

# MICRO™

THE 6502/6809 JOURNAL



## 6809 Feature

**BASIC Utilities for Apple and PET**

**Votrax Interface**

**Inexpensive Mass Storage Techniques**





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IT OBSOLETES MOST OTHER SYSTEMS  
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The Chieftain series includes 5¼- and 8-inch Winchester that range from 4- to 60-megabyte capacity, and higher as technology advances. All hard disk Chieftains include 64-k memory with two serial ports and DOS69D disk operating system.

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No matter which Chieftain you select . . . 5¼- or 8-inch floppy, or 5¼- or 8-inch

Winchester with tape or floppy back-up . . . they *all* run under DOS or OS-9 with *no need* to modify hardware or software.

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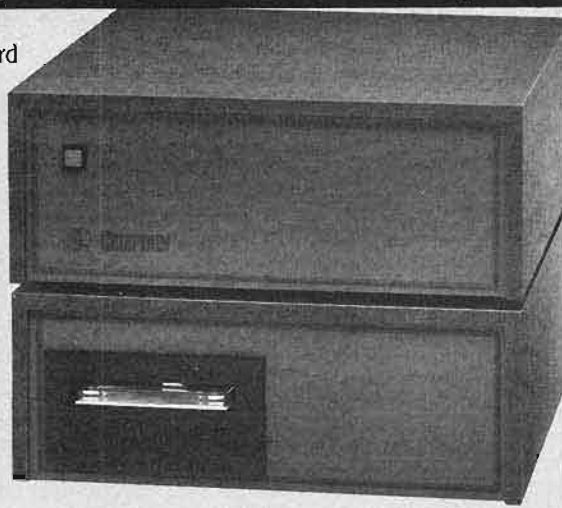
You'll probably never use it, but any Chieftain hard disk system can drive up to 20 other Winchester, and four tape drives, with a single DMA interface board!

## ● SMOKE SIGNAL'S HERITAGE OF EXCELLENCE

This new-generation computer is accompanied by the same *Endurance-Certified* quality Dealers and end-users all over the world have come to expect from Smoke Signal. And support, software selection and extremely competitive pricing are very much a part of that enviable reputation.

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- The following functions are also included:
- DYNAMIC DISPLAY of all file names in the Directory.
  - RENAMING the "HELLO" program.

- A SIMULATED CATALOG to show the modified Directory before it is written to the Diskette.
- ALPHABETIZING the file names.
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- DELETING files.
- DELETING DOS for increased data storage.
- A powerful SMART KEY to automatically locate the next valid file name for any specified operation.

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- A BRUTE FORCE COPY made for Pascal, FORTRAN, and CPM diskettes.
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- Optional 'INIT' of copy diskette.
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SUPER DISK COPY was one of only two programs to receive a rating of 100 in PRICE/USEFULNESS RATIO in THE BOOK OF APPLE COMPUTER SOFTWARE 1982. They said "This is a definite MUST HAVE utility package."

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- A 2 letter classification code can be added to each file name. The classifications are retained when the disk volume is updated.
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- Multi-Disk Catalog is written entirely in machine language, so it is very fast.
- A powerful search mask can be used to find a file name or groups of file names.
- Multi-Disk Catalog supports special printer interfaces.
- Both sides of a diskette may be entered under the same disk number.
- Titles may be entered for each diskette and much more!

"There is no doubt about it, this is the best and most versatile master catalog program available!"—THE BOOK OF APPLE COMPUTER SOFTWARE 1982.

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THE 6502/6809 JOURNAL

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### **Applefest/San Francisco**

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## About the Cover

FLOWER	PERIOD	COLOR
Zinnia	Aug.-Sept.	Multi
Tulip	May-June	Various
Marigold	Jul.-Aug.	Gold
Irish	May-June	White-Purple
Crocus	April	Purple, yellow, white
Peony	June	Pink, white, dusky
Aster	Aug.-Sept.	Multi

This month's cover launches MICRO into spring with colorful tulips. A microcomputer could be used to plan garden planting. Given the characteristics of the plants — their growing seasons, stature, flower color, etc. — the program would assist in planting for best balance.

The 'spring' theme of the cover also relates directly to the editorial theme of the issue — the 6809. This is truly the spring of the 6809, as well!

