Minimum order $10.00. Orders less than $75.00 include 10% shipping and handling; excess refunded. Just in case . . . please include your phone no. **"Sorry, no over the counter sales"** Good thru Aug 15, 1978

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24 PIN DIP PLUGS WITH COVERS

3 / $1.00

40 / $10.00

NLS MS-215 DUAL TRACE MINISCOPE $395.00

NLS MS-215 DUAL TRACE MINISCOPE $395.00

FREE PROBES FREE PROBES FREE PROBES

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COMPUTER PERIPHERAL & PARTS WORKSHOP

MAIL ORDER

POLY PAKS INTRODUCES THE FIRST MAGAZINE RETAIL STORE FOR THE ELECTRONIC MAIL-ORDER HOBBYIST!

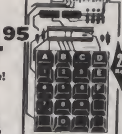
"RED" LED READOUTS!

as low as **20¢ each**

Cat. No.	Size	Description	Sale
7K1890	.127"	MAN-3**	5 for $1.00
7K1503	.19	MAN-4*	2 for $1.19
7K1273	.27	MAN-1*	$1.00
7K3093	.33	MAN-72 equal*	$1.19
7K3161	.33	MAN-74 equal**	$1.19
7K3512	.35	FND359**	$1.00
7K2949	.5	FND500*	$1.50
7K2950	.5	FND507*	$1.50
7K3483	.5	727-Dual**	$2.50
7K2485	.5	727-Dual*	$2.50
7K2256	.6	747*	$1.95

*Common Anode **Common Cathode

HEXADECIMAL MICROPROCESSOR AND CONTROL KEYBOARD KIT! 34.95



Address microprocessors, control computer operated equipment. 2 key rollover. Has 20 keys, 16 encoded, 4 external to be assigned by user. Output 4 bit binary. Also, an EXCLUSIVE FEATURE...4 leds display the binary output. TTL/CMOS compatible, requires +5, 12VDC. Complete kit! Nothing else to buy! With instructions.

Wt. 2 lbs.

- 4 bit binary/hexadecimal output plus strobe!
- New! Improved design! Saves you time!
- Keyboard pre-assembled onto PC board!

Cat. No. 7K5009 Hexadecimal Kit $34.95
Cat. No. 7K5010 Hexadecimal Wired $39.95

POLY PAKS SPECIAL

BUY $15 WORTH Take **10%** DISCOUNT

BUY $100 WORTH Take **25%** DISCOUNT

FROM THIS AD ONLY

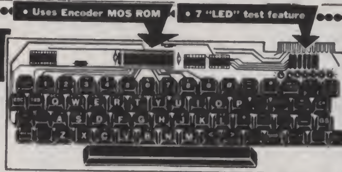
DISCRETE LED'S 6 for $1.19

Order in multiples of 6 of each type!

	Cat. No.	Description	Similar to
JUMBO .34" h	7K2135	Jumbo Red	MV5053
	7K2136	Jumbo Yellow	XC556Y
	7K2138	Jumbo Green	XC556G
MEDIUM .24"	7K2785	Medium Red	XC22
	7K2788	Medium Green	XC22G
MICRO .21" (TO-18)	7K2137	Micro Red	XC209
	7K1948	Micro Yellow	XC209Y
	7K2140	Micro Green	XC290G

$65. NEW KEYBOARD & ENCODER KIT

• Uses Encoder MOS ROM • 7 "LED" test feature



Cat. No. 7K5001 Kit $69.95
Cat. No. 7K5002 Wired $75.00

Outputs standard 7 bit ASCII; interfaces with most data systems. Keyboard pre-assembled onto PC board, 2 key rollover. Electronic shift lock and carriage return. 4 modes: Normal, control, shift, shift/control. Additional functions can be assigned by user. +5, -12VDC, 200 ma. Negative or positive logic, jumper selectable. Exlcusive test feature...7 LED's display the ASCII code. Complete kit, nothing else to buy! Size: 13" x 5 1/2 x 1 1/4". 3 lbs.

- Uses MOS Encoder ROM!
- 7 LED Test Feature!
- 64 key keyboard!
- Encodes 128 ASCII Characters
- Interfaces with ALTAIR, IMSAI, and more!

MICROPROCESSORS! MEMORIES! SUPPORT!

Order by Cat. No. 7K3459 and type

Type	Description	Sale
MC6800L	8 bit CPU	$19.95
8080A	8 bit CPU, 2 usec	11.95
Z80A	8 bit CPU	24.95
8008	CPU	9.95
1101	256 x 1 stat. RAM	.69
1103	1K Dyn RAM	1.29
1702A	256 x 8 EPROM	5.95
2102-L1	1K x 1 Lo-power RAM	1.69
2111	256 x 4 Stat. RAM	5.95
2708	8K EPROM	10.95
MK4116	16K Dyn RAM	29.95
MK4200P11	4K x 1 Dyn RAM, 350nsec	3.95
MM5202	2K PROM	6.95
MM5203	2K EPROM	8.95
MM5260	1K Dyn RAM	.99
MM5262	2K x 1 Dyn RAM	.99
8212	8 bit I/O port	3.95
8216	Bi-direct bus driver	3.95
8224	Clock Gen	4.95
	System cont.	9.95
8251	Communication int	11.50
8255	Periph inter	11.95

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Order by Cat. No. 7K5112 and value!

Mfd	WVCD	Sale
8,000	50	$2.75
13,000	40	2.25
14,000	50	2.75
15,000	12	1.50
22,000	75	3.95
24,000	30	2.50
44,000	30	3.95

Low Power ICs

Order By Cat. No. 7K3667 & Type No.

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74LS02	.32	74LS138	1.24
74LS04	.35	74LS139	1.24
74LS08	.32	74LS151	1.24
74LS10	.32	74LS153	1.25
74LS11	.32	74LS155	1.25
74LS13	.64	74LS160	1.47
74LS20	.32	74LS161	1.47
74LS21	.32	74LS162	1.47
74LS22	.32	74LS163	1.47
74LS27	.39	74LS168	1.68
74LS30	.32	74LS169	1.68
74LS32	.39	74LS173	1.68
74LS37	.45	74LS174	1.05
74LS38	.45	74LS190	1.77
74LS42	1.19	74LS191	1.75
74LS47	.99	74LS192	1.75
74LS74	.49	74LS193	1.75
74LS90	.89	74LS195	1.25
74LS92	.89	74LS197	1.25
74LS93	.89	74LS257	1.35
74LS109	.58	74LS266	.54
74LS112	.58	74LS366	.66
74LS113	.58	74LS368	.69
74LS114	.49	74LS390	2.95

C-MOS

Order By Cat. No. 7K2320 & Type No.

Type	Sale	Type	Sale
CD4000	$.29	CD4022	1.19
CD4001	.29	CD4023	.29
CD4002	.29	CD4024	.79
CD4006	1.19	CD4025	.34
CD4007	.29	CD4027	.69
CD4008	.79	CD4028	.89
CD4009	.59	CD4029	1.19
CD4010	.59	CD4030	.49
CD4011	.29	CD4033	1.60
CD4012	.29	CD4035	.99
CD4013	.69	CD4040	1.19
CD4015	1.19	CD4041	1.25
CD4016	.49	CD4042	.88
CD4017	1.19	CD4046	1.79
CD4018	1.19	CD4049	.49
CD4019	.49	CD4066	.79
CD4020	.99	CD4071	.29
CD4021	1.29		

FULL WAVE BRIDGE RECTIFIERS!

PIV	2 AMP (#7K1346)	6 AMP (#7K2456)	10 AMP (#7K2447)	25 AMP (#7K2273)
50	$ .59	$ .88	$1.05	$1.20
100	.65	.99	1.15	1.25
200	.69	1.19	1.29	1.95
400	.89	1.40	1.79	2.95
600	.99	1.69	1.95	3.95
800	1.19	1.95	2.25	4.95
1000	1.25	2.25	2.50	5.50

Orer by Cat. No. Amperage and Voltage

TTL'S

Type	Sale	Type	Sale
SN7400	$0.14	SN7472	.26
SN7401	.14	SN7473	.31
SN7402	.17	SN7474	.31
SN7403	.14	SN7475	.48
SN7404	.17	SN7476	.39
SN7405	.18	SN7483	.69
SN7406	.19	SN7485	.88
SN7407	.24	SN7486	.29
SN7408	.18	SN7490	.69
SN7410	.14	SN7492	.45
SN7411	.19	SN7493	.45
SN7413	.39	SN74107	.29
SN7414	.61	SN74121	.31
SN7417	.24	SN74123	.49
SN7420	.14	SN74125	.39
SN7427	.26	SN74132	.83
SN7430	.14	SN74145	.89
SN7432	.24	SN74151	.63
SN7437	.24	SN74153	.63
SN7440	.14	SN74154	.99
SN7441	.79	SN74157	.64
SN7442	.49	SN74161	.87
SN7445	.69	SN74164	.95
SN7446	.79	SN74174	.93
SN7447	.79	SN74175	.88
SN7448	.75	SN74181	1.95
SN7450	.14	SN74190	1.15
SN7451	.14	SN74191	.99
SN7470	.28	SN74192	.83
		SN74193	.83
		SN74195	.75
		SN74251	1.39

SPECTRA-TWIST RIBBON CABLE

• Twisted pairs of brightly colored cable! 24AWG

Cat. No. 7K3680 48 cond. 2 ft. $1.98
Cat. No. 7K4081 32 cond. 2 ft. $1.98

SILICON POWER STUD RECTIFIERS!

Order by Cat. No. Amperage and voltage.

PIV	12 AMP (#7K727)	50 AMP (#7K727)	250 AMP (#7K685)
50	$ .29	$ .75	$4.95
100	.36	1.10	6.50
200	.45	1.35	7.50
400	.61	1.75	8.50
600	.79	2.25	10.50
800	.90	2.75	11.50

RIBBON CABLE AT THIN PRICES

- Ultra-flat! • 28 AWG!
- Single color! indexed!

Cond.	Sale
20	8 ft. $1.98
26	6 ft. $1.98
34	5 ft. $1.98
40	4 ft. $1.98
50	3 ft. $1.98

Order by Cat. No. 7K3939 and conductors

POLY PAKS "CHIPS" AWAY IC AND CRYSTAL PRICES!

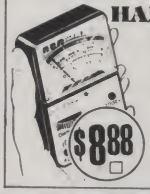
Order by Cat No. 7K4048 and Type No!

Type	Description	Sale
ICM7205	Stopwatch	$14.95
AY3-8500-1	6 TV Games	9.95
MMS330	4½ Digit DVM	4.95
8038C	Volt Control Osc.	4.95
KR2376-139	BCD Encoder Rom	6.95
KR2376-ST	ASCII Encoder Rom	14.95
11C90DC	650MHz Prescaler	14.95
95H90DC	350MHz Prescaler	8.88
MC14410	Touch Tone Chip	9.95
MK2002P	Char Gen. (sim 2513)	3.95
7207A/7208	Freq Counter pair	24.95
ICM7107	3½ Digit DVM/DMM	12.50
MMS369	60 Hz Timebase IC	1.95
3.579MHz	Timebase Xtal	1.95
1.00MHz	Touchtone Xtal	5.95
3.2768MHz	Stopwatch Xtal	4.95

DIP SWITCHES

Cat. No.	Switches	Sale
7K 3668	2	$.77
7K 3669	3	.88
7K 3021	4	.99
7K 3670	5	1.19
7K 3671	6	1.29
7K 2677	7	1.79

HANDY COMPUTER MULTITESTER



$8.88

- 1000 ohms per volt

1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150ma; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size $2^3/_8$ x $3^1/_2$ x $1^3/_8$". Wt. 5 ozs. Cat. No. 7K3921

EECO 10-POSITION BCD THUMBWHEEL SWITCH

1-2-4-8 BCD encoding! Positions labeled 0-7, F, L. (F coded for 8, L coded for 9). White numerals on a black background. Eeco 800 series. $1^1/_4$ x $1^1/_4$ x $^1/_2$". Cat. No. 7K3846

3 for $4. **$1.49**

GIANT SALE! MICRO-MINI TOGGLE SWITCHES

- 3A, 125VAC contacts or better
- Complete with mounting hardware! *Center off

Cat. No.	Contacts	Sale
7K3936	SPST	$1.19
7K4036	SPDT	1.29
7K5085	SPDT*	1.39
7K4037	DPDT	1.45

IC SOCKETS

as low as **17¢** ea.

- Low profile, solder tail.

7K2123	8 pin minidip	$ .17
7K1308	14 pin dip	.19
7K1309	16 pin dip	.22
7K3378	18 pin dip	.25

WOW!

"MICRO-TONE" AUTOPATCH ENCODER KIT 26.88

Only 2 1/8 x 1 5/8 x 1/2", small enough to mount in a mike! Snap action bubble keys contact. Features output level control, xtal controlled digitally synthesized tones, on-chip oscillator. Requires 4.5 to 5.5 VDC. Complete kit! Nothing else to buy! Wt. 12 oz.

- Complete in its own mini-cabinet!
- Family!
- Friends!
- Emergency!

Cat. No. 7K4086 kit $26.88
Cat. No. 7K4087 wired $32.95

LINEARS

Type	Sale	Type	Sale
LM301H, V	$.25	LM380N	1.19
LM307H, V, N	.25	LM381N	1.19
LM308H, V	.79	LM555V	.44
LM309K	1.19	LM558V	.69
LM311H, V	.79	LM565N	.65
LM320T-5V	1.19	LM567V	1.40
LM340T-5V	1.19	LM703H	.39
LM340T-12V	1.19	LM709H, N	.22
LM340T-15V	1.19	LM710N	.29
LM340K-5V	1.19	LM723N	.42
LM340K-12V	1.19	LM741H, V, N	.29
LM340K-15V	1.19	LM747H, N	.59
LM322N	1.19	LM1458V	.69
LM324N	.99	LM1800N	1.49
LM339N	1.09	LM3900N	.35
LM377N	1.50	LM39009V	1.19
LM379N	4.95	LM75491	.69
		LM75492	.75
		PA263	1.50

SPECTROL "SKINNY-TRIMS"

3/8" square, screwdriver shaft. 2% tol. 1/4 watt. Cermet PC leads. Order by Cat. No. and value.

2 for $1

Ohms	
10**	
50**	
100**	5K*
200**	10K*
500*	20K**
1K*	50K**
2K**	100K**

No. 7K 3863 25 turn upright, type 64
No. 7K 3866 single turn, flat, type 63

*Available in all types
**Available in Cat. No. 3863 only.

MOTHERBOARD EDGE CONNECTOR

106 pins (53 each side). Use with IMSAI & ALTAIR! 0.125" pin ctrs, goldplated 5/8" wire wrap leads. Open ends, fit wide PC boards. 8 ozs. Cat. No. 7K3987

$2.50

COMPUTER GRAPHICS "JOYSTICK"

2 for $8. **$4.50**

- Four 100K pots!
- Chrome handle and knob!

Wt. 10 oz. Cat. No. 7K3808A

$9.95 IMC "PEWEE" BOXER FAN

- Smallest Box Fan Made!
- Only 3 ⅛" SQ, 1⅝" Deep!

Cat. No. 7K5249

Quiet! Dependable! Powerful! Delivers 36 cfm Scarcely Audible Noise Level! Sleeve bearings rated for 10 years life! Perfect for cooling, ventillation, heating: for computers, power supplies, hi-fi eqpt, light projectors & more. 7-Blade flame-retardant polycarbonate fan, housed in die cast aluminum block. Wt. 1 lb.

For Hi-Fi and Computers. 115 VAC!

10 AMP POWER TAB SCR'S, TRIACS, QUADRACS!

Order by Cat. No. and Voltage

	Cat. No.
SCR'S	7K1730
TRIACS	7K1448
QUADRACS	7K1590

PIV	SALE
50	$.55
100	.69
200	.88
400	1.19
600	1.59

TRANSFORMER SALE

LOOK!

• 110VAC Primaries

Cat. No.	Output V.	Amps		Sale Each
7K 3399	6.3V	500ma	Metal encased	$1.98
7K 3814	6.3V	1A	Open frame	$2.49
7K 3412	12V	300ma	Open frame	$1.95
7K14029	12V	1A	Open frame	$2.49
7K 3875	110V	300ma	Isolation	$1.19

1N4000 Epoxy Rectifiers

• Miniature! • 1.5 Amp!