Cover photo: Betsey Bolton  
Lowell, Massachusetts

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# MICRO

## Editorial

### Support the 6809!

Personal computers make the transfer of information easier by removing unnecessary barriers between minds. The result is more than just added convenience. According to information theory (and common sense), if it is easier for people not to have information than to have it, they won't have it. How many times have you known that you could obtain a piece of information if you were willing to make the trip to the library? Chances are you stayed home and remained ignorant. Personal computers offer us the possibility of lives that are "barrier-free" with respect to information.

"Barrier-free" is a term used to describe building designs that don't lock out the handicapped. Nearly everyone has been handicapped at one time or another by not having access to the right information at the right time. What may be called the "personal computing movement" generates such intense enthusiasm because we are dimly aware that making the flow of information barrier-free can offer human society opportunities for advancement greater than any known before in history.

Even so, the personal computing industry has been responsible for creating some new barriers as it removes the old ones. The familiar "Tower of Babel" analogy aptly describes the problem — those who can't use each new computer language far outnumber those who can. In the Biblical story, the Tower of Babel was a joint effort by all of humanity to build a structure that would attain the heavens. To prevent this, God inflicted "Babel" on his presumptuous children so that only small groups could solve problems in common with the aid of that powerful tool, language. As humanity still strives to create that great tower of common understanding, it is still language, our greatest resource, that is our most imposing barrier.

Those of us who are professionally involved in the growth of personal computers have a responsibility to make this technology as barrier-free as possible. Barriers that have become

familiar — between the Apple world and the TRS-80 world, for example — are not in anyone's long-term best interest. Nor are they going to be meaningful much longer. Radio Shack has announced the Model 16, which will incorporate the 68000, the same chip rumored to be part of the next-generation Apple. But even when systems use the same CPU, it can be extremely difficult to alter code written for one configuration to run on another unless system transportability has been a major design consideration from the start.

There is a microprocessor available now that can play a significant role in removing barriers between systems. The 6809 microprocessor, designed at Motorola, removes obstacles to transportability that the 6502, for all its virtues, created. Hardware considerations required a fixed page zero location in the 6502, making it very difficult to alter 6502 software written for a specific system to run on another 6502 configuration. The 6809's Direct Page Register, however, permits the software itself to establish page zero in the process of adapting to specific system configurations. The result: position-independent code.

One of MICRO's primary concerns is to promote the removal of barriers to software transportability. We are pleased, therefore, to feature the 6809 processor in this issue, which includes a discussion of the 6809 *vis-a-vis* the 6502 by Messrs. Walker and Whiteside of Motorola.

I would like to conclude by taking this opportunity to introduce myself to the readers of MICRO. As Senior Editor, I hope to help MICRO become an even more effective information interchange between serious computerists. If you have any comments or ideas, write or call me at MICRO. Or reach me at 71535,231 on the Compu-Serve network.

*Lawrence Kepple*



# AIM User Device Arbiter

by Joel Swank

Expand the AIM's user input and output ports up to 83 devices each with the User Device Arbiter.

**AIM User Device Arbiter**  
requires:  
AIM-65

One of AIM's strongest features is the user I/O port, system device "U". With this user hook you can interface a wide variety of devices to the AIM and they will work with all AIM firmware. Unfortunately only one input and one output device can be available at a time. Since I use several devices on the user port, remembering the device driver addresses and manually changing the user vectors was inconvenient. To relieve this problem, I wrote the User Device Arbiter (UDA).

UDA separates the AIM user port into as many as 83 sub-devices. Each sub-device is represented by a one-character code. When I specify "U" in response to the IN= or OUT= prompt, the UDA receives control and displays the prompt DEVICE=. If I enter the one-character sub-device code, the open routine for that device is then executed. Any subsequent calls to the user port are sent to the device driver through the secondary user vector in the UDA.