Order by Cat. No. and Type No.

Cat. No.	Type No.	PIV	Price
7K2377	1N4001	50	10 for $.65
7K2378	1N4002	100	10 for .75
7K2379	1N4003	200	10 for .85
7K2380	1N4004	400	10 for .99
7K2381	1N4005	600	10 for 1.29
7K2382	1N4006	800	10 for 1.39
7K2383	1N4007	1000	10 for 1.49

WRITE FOR POLY PAKS 1978 CATALOG

FREE!

FEATURING:

- Computer Components!
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- Solar Energy! Semi's!
- Test Equipment!
- Fiber Optics! Plus More n' More!

Terms: Add postage Rated: net 30
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Retail: 16-18 Del Carmine St., Wakefield,

MINIMUM ORDER — $6.00

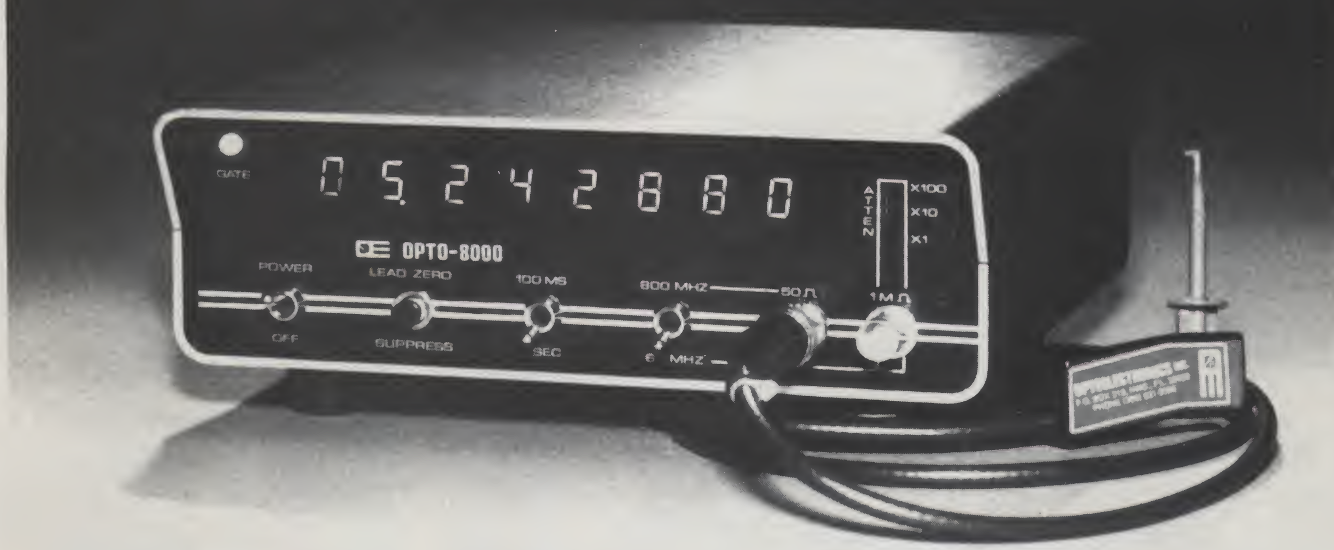
POLY PAKS®

C.O.D.'s MAY BE PHONED

P.O. BOX 942-K7
LYNNFIELD, MA.
ZIP 01940

600 MHZ. FREQUENCY COUNTER
±0.1 PPM TCXO

OPTO-8000.1



This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — *Guaranteed* — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). **Even kits require no adjustment for guaranteed accuracy!** Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090″ thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes "Lead Zero Blanking Control" and a gate period indicator LED. AC and DC power cords with plugs included.

OPTOELECTRONICS, INC.

5821 NE 14 Avenue
Ft. Lauderdale, FL 33334
Phones: (305) 771-2050 771-2051
Phone orders accepted 6 days, until 7 p.m.

03

master charge
BANKAMERICARD

SPECIFICATIONS:
Time Base—TCXO ±0.1 PPM GUARANTEED!
Frequency Range—10 Hz to 600 MHz
Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
Decimal Point—Automatic
All IC's socketed (kits and factory-wired)
Display—8 digit LED
Gate Times—1 second and 1/10 second
Selectable Input Attenuation—X1, X10, X100
Input Connectors Type —BNC
Approximate Size—3″h x 7½″w x 6½″d
Approximate Weight—2½ pounds
Cabinet—black anodized aluminum (.090″ thickness)
Input Power—9-15 VDC, 115 VAC 50/60 Hz
or internal batteries
OPTO-8000.1 Factory Wired **$299.95**
OPTO-8000.1K Kit **$249.95**

ACCESSORIES:
Battery-Pack Option—Internal Ni-Cad Batteries and charging unit **$19.95**
Probes: P-100—DC Probe, may also be used with scope **$13.95**
P-101—LO-Pass Probe, very useful at audio frequencies **$16.95**
P-102—High Impedence Probe, ideal general purpose usage **$16.95**

VHF RF Pick-Up Antenna-Rubber Duck w/BNC #Duck-4H **$12.50**
Right Angle BNC adapter #RA-BNC **$ 2.95**

FC-50 — Opto-8000 Conversion Kits:
Owners of FC-50 counters with #PSL-650 Prescaler can use this kit to convert their units to the Opto-8000 style case, including most of the features.

FC-50 — Opto-8000 **Kit $59.95**
*FC-50 — Opto-8000F **Factory Update $99.95**
FC-50 — Opto-8000.1 (w/TCXO) **Kit $109.95**
*FC-50 — Opto-8000.1F **Factory Update $149.95**
*Units returned for factory update must be completely assembled and operational

TERMS: Orders to U.S. and Canada, add 5% to maximum of $10.00 per order for shipping, handling and insurance. To all other countries, add 10% of total order. Florida residents add 4% state tax. C.O.D. fee: $1.00. Personal checks must clear before merchandise is shipped.

7400 TTL

SN7400N	16	SN7472N	.29	SN74160N	.89
SN7401N	18	SN7473N	.35	SN74161N	.89
SN7402N	18	SN7474N	.35	SN74162N	1.95
SN7403N	18	SN7475N	.49	SN74163N	.89
SN7404N	18	SN7476N	.35	SN74164N	.89
SN7405N	20	SN7479N	5.00	SN74165N	.89
SN7406N	29	SN7480N	.50	SN74166N	1.25
SN7407N	29	SN7482N	.99	SN74167N	1.95
SN7408N	20	SN7483N	.59	SN74170N	1.59
SN7409N	20	SN7485N	.79	SN74172N	6.00
SN7410N	18	SN7486N	.35	SN74173N	1.25
SN7411N	25	SN7489N	1.75	SN74174N	.89
SN7412N	25	SN7490N	.45	SN74175N	.79
SN7413N	40	SN7491N	.59	SN74176N	.79
SN7414N	70	SN7492N	.43	SN74177N	.79
SN7416N	25	SN7493N	.43	SN74179N	1.95
SN7417N	25	SN7494N	.65	SN74180N	.79
SN7420N	20	SN7495N	.65	SN74181N	1.95
SN7421N	29	SN7496N	.65	SN74182N	.79
SN7422N	39	SN7497N	3.00	SN74184N	1.95
SN7423N	29	SN74100N	.89	SN74185N	1.95
SN7425N	29	SN74107N	.35	SN74186N	9.95
SN7426N	29	SN74109N	.59	SN74188N	3.95
SN7427N	25	SN74116N	1.95	SN74190N	1.25
SN7429N	39	SN74121N	.35	SN74191N	1.25
SN7430N	20	SN74122N	.39	SN74192N	.79
SN7432N	25	SN74123N	.49	SN74193N	.79
SN7437N	25	SN74125N	.49	SN74194N	.89
SN7438N	25	SN74126N	.49	SN74195N	.69
SN7439N	25	SN74132N	.75	SN74196N	.89
SN7440N	20	SN74136N	.75	SN74197N	.89
SN7441N	89	SN74141N	.79	SN74198N	1.49
SN7442N	49	SN74142N	2.95	SN74199N	1.49
SN7443N	.75	SN74143N	2.95	SN74200N	5.59
SN7444N	.75	SN74144N	2.95	SN74251N	1.79
SN7445N	.75	SN74145N	.79	SN74279N	.79
SN7446N	69	SN74147N	1.95	SN74283N	2.25
SN7447N	59	SN74148N	1.29	SN74284N	3.95
SN7448N	.79	SN74150N	.89	SN74285N	3.95
SN7450N	20	SN74151N	.59	SN74365N	.69
SN7451N	20	SN74153N	.59	SN74366N	.69
SN7453N	20	SN74154N	.99	SN74367N	.69
SN7454N	20	SN74155N	.79	SN74368N	.69
SN7459A	25	SN74156N	.79	SN74390N	1.95
SN7460N	20	SN74157N	.65	SN74393N	1.95
SN7470N	29				