UDA is a simple, table-driven routine. There are two logically identical routines, one for input and one for output. The Arbiter routines are only executed when they are entered with the carry flag clear (open call). The response to the DEVICE= prompt is used as a search argument for the device table, which is a list of device codes and device driver routine addresses. The driver routines are the same routines whose addresses would normally be stored in the user vectors. The tables must be terminated with a zero. If a device code is not found in the table, the error message UNKNOWN DEVICE is displayed and the DEVICE= prompt re-issued. When the device code is

```

: UDA : THE AIM USER DEVICE ARBITER
:
: FUNCTION:
: TO SELECT AMONG MULTIPLE DEVICES FOR
: I/O VIA THE AIM USER PORT.
:
: AIM USER UDA ADDRESSES
UDAB  =#$A000
UDARB =#$A002
UPCR  =#$A00C
UIFR  =#$A00D
UIER  =#$A00E
:
: AIM SUBROUTINES
TTYTST =#$E842      ;TEST FOR TTY MODE
BLANK  =#$E83E      ;SEND SPACE TO D/P
OUTPUT =#$E97A      ;ACCUM TO D/P
EQUAL  =#$E7D8      ;? TO THE D/P
REDOUT =#$E973      ;READ KBD WITH ECHO
CRLW   =#$EA13      ;CR LF TO D/P
COMIN  =#$E1A1      ;AIM RE-ENTRY
:
UJIN   =#$108       ;AIM USER I/O VECTORS
:
: OUTSIDE ADDRESSES
UICIN  =#$862F      ;MIC-20 I/O
UICDT  =#$8648
DISKIN =#$93C3      ;DISK I/O DRIVERS
DISKOT =#$937A
BUFFIN =#$8996      ;BUFFER MANAGER I/O DRIVERS
BUFFOT =#$8841
:
*=$8000
:
: ROUTINE TO INITIALIZE THE USER I/O VECTORS
8000 A0 03 INITIAL LDY #3
8002 B9 E8 80 INILUP LDA UVECS,Y      ;INIT USER I/O VECTORS
8005 99 08 01 STA UJIN,Y
8008 6A      DEY
8009 1A F7 BPL INILUP
800B 4C A1 E1 JMP COMIN
800E
800E
:
: ARBITER ROUTINES
:
800E : ENTRY FOR USER INPUT
800E B0 22 USERI BCS JMPIN      ;ALREADY OPEN
8010 20 AF 80 GETI JSR GETDEV      ;INPUT DESIRED DEVICE
8013 A0 00 LDY #0      ;PREPARE TO SEARCH TABLE
8015 BE D1 80 UDILUP LDX DTABI,Y      ;END OF TABLE?
8018 F0 18 BEQ NODEVI      ;YES, ERROR
801A D9 D1 80 CMP DTABI,Y      ;MATCH?
801D F0 05 BEQ MQUADI      ;YES, DISPATCH IT
801F C8      INY
8020 C8      INY      ;NO, BUMP TO NEXT
8021 C8      INY
8022 D0 F1 BNE UDILUP      ;TRY AGAIN
8024 C8      MQUADI INY      ;FOUND - BUMP TO ADDRESS
8025 B9 D1 80 LDA DTABI,Y      ;MOVE ADDRESS TO VECTOR
8028 8D 12 81 STA IVEC
802B B9 D2 80 LDA DTABI+1,Y
802E 8D 13 81 STA IVEC+1
8031 18      CLC
8032 6C 12 81 JMPIN JMP <IVEC>      ;EXECUTE DEVICE DRIVER

```

(Continued)



# DOS FOR AIM-65<sup>®</sup>: \$499.<sup>00</sup>

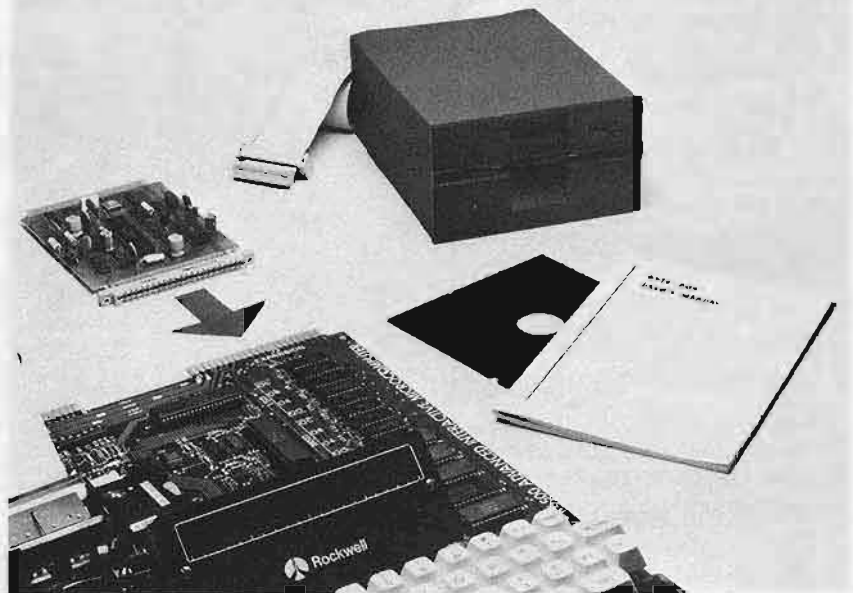
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Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone \_\_\_\_\_  home  work

I own an AIM-65.

I'm thinking of buying an AIM-65.

Send full BYTE-DOS Data.



found in the table, the succeeding two bytes are moved to the secondary user vectors. Subsequent calls to the device "U" vectors with carry flag set (I/O call) are directed through these secondary vectors.

My device tables contain three input devices and four output devices. Included in the assembly is the driver for my BASE 2 printer. The drivers for my disk, buffer manager, and VIC-20 parallel link, are located elsewhere. Devices can easily be added by inserting their device codes and driver routine addresses in the tables. To avoid selecting the wrong device, have each open routine display a message that identifies which device was selected.

Included at the beginning of UDA is a routine that initializes the user I/O vectors with the addresses of the arbiter routines. Execute this routine only once after UDA is loaded. UDA has no effect on AIM's restriction of having only one input and one output device open at a time.

The author may be contacted at 25730 Beach Dr., Rockaway, OR 97136.

## COLOR VIDEO MONITORS

### • COMPOSITE VIDEO INPUT, NTSC:

TC-700 13" color monitor/TV receiver, switchable, \$349.00. TC-900 19" monitor/TV receiver, \$449.00.

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• **RGB converter board** for Apple 11, provides RGB video and sync; mod. VCB-A2. \$179.00.

• **Sony TV to RGB and composite video monitor conversion kit**, RGB-100: \$295.00 (available January 1982).

For additional information, contact:

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Warrington, PA 18976

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DEALER INQUIRIES INVITED

```

8035 20 C3 80 NODEVI JSR DIUERR ;ERROR MSG
8038 4C 10 80 JMP GETI ;RETRY

803B ; ENTRY FOR USER OUTPUT

803B B0 22 USERO BCS JMPOT ;ALREADY OPEN

803D 20 AF 80 GETO JSR GETDEV ;INPUT DESIRED DEVICE
8040 A0 00 LDY #0 ;PREPARE TO SEARCH TABLE
8042 BE DB 80 UDQLUP LDX DTABO.Y ;END OF TABLE?
8045 F0 1B BEQ NODEVO ;YES, ERROR
8047 09 08 80 CMP DTABO.Y ;MATCH?
804A F0 05 BEQ MOURADO ;YES, DISPATCH IT
804C C8 INY
804D C8 INY ;NO, BUMP TO NEXT
804E C8 INY
804F D0 F1 BNE UDQLUP ;TRY AGAIN

8051 C8 MOURADO INY ;FOUND - BUMP TO ADDRESS
8052 B9 DB 80 LDA DTABO.Y ;MOVE ADDRESS TO VECTOR
8055 9D 14 81 STA OVEC
8058 B9 DC 80 LDA DTABO+1,Y
805B 8D 15 81 STA OVEC+1
805E 18 CLC

805F 6C 14 81 JMPOT JMP (OVEC) ;EXECUTE DEVICE DRIVER

8062 20 C3 80 NODEVO JSR DIUERR ;ERROR MSG
8065 4C 3D 80 JMP GETO ;RETRY

8068 ;BASE 2 INTERFACE FOR THE AIM 65
8068 ;USES THE B PORT OF THE USER 6522 VIA

8068 ; ENTRY TO USE THE BASE 2 THROUGH THE
8068 ; AIM USER OUTPUT VECTOR.

8068 B0 33 BASEOT BCS UBAS ;BRANCH ON OUTPUT CALL
806A A0 0F LDY #BASMSG-LITS;DISPLAY "BASE-2"
806C 20 C5 80 JSR PMSG

806F ; SUBROUTINE TO INITIALIZE THE VIA
806F A9 FF BASINT LDA #FF ;ALL BITS OUTPUT
8071 8D 02 A0 STA UDRB
8074 AD 0C A0 LDA UPCR
8077 29 0F AND #0F
8079 09 A0 ORA #A0 ;SET AUTO PULSE MODE
807B 8D 0C A0 STA UPCR
807E A9 00 LDA #0 ;SEND A NULL TO GET THINGS
; STARTED

8080 8D 00 A0 STA UDRB
8083 A2 00 LDX #0
8085 BD 03 81 BASLUP LDA INITS,X ;LOOP TO SEND
8088 F0 06 BEQ CKTERM ;PARMS TO BASE2
808A 20 A2 80 JSR BASOUT
808D E8 INX
808E D0 F5 BNE BASLUP
8090 20 42 E8 CKTERM JSR TTYTST ;TTY MODE?
8093 F0 04 BEQ DIS ;YES
8095 A9 37 LDA #55 ;NO, ENABLE AUTO LF
8097 D0 09 BNE BASOUT
8099 A9 38 DIS LDA #56 ;DISABLE AUTO LF
809B D0 05 BNE BASOUT

809D ; CHARACTER FROM USER OUTPUT COMES HERE

809D 68 UBAS PLA
809E C9 FF CMP #FF ;IGNORE AIM NULL CODES
80A0 F0 0C BEQ BRET

80A2 ; SUBROUTINE TO SEND 1 CHARACTER TO THE BASE2

80A2 48 BASOUT PHA
80A3 AC 0D A0 BOTLUP LDA UIFR ;GET VIA STATUS
80A6 29 10 AND #10 ;IS PRINTER READY?
80A8 F0 F9 BEQ BOTLUP ;NO, WAIT
80AA 68 PLA
80AB 8D 0D A0 STA UDRB ;YES, SEND CHARACTER
80AE 60 BRET RTS

80AF ; GETDEV : INPUT DEVICE CODE FROM CONSOLE

80AF 20 13 EA GETDEV JSR CRLW ;NEW LINE
80B2 A0 08 LDY #DEUMSG-LITS;PROMPT "DEVICE="
80B4 20 C5 80 JSR PMSG