C/MOS

CD4000	.23	CD4028	.89	CD4070	.55
CD4001	.23	CD4029	1.19	CD4071	.23
CD4002	.23	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4076	1.39
CD4007	.25	CD4040	1.19	CD4081	.23
CD4009	.49	CD4041	1.25	CD4082	.23
CD4010	.49	CD4042	.99	CD4093	.99
CD4011	.23	CD4043	.89	CD4098	2.49
CD4012	.25	CD4044	.89	MC14409	14.95
CD4013	.39	CD4046	1.79	MC14410	14.95
CD4014	1.39	CD4047	2.50	MC14411	14.95
CD4015	1.19	CD4048	1.35	MC14419	4.95
CD4016	.49	CD4049	.49	MC14433	19.95
CD4017	1.19	CD4050	.49	MC14506	.75
CD4018	.99	CD4051	1.19	MC14507	.99
CD4019	.49	CD4053	1.19	MC14562	14.50
CD4020	1.19	CD4056	2.95	MC14583	3.50
CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.49	CD4510	1.39
CD4023	.23	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
CD4027	.69			CD4566	2.25

74C00

74C00	.39	74C89	6.49	74C163	3.00
74C02	.55	74C90	3.00	74C164	3.25
74C04	.75	74C93	2.00	74C173	2.60
74C08	.75	74C95	2.00	74C192	3.49
74C10	.65	74C107	1.25	74C193	2.75
74C14	3.00	74C151	2.90	74C195	2.75
74C20	.65	74C154	3.00	74C922	9.95
74C30	.65	74C157	2.15	74C923	8.95
74C42	2.15	74C160	3.25	74C925	14.95
74C48	4.75	74C161	3.25	74C926	11.95
74C73	1.50			80C95	1.50
74C74	1.15			80C97	1.50

LINEAR

78MG	1.75	LM340T-8	1.25	LM733N	1.00
LM300H	.80	LM340T-12	1.25	LM739N	1.19
LM301H	.35	LM340T-15	1.25	LM741CH	.35
LM301CN	.35	LM340T-18	1.25	LM741CN	.35
LM302H	.75	LM340T-24	1.25	LM741-14N	.39
LM304H	1.00	LM351CN	.65	LM747H	.79
LM305H	.60	LM350N	1.00	LM747N	.79
LM307CN/H	.35	LM370N	1.15	LM748H	.39
LM308H	1.00	LM373N	3.25	LM748N	.39
LM308CN	1.00	LM377N	4.00	LM1303N	.90
LM309H	1.10	LM380N	1.25	LM1304N	1.19
LM309K	1.25	LM380CN	.99	LM1305N	1.40
LM310CN	1.15	LM381N	1.79	LM1307N	.85
LM311H	.90	LM382N	1.79	LM1310N	2.95
LM311N	.90	NE501N	8.00	LM1351N	1.65
LM317K	6.50	NE510A	8.00	LM1414N	1.75
LM318CN	1.50	NE529A	4.95	LM1458CN/H	.59
LM319N	1.30	NE531H	3.00	MC1488	1.95
LM320K-5	1.35	NE536T	6.00	MC1489	1.95
LM320K-5.2	1.35	NE540L	6.00	LM1496N	.95
LM320K-12	1.35	NE550N	1.30	LM1556V	1.75
LM320K-15	1.35	NE555V	.39	MC1741SCP	3.00
LM320K-18	1.35	NE556	.99	LM2901N	2.95
LM320K-24	1.35	NE560B	5.00	LM3053	1.50
LM320T-5	1.25	NE561B	5.00	LM3065N	.69
LM320T-5.2	1.25	NE562B	5.00	LM3900N(3401)	.49
LM320T-8	1.25	NE565H	1.75	LM3905N	.89
LM320T-12	1.25	NE565N	1.25	LM3909	1.25
LM320T-15	1.25	NE566CN	1.75	MC5558V	1.00
LM320T-18	1.25	NE567H	1.25	LM7525N	.90
LM320T-24	1.25	NE567V	.99	LM7534N	.75
LM323K-5	5.95	NE570	10.50	80388	4.95
LM324N	1.80	LM703CN/H	.45	LM75450	.49
LM339N	.99	LM709H	.29	75451CN	.39
LM340K-5	1.35	LM709N	.29	75452CN	.39
LM340K-6	1.35	LM710N	.79	75453CN	.39
LM340K-8	1.35	LM711N	.39	75454CN	.39
LM340K-12	1.35	LM723H	.55	75491CN	.79
LM340K-15	1.35	LM723N	.55	75492CN	.89
LM340K-18	1.35			75494CN	.89
LM340K-24	1.35			RC4151	5.95
LM340T-5	1.25			RC4194	5.95
LM340T-6	1.25			RC4195	4.49

74LS00 TTL

74LS00	.23	74LS74	.35	74LS155	.69
74LS02	.23	74LS75	.49	74LS157	.69
74LS03	.23	74LS76	.35	74LS160	.89
74LS04	.29	74LS83	.75	74LS161	.89
74LS05	.29	74LS85	.99	74LS162	.89
74LS08	.23	74LS86	.35	74LS163	.89
74LS10	.23	74LS90	.49	74LS164	.99
74LS13	.49	74LS92	.59	74LS175	.79
74LS14	.99	74LS93	.59	74LS181	2.49
74LS20	.23	74LS95	.79	74LS190	.89
74LS26	.29	74LS96	.89	74LS191	.89
74LS27	.29	74LS107	.35	74LS192	.89
74LS28	.29	74LS109	.35	74LS193	.89
74LS30	.23	74LS112	.35	74LS194	.89
74LS32	.29	74LS123	.99	74LS195	.89
74LS40	.29	74LS132	.79	74LS253	.79
74LS42	.69	74LS136	.39	74LS257	.69
74LS47	.69	74LS138	.69	74LS260	.55
74LS51	.23	74LS139	.69	74LS279	.59
74LS55	.23	74LS151	.69	74LS367	.59
74LS73	.35			74LS368	.59
				74LS670	1.95

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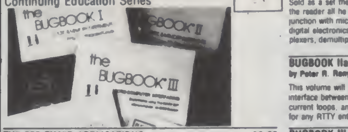

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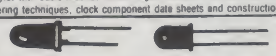
DISCRETE LEDS



.125" dia.			.200" dia.			.185" dia.			.200" dia.			.190" dia.		
XC209	Red	5/$1	XC22	Red	5/$1	XC526	Red	5/$1	XC556	Red	5/$1	XC111	Red	5/$1
XC209	Green	4/$1	XC22	Green	4/$1	XC526	Red	100/$8	XC556	Red	100/$8	XC111	Green	4/$1
XC209	Orange	4/$1	XC22	Yellow	4/$1	XC526	Green	4/$1	XC556	Green	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC22	Orange	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1	XC111	Orange	4/$1
			SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Orange	4/$1			
									XC556	Cle	7/$1			