```



```

80B7 20 D8 E7      JSR EQUAL
80BA 20 73 E9      JSR REDOUT      ;GET REPLY
80BD 48             PHA

80BE 20 3E E8      JSR BLANK        ;SEND SPACE
80C1 68             PLA
80C2 60             RTS

80C3              ;   DIVERR : DISPLAY ERROR MESSAGE

80C3 A0 00         DIVERR LDY #ERRMSG-LITS

80C5              ;   PMSG : MESSAGE WRITER

80C5 B9 EC 80     PMSG  LDA LITS,Y      ;GET A CHAR
80C8 F0 06         BEQ PDUN        ;QUIT ON NULL
80CA 20 7A E9     JSR OUTPUT      ;SEND IT
80CD C8             INY
80CE D0 F5         BNE PMSG
80D0 60             PDUN  RTS

80D1              ;   DATA TABLES

80D1              ;   TABLE OF INPUT DEVICES

80D1 DTAB1  =*
80D1 44             .BYT 'D'
80D2 C3 93         .WOR DISKIN
80D4 56             .BYT 'U'
80D5 2F 86         .WOR VICIN
80D7 42             .BYT 'B'
80D8 96 88         .WOR BUFIN
80DA 00             .BYT 0

80DB              ;   TABLE OF OUTPUT DEVICES

80DB DTAB0  =*
80DB 44             .BYT 'D'
80DC 7A 93         .WOR DISKOT
80DE 56             .BYT 'U'
80DF 48 96         .WOR VICOT
80E1 42             .BYT 'B'
80E2 41 88         .WOR BUFFOT
80E4 50             .BYT 'P'
80E5 68 80         .WOR BASEOT
80E7 00             .BYT 0

80E8              ;   USER I/O VECTOR INITS

80E8 UECS  .WOR USERI
80EA 3B 80         .WOR USERO

80EC              ;   MESSAGE TABLE

80EC LITS  =*
80EC 55 4E         ERRMSG .BYT 'UNKNOWN '
80F4 44 45         DEUMSG .BYT 'DEVICE',0
80F6 00
80FB 42 41         BASMSG .BYT 'BASE 2 ',0
80FD 00

80FE              ;   TABLE OF INIT PARMS FOR BASE2
80FE              ;   : 96 CPL, 8 LPI, 88 LPP,
80FE              ;   : AUTO FF 4 LINES UP

8103 1B           INITS .BYT 27,50,27,84,88,27,57,4
8104 32
8105 1B
8106 54
8107 58
8108 1B
8109 39
810A 04
810B 1B           .BYT 27,58,27,98,18,27,0
810C 3A
810D 1B
810E 62
810F 12
8110 1B
8111 00

8112              ;   SECONDARY USER I/O VECTORS
8112              ;   MUST BE IN RAM

8112 00 00         IVEC  .WOR 0
8114 00 00         OVEC  .WOR 0

```

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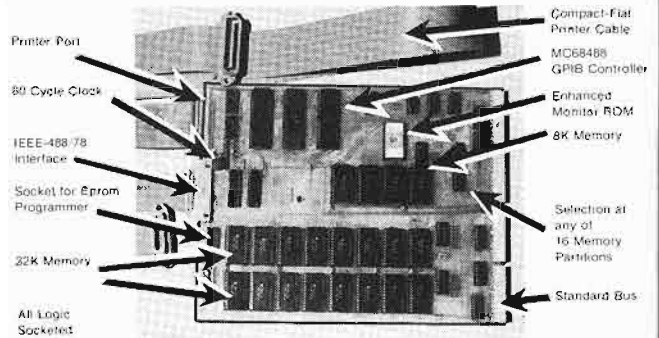
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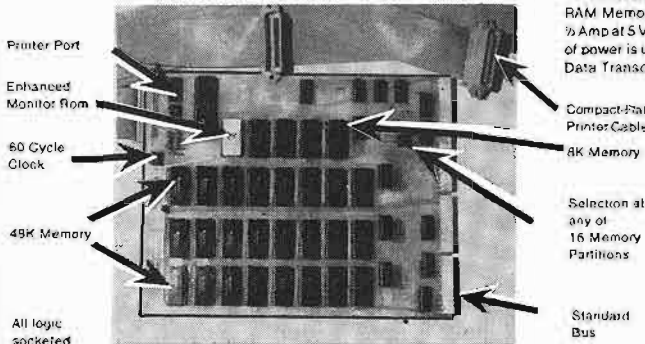
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# General Purpose Tape I/O for OSI

by Jerry D. Boucher

This relocatable program provides extremely flexible cassette LOAD and SAVE functions. Nearly every location and format can be accommodated.

## TAPE LOAD

requires:

OSI C2 Series One or Two cassette recorders

The program can be modified easily to work on other OSI machines.

There are numerous occasions when the cassette tape SAVE and LOAD functions on OSI microcomputers are awkward or inadequate. The limitations of 7-bit bytes, language-dependent format, inflexible storage location, and loss of control characters from tape have frequently forced me to write a dedicated I/O routine for each job. A problem occurred when I increased the baud-rate of the tape I/O and needed to copy my library of tapes at a higher speed. Copying the mixed format (machine language and CHECKSUM) of the Assembler/Editor, Extended Monitor and my own program packages was almost impossible with the existing firmware. The general purpose I/O program presented in listing 1 was my solution to that and other serial I/O problems.

My general purpose program will permit the transfer of data from one tape to another, regardless of the format or content of the data. The program can also be used to LOAD non-standard data into the computer's memory for use with other programs. For example, data may be loaded with

Listing 1: Tape LOAD and SAVE Routine, Assembly Language.

```

10 0000          ;TAPE LOAD AND SAVE
20 0000          ;J.D. BOUCHER, 8/31/81
30 0000          ;
40 1000          * = $1000
50 1000          MEM = $E0
60 1000 4C1C10   START  JMP S3
70 1003 A000     ST      LDY #000  FIRST PROMPT
80 1005 B9D210   S1     LDA TAB1.Y
90 1008 202DBF   JSR $BF20
100 100B 00     DEY
110 100C D0F7    BNE S1
120 100F D00FD   SP2    PLA $F000
130 1011 C97F    CLD #57F
140 1013 C019    BCC S2
150 1015 202DBF   JSR $BF20
160 1018 C950    CMP #550  LEN
170 101A D000    BPL SP1
180 101C A011    LDY #011  SET MEMORY PAUL
190 101F B5E1    STA MEM11
200 1020 A000    LDY #000
210 1022 B5E0    STA MEM
220 1024 D007    SP1    LDY #007  SECOND PROMPT
230 1026 D00010  SP2    LDA TAB2.Y
240 1028 202DBF   JSR $BF20
250 102C 00     DEY
260 102D D0F7    BNE SP2
270 102F 2000FD   SP3    JSR $F000  GET L OR S
280 1032 202DBF   JSR $BF20
290 1035 40     PHA
300 1036 A000    LDY #000  THIRD PROMPT
310 1038 B9E210   TP1    LDA TAB3.Y
320 103B 202DBF   JSR $BF20
330 103E 00     DEY
340 103F D0F7    BNE TP1
350 1041 50     PLA
360 1042 C94C    CMP #54C  CHECK I OR S
370 1044 F005    BEQ IN   LOAD
380 1046 C953    CMP #553  SAVE
390 1048 F03F    BEQ OUT
400 104A D0E3    BNE SP3
410 104C 7000FD   IN     JSR $F000  GET START MARK
420 104F C90D    CMP #50D  IGNORE IF RETURN
430 1051 F01B    BEQ IN2
440 1053 B0B510   STA $TMARK+1
450 1056 202DBF   JSR $BF20
460 1059 20AD10   JSR SKIP
470 105C 20C210   IN1    JSR RUBCHK
480 105F B0A2    RCS ST
490 1061 20B010   JSR INPUT READ INPUT UNTIL
500 1064 C92E    CMP #52E  START MARK FOUND
510 1066 D0F4    BNE IN1
520 1068 91E0    STA (MEM).Y
530 106A 202DBF   JSR $BF20
540 106D C0     INY
550 106E 20AD10   IN2    JSR SKIP
560 1071 20C210   IN3    JSR RUBCHK
570 1074 B0BD    IN4    BCS ST