.085" dia. MV50 - Red 6/$1
.170" dia. MV10 Red - 4/$1
INFRA-RED LED ¼" x ¼" x 1/16" Flat 5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	270	2.95	MAN 6680	Common Cathode-orange	.560	.99
MAN 2	5 x 7 Dot Matrix-red	300	4.95	MAN 6710	Common Anode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	125	.25	MAN 6730	Common Anode-red ±1	.560	.99
MAN 4	Common Cathode-red	187	1.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 52	Common Anode-green	.300	1.25	MAN 6750	Common Cathode-red ±1	.560	.99
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.99
MAN 72	Common Anode-red	.300	.99	MAN 6780	Common Cathode-red	.560	.99
MAN 74	Common Cathode-red	.300	1.25	DL701	Common Anode-red ±1	.300	.99
MAN 81	Common Anode-yellow	.300	.99	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.99	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3630	Common Anode-orange ±1	.300	.99	DL746	Common Anode-red ±1	.630	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.300	.99	DL749	Common Cathode-red ±1	.630	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4730	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Anode	.350	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode (FND500)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6630	Common Anode-orange	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6650	Common Cathode-orange ±1	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6660	Common Anode-orange	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

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CA3013	2.15	CA3082	2.00
CA2023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
CA3060	3.25	CA3160	1.25
CA3080	.85	CA3401	.49
CA3081	2.00	CA3600	3.50

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MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
5030	7.95

CLOCK CHIPS

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MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
7001	5.95

9374 - 7-segment LED driver common anode LEDs $ .99

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	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$ .17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$ .27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$ .30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.75	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$ .40	.38	.35	22 pin WW	.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	
ASST. 1	5 ea	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	1/4 WATT 5% 50 PCS.
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	1/4 WATT 5% 50 PCS.
		470 OHM	560 OHM	680 OHM	820 OHM	1K	
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	1/4 WATT 5% 50 PCS.
		3.3K	3.9K	4.7K	5.6K	6.8K	
ASST. 4	5 ea.	8.2K	10K	12K	15K	18K	1/4 WATT 5% 50 PCS.
		22K	27K	33K	39K	47K	
ASST. 5	5 ea.	56K	68K	82K	100K	120K	1/4 WATT 5% 50 PCS.
		150K	180K	220K	270K	330K	
ASST. 6	5 ea.	390K	470K	560K	680K	820K	1/4 WATT 5% 50 PCS.
		1M	1.2M	1.5M	1.8M	2.2M	
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	1/4 WATT 5% 50 PCS.

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WIRE-WRAP KIT — WK-2-W

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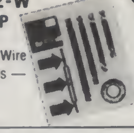

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- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

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WRAP • STRIP • UNWRAP - $6.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

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- 50 ft 30 AWG KYNAR wire wrap wire **$3.95 ea.**
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- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

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Specify blue, yellow, white or red **$1.98/spool**

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XR320	1.55	XR2207	3.85	XR4136	1.25
XR555	.39	XR2208	5.20	XR4151	2.85
XR556	.99	XR2209	1.75	XR4194	1.45
XR567CP	.99	XR2211	5.25	XR4202	3.60
XR567CT	1.25	XR2212	4.35	XR4212	2.05
XR1310P	1.30	XR2240	3.45	XR4558	.75
XR1468CN	3.85	XR2264	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.47

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MOA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MOA 980-3	12A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	.65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001μF	.05	.04	.035
22 pf	.05	.04	.03	.0047μF	.05	.04	.035
47 pf	.05	.04	.03	.01μF	.05	.04	.035
100 pf	.05	.04	.03	.022μF	.06	.05	.04
220 pf	.05	.04	.03	.047μF	.06	.05	.04
470 pf	.05	.04	.035	.1μF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

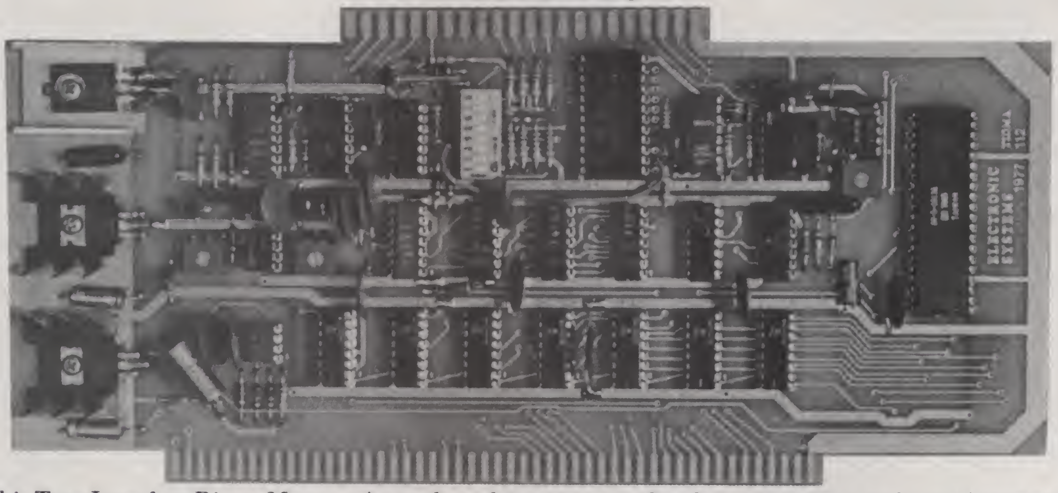
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-99	100+	Radial Lead	1-9	10-99	100+
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.18	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.18	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.18	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

ELECTRONIC SYSTEMS
P.O. Box 9641 San Jose CA 95157
(408) 374-5984

FOR CATALOG INCLUDING PARTS LISTS AND SCHEMATICS, SEND A SELF ADDRESSED ENVELOPE WITH 24¢ POSTAGE.

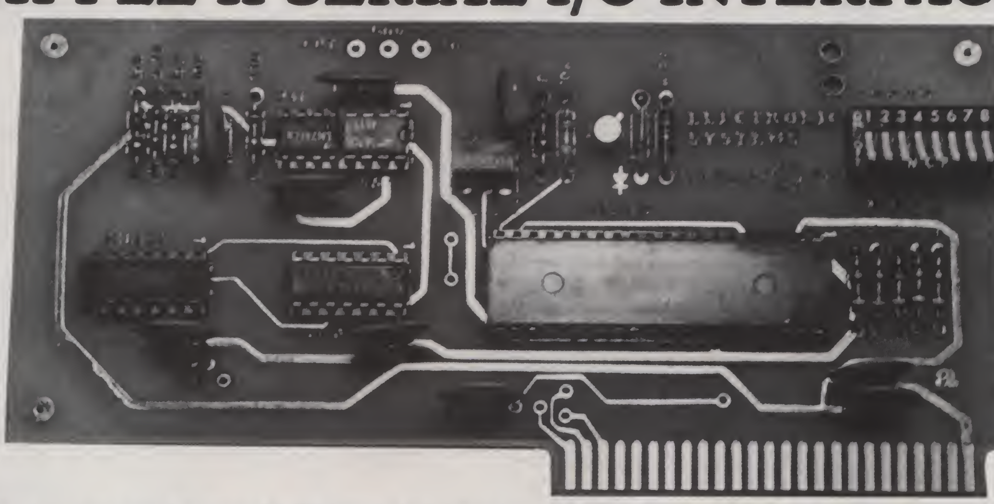
TIDMA



With this Tape Interface Direct Memory Access board you can record and play programs without a bootstrap loader (no prom). This can be up and running as fast as putting it in the socket. It takes complete control of the S-100 bus and reads or writes directly into the memory without the need for the microprocessor. It has an FSK encoder/decoder for direct connections to a low cost cassette recorder at 1200 baud, and inputs and outputs for direct connections to a digital recorder at any baud rate. This board is S-100 bus compatible.

Board only $35.00 Part No. 112; with parts $110.00 Part No. 112A

APPLE II SERIAL I/O INTERFACE



This serial I/O port works up to 30,000 baud. Software included are, an input and output routine from the Apple monitor or basic to a teletype or other serial printer. Also a program for using the Apple II for a video terminal or an intelligent terminal. It plugs into one of the Apple II peripheral connectors. It uses very low current. The input and output are RS-232.

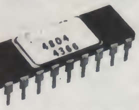
Board only $15.00 Part No. 2; with parts $42.00 Part No. 2A. Assembled and tested $62.00 Part No. 2C.

To Order:

Mention part number and description. For parts kits add "A" to part number. Shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. Dealer inquiries invited. 24 Hour Order Line: (408) 374-5984. Circuits designed by John Bell.

VISA master charge

4804 STATIC, TTL IN/OUT 1024x4 N-MOS RAM



GENERAL DESCRIPTION

Part Number 4804 is a 4K semiconductor random access memory organized as 1024 4-bit words. It is fully static and needs no clock or refresh pulses. It requires a single +5 volt power supply and is fully TTL compatible on input and output lines. The 4804 is packaged in a convenient 18 pin dual-in-line package.

FEATURES

- Single +5V Power Supply
- 1Kx4 Organization
- Replaces 4 1024x1 Static RAMs
- Completely Static—No Clocks or Refresh
- 18 Pin Package
- Access/Cycle 600nsec max
- 250 mw Typical Operating Power
- Common I/O Bus
- TTL Compatible I/O
- Three State Outputs

TRUTH TABLE

$\overline{CE}$	R/$\overline{W}$	DI/DO	STATUS	MODE
H	Don't Care	High Z	Deselect	Standby
L	H	Data	Selected	READ
L	L	L	Selected	Write 0
L	L	H	Selected	Write 1

WRITE CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4804 MIN	MAX
Write Cycle Time	T_{WC}	600	
Address To Write Time	T_{AW}	100	
Write Pulse Width	T_{WP}	500	
Write Recovery Time	T_{WR}	0	
Data Set Up Time	T_{DW}	350	
Data Hold Time	T_{DH}	0	
Output Disable From Write or Chip Enable	T_{OTW}		150

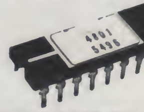
READ CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4804 MIN	MAX
Read Cycle Time	T_{RC}	600	
Access Time	T_{A}		600
Chip Enable to Output Enable	T_{CO}		200
Data Valid After Address	T_{OH1}	150	
Previous Data Valid After Chip De-Select	T_{OH2}	25	

$8.95 8/$60.00 16/$100.00

Annie Sez
Don't let your project fizzle out because you can't get that hot new item. Things are poppin' at TRI-TEK so watch our ads in Kilobaud and be sure to get our catalog.

4801 STATIC, TTL IN/OUT 4096x1 N-MOS RAM



GENERAL DESCRIPTION

Part Number 4801 is a 4K semiconductor random access memory organized as 4096 1-bit words. It is fully static and needs no clock or refresh pulses. It requires a single +5 volt power supply and is fully TTL compatible on input and output lines. The 4801 is packaged in a convenient 18 pin dual-in-line package.

FEATURES

- Single +5V Power Supply
- 4Kx1 Organization
- Replaces 4 1024x1 Static RAMs
- Completely Static—No Clocks or Refresh
- 18 Pin Package
- Access/Cycle Times
- 250 mw Typical Operating Power
- Separate Data In and Data Out
- TTL Compatible I/O
- Three State Outputs
- Data Bus Compatible I/O Function

TRUTH TABLE

$\overline{CE}$	R/$\overline{W}$	DI	DO	STATUS	MODE
H	Don't Care	Don't Care	High Z	Deselect	Standby
L	H	Don't Care	Data	Selected	READ
L	L	L	High Z	Selected	Write 0
L	L	H	High Z	Selected	Write 1

READ CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4801 MIN	MAX
Read Cycle Time	T_{RC}	600	
Access Time	T_{A}		600
Chip Enable to Output Enable	T_{CO}		200
Data Valid After Address	T_{OH1}	150	
Previous Data Valid After Chip De-Select	T_{OH2}	25	

WRITE CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4801 MIN	MAX
Write Cycle Time	T_{WC}	600	
Address To Write Time	T_{AW}	100	
Write Pulse Switch	T_{WP}	500	
Write Recovery Time	T_{WR}	0	
Data Set Up Time	T_{DW}	350	
Data Hold Time	T_{DH}	0	
Output Disable From Write or Chip Enable	T_{OTW}		150

$8.95 8/$60.00 16/$100.00

INTEGRATED TONE RECEIVER
MK5102(N)-5

FEATURES

- ☐ Detects all 16 standard DTMF digits
- ☐ Requires minimum external parts count for minimum system cost
- ☐ Uses inexpensive 3.579545 MHz crystal for reference
- ☐ Digital counter detection with period averaging insures minimum false response
- ☐ 16-pin package for high system density
- ☐ Single supply 5 Volts ± 10%
- ☐ Output in either 4-bit binary code or dual 2-bit row/column code
- ☐ Latched outputs

DESCRIPTION

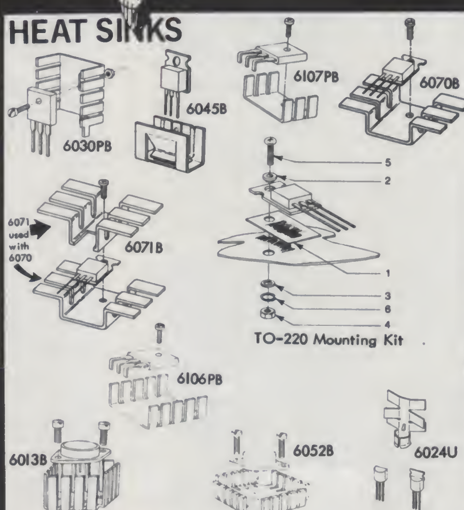
The MK5102 is a monolithic integrated circuit fabricated using the complementary-symmetry MOS (CMOS) process. Using an inexpensive 3.579545 MHz television colorburst crystal for reference, the MK5102 detects and decodes the 8 standard DTMF frequencies used in telephone dialing. The requirement of only a single supply and its construction in a 16-pin package make the MK5102 ideal for applications requiring minimum size and external parts count.

DETECTION FREQUENCY

Low Group f_o	High Group f_o
Row 1 = 697 Hz	Column 1 = 1209 Hz
Row 2 = 770 Hz	Column 2 = 1336 Hz
Row 3 = 852 Hz	Column 3 = 1477 Hz
Row 4 = 941 Hz	Column 4 = 1633 Hz

SPECIAL KILOBAUD INTRO PRICE 'TIL JULY 31, 1978
MK5102N-5..............................$33.00
Specs....................................... .40

HEAT SINKS



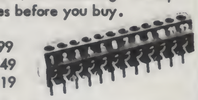
Economical 1 piece heat sinks for plastic power parts in TO-220 and Motorola cases 77, 90, 199, and TO-126. All are black anodized aluminum. "B" series is anodized after forming. "PB" series is anodized prior to forming.

THM	6030PB	Vertical	25¢, 5/$1.00, 10/$1.90
THM	6045B	Slip Over	30¢, 4/$1.00, 10/$2.00
THM	6070B	Extra Disipation Horiz.	35¢, 3/$1.00, 10/$3.00
THM	6071B	Top Hat for 6070	35¢, 3/$1.00, 10/$3.00
THM	6106PB	Flat With Fingers	30¢, 4/$1.00, 10/$2.00
THM	6107PB	Smaller Size Flat	25¢, 5/$1.00, 10/$1.90
THM	6013B	TO-3 Diamond	69¢, 4/$2.50, 10/$5.00
THM	6024-U	Unfinished TO-92	10/$1.00, 100/$5.00
THM-6052B		TO-3 Square	60¢, 5/$2.50, 10/$4.25

TO-220 6 Piece Mounting Kit - Handy Package...25¢

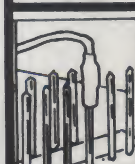
P. C. BOARD TERMINAL STRIP

Molded body encloses postive screw activated clamp which will accomodate wire sizes 14-30 AWG. Contacts and pins are solder plated copper. Pins are on .200 inch (5.08mM) for standard P. C. mounting. 10Amp rating. Compare our prices before you buy.