```

(Continued)



**Listing 1 (Continued)**

```

580 1076 208810      JSR INPUT    LOAD AND STORE
590 1079 2020BF      JSR $BF2D    ALL AFTER START
600 107C 91E0        STA (MEM),Y
610 107E D1E0        CMP (MEM),Y
620 1080 D0B1        BNE ST
630 1082 C8         INY
640 1083 D0EC        BNE IN3
650 1085 E6E1        INC MEM+1
660 1087 D0EB        BNE IN3
670 1089 2000FD      OUT   JSR $FD00    NEW START MARK?
680 108C C90D        CMP $50D     IGNORE IF RETURN.
690 108E F005        BEO OUT1
700 1090 2020BF      JSR $BF2D
710 1093 2015BF      JSR $BF15
720 1096 20AD10      OUT1  JSR SKIP
730 1099 20C210      OUT2  JSR RUBCHK
740 109C 0006        BCS IN4
750 109E B1E0        LDA (MEM),Y
760 10A0 2015BF      JSR $BF15
770 10A3 2020BF      JSR $BF2D
780 10A6 C8         INY
790 10A7 D0FB        BNE OUT2
800 10A9 E6E1        INC MEM+1
810 10AB D0EC        BNE OUT2
820 10AD A30A        SKIP   LDA $50A
830 10AF 2020BF      JSR $BF2D
840 10B2 A90D        LDA $50D
850 10B4 2020BF      JSR $BF2D
860 10B7 50         RTS
870 10B8 AD00FC      INPUT  LDA $FC00
880 10BB 4A         LSR A
890 10BC 90FA        BCC INPUT
900 10BE AD01FC      LDA $FC01
910 10C1 60         RTS
920 10C2 A940        RUBCHK LDA $540
930 10C4 0D00DF      STA $DF00
940 10C7 AD00DF      LDA $DF00
950 10CA C904        CMP $504
960 10CC F002        BEO RB2
970 10CE 18         CLC
980 10CF 60         RTS
990 10D0 3B        RB2   SEC
1000 10D1 60        RTS
1010 10D2 203F      TAB1  .DBYTE $203F,$5A49,$4E49,$0D0A
1010 10D4 5A49
1010 10D6 4E49
1010 10D8 0D0A
1020 10DA 203F      TAB2  .DBYTE $203F,$532F,$4C00,$0A00
1020 10DC 532F
1020 10DE 4C00
1020 10E0 0A00
1030 10E2 203F      TAB3  .DBYTE $203F,$5452,$4154,$530D,$0A00
1030 10E4 5452
1030 10E6 4154
1030 10E8 530D
1030 10EA 0A00

```

the program, held in memory, and retrieved with PEEK statements for processing in BASIC. Or straight text may be stored and LOADED on tapes for use with a word processor. The program can be used in conjunction with the Monitor or Extended Monitor to inspect the contents of a tape for format or for bug-hunting. It can also be used to SAVE any portion of the computer's memory to tape; for example, tokenized BASIC programs.

The portion of the program that actually performs the LOADs and SAVEs is quite simple. Any string of characters present at the serial input port is sequentially stored in memory with a LOAD. With a SAVE the string is sequentially routed to the serial output port. This string includes control characters, line-feeds, data, or any valid ASCII character that might be on the

tape. The rest