4 pole	TS-2504	.99
8 pole	TS-2508	1.49
12 pole	TS-2512	2.19

Signetics 2504TA 1024 bit S.R. memory (1404A)...	.50
MCM 6571P Character Generator	9.95
MCM6571AP Character Generator	9.95
MC14409P Telephone Rotary Pulser	10.98
MC14419P Touch Pad Converter for 14409	4.25
MC14411P Baud Rate Generator	11.98
MC14412VP CMOS Modem Chip	16.95
MM57109N Number Cruncher Micro	18.95
74C915 7 Segment to BCD Converter	2.99
74C922 16 Key Keyboard Encoder	6.35
74C923 20 key Keyboard Encoder	6.45
74C925 4 Decade Counter w/latches	12.00
74C926 4 Decade Counter w/carry	12.00
74C935-1 3½ Digit DVM CMOS Chip	16.98



Jumper Kits for .025 Square Posts. . All material for making jumpers for quick circuit changes and prototyping. Use for breadboarding, trouble shooting, field modifications. Fits standard IC socket wire/wrap posts. Excellent wiping action on gold plated box contacts.

Kit contain 10 box contacts, heat shrinkable sleeving, and 5 feet of wire plus instruction sheet.

JCK-5101....(5 double jumpers)$2.75, 4 kits/$10.00

DEALER PRICING AVAILABLE UPON REQUEST

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7808 North 27th Avenue
Phoenix, Arizona 85021
(602) 995-9352

T1

- Please give street address for UPS shipping when possible.
- C.O.D. NO parcel post C.O.D. UPS C.O.D. Add 85¢ to order.
- Any correspondence not connected with your order, please use separate sheet and include SASE for reply.
- Orders less than $10 ($15 foreign) please add $1 handling.
- Prices are subject to change without notice.
- Any refunds will be by check, not credit vouchers.
- Terms. Check, money order, credit card. Net 30 days to rated firms, schools and government agencies.
- If we should be temporarily out of stock on an item, it will be placed on back order. If we cannot ship in 30 days, you will be notified of the expected shipping date and furnished with a postage paid card with which to cancel your order if desired.
- We pay surface shipping only in USA, Canada and Mexico.
- For premium shipping (first class, special handling, etc.) add extra. Excell will be refunded.
- Foreign orders (except Canada and Mexico) estimate and add shipping. Excess will be refunded.

Charge card telephone orders ($20 min.) will be accepted 9-5:30 P.M. except weekends. Telephone 995-9352. No collect calls please.

DIODES/ZENERS

1N914	100v	10mA	.05
1N4005	600v	1A	.08
1N4007	1000v	1A	.15
1N4148	75v	10mA	.05
1N753A	6.2v	z	.25
1N758A	10v	z	.25
1N759A	12v	z	.25
1N4733	5.1v	z	.25
1N5243	13v	z	.25
1N5244B	14v	z	.25
1N5245B	15v	z	.25

SOCKETS/BRIDGES

8-pin	pcb	.25	ww	.45
14-pin	pcb	.25	ww	.40
16-pin	pcb	.25	ww	.40
18-pin	pcb	.25	ww	.75
22-pin	pcb	.45	ww	1.25
24-pin	pcb	.35	ww	1.10
28-pin	pcb	.35	ww	1.45
40-pin	pcb	.50	ww	1.25

Molex pins	.01	To-3 Sockets	.45
2 Amp Bridge		100-prv	1.20
25 Amp Bridge		200-prv	1.95

TRANSISTORS, LEDS, etc.

2N2222A	NPN (2N2222 Plastic .10)	.15
2N2907A	PNP	.15
2N3906	PNP (Plastic)	.10
2N3904	NPN (Plastic)	.10
2N3054	NPN	.35
2N3055	NPN 15A 60v	.50
T1P125	PNP Darlington	.35
LED Green, Red, Clear, Yellow		.15
D.L.747	7 seg 5/8" High com-anode	1.95
XAN72	7 seg com-anode (Red)	1.25
MAN71	7 seg com-anode (Red)	1.25
MAN3610	7 seg com-anode (Orange)	1.25
MAN82A	7 seg com-anode (Yellow)	1.25
MAN74A	7 seg com-cathode (Red)	1.50
FND359	7 seg com-cathode (Red)	1.25

C MOS

4000	.15
4001	.15
4002	.20
4004	3.95
4006	.95
4007	.35
4008	.95
4009	.45
4010	.45
4011	.20
4012	.20
4013	.40
4014	.95
4015	.90
4016	.35
4017	1.10
4018	1.10
4019	.50
4020	.85
4021	1.00
4022	.85
4023	.25
4024	.75
4025	.30
4026	1.95
4027	.50
4028	.95
4030	.35
4033	1.50
4034	2.45
4035	1.25
4040	1.35
4041	.69
4042	.95
4043	.95
4044	.95
4046	1.75
4049	.45
4050	.45
4066	.95
4069	.40
4071	.35
4081	.70
4082	.45
MC14409	14.50
MC14419	4.85

— T T L —

7400	.15	7473	.25	74176	1.25	74H72	.45	74S133	.40
7401	.15	7474	.30	74180	.75	74H101	.75	74S140	.55
7402	.20	7475	.35	74181	2.25	74H103	.75	74S151	.30
7403	.20	7476	.40	74182	.95	74H106	.95	74S153	.35
7404	.15	7480	.55	74190	1.75			74S157	.75
7405	.25	7481	.75	74191	1.05	74L00	.25	74S158	.30
7406	.35	7483	.95	74192	.75	74L02	.25	74S194	1.05
7407	.55	7485	.75	74193	.85	74L03	.30	74S257 (8123)	1.05
7408	.25	7486	.25	74194	1.25	74L04	.30		
7409	.15	7489	1.35	74195	.95	74L10	.30	74LS00	.25
7410	.10	7490	.55	74196	1.25	74L20	.35	74LS01	.35
7411	.25	7491	.95	74197	1.25	74L30	.45	74LS02	.35
7412	.30	7492	.95	74198	2.35	74L47	1.95	74LS04	.30
7413	.35	7493	.35	74221	1.00	74L51	.45	74LS05	.45
7414	1.10	7494	.75	74367	.85	74L55	.65	74LS08	.25
7416	.25	7495	.60			74L72	.45	74LS09	.35
7417	.40	7496	.80	75108A	.35	74L73	.40	74LS10	.35
7420	.15	74100	1.15	75110	.35	74L74	.45	74LS11	.35
7426	.30	74107	.35	75491	.50	74L75	.55	74LS20	.25
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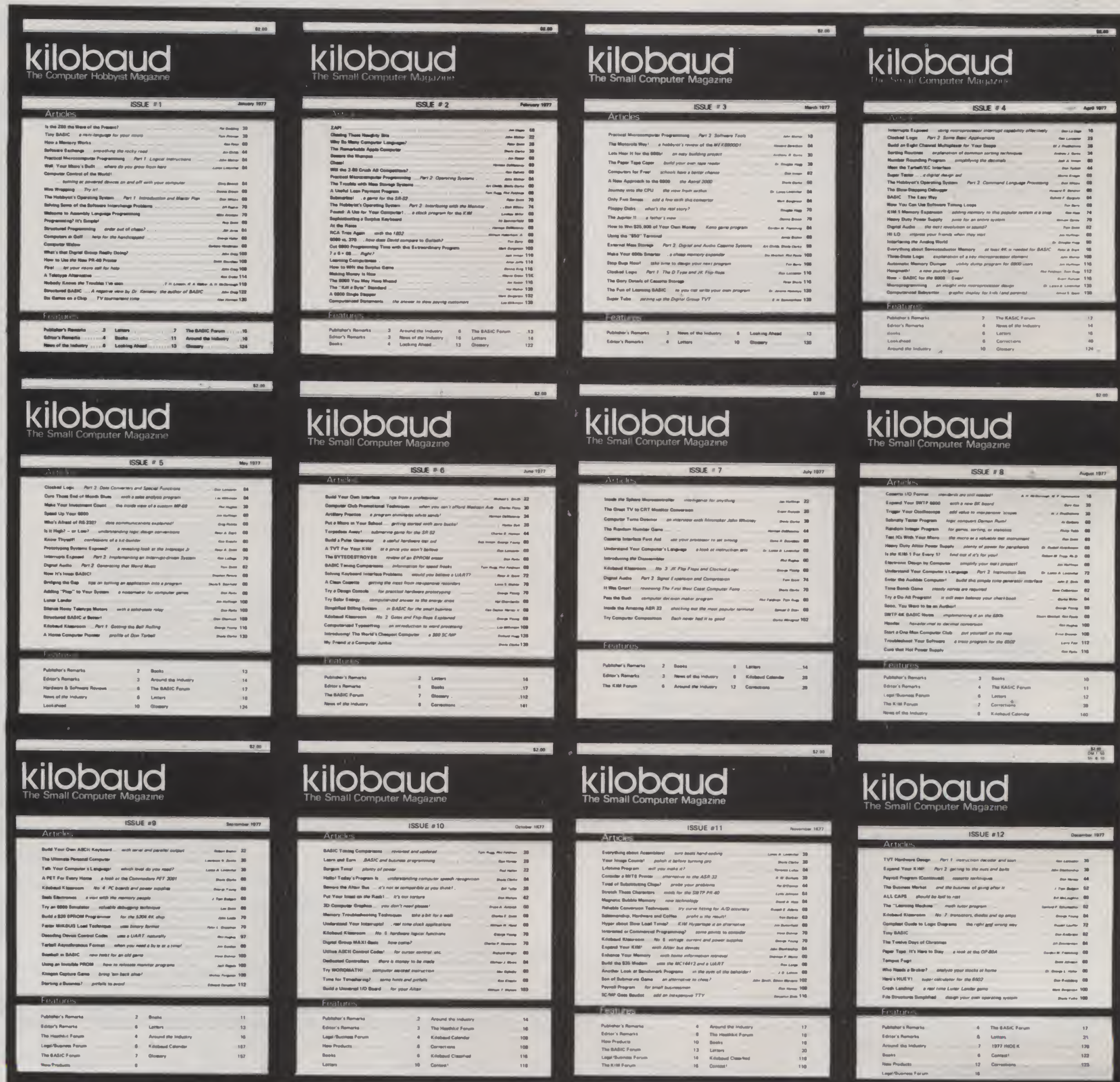

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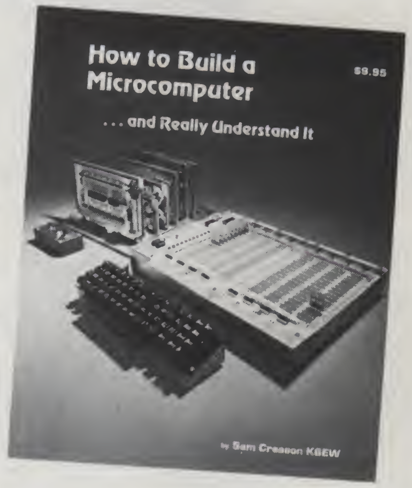

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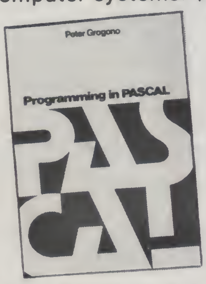

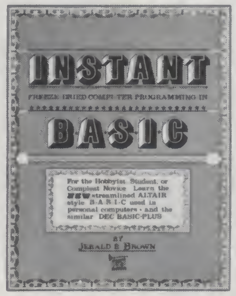

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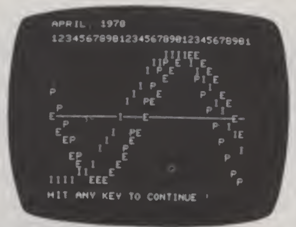

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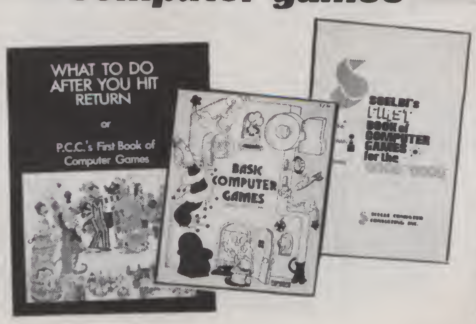

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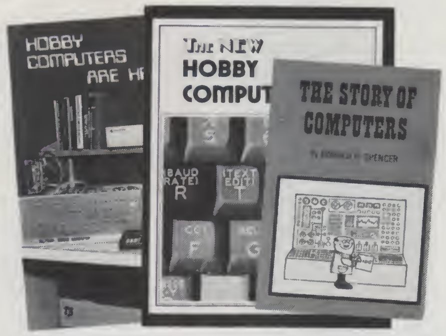

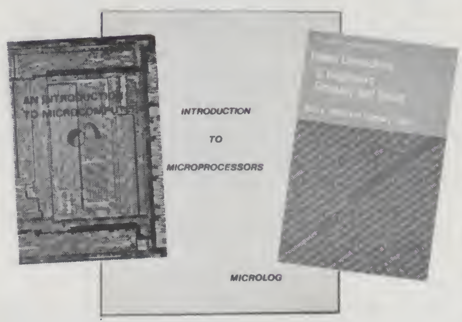

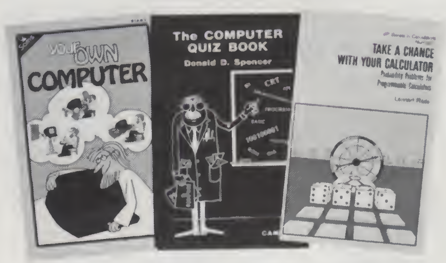

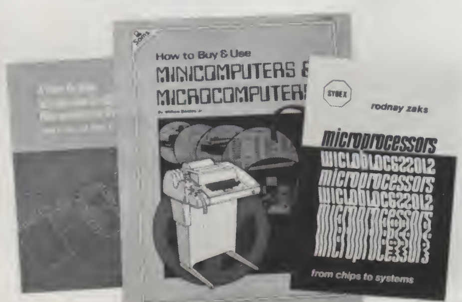

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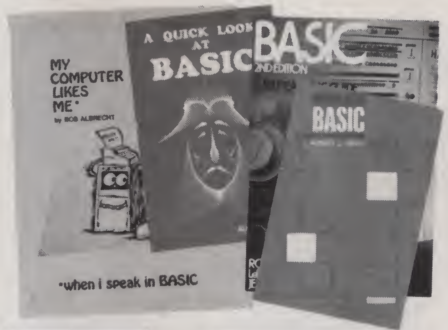

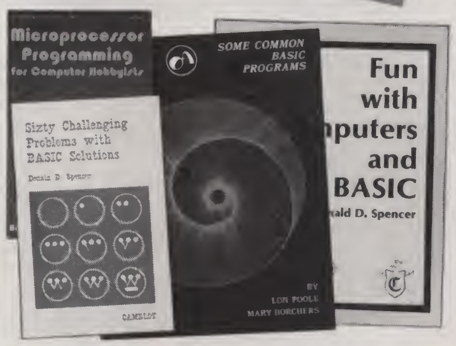

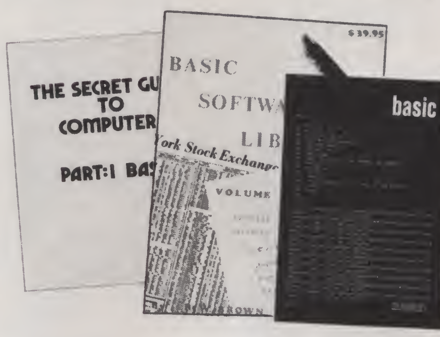

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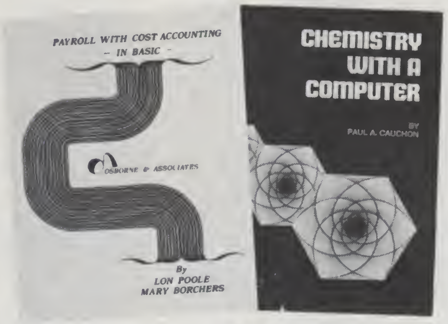

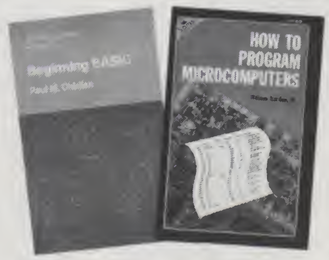

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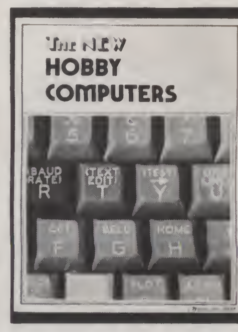

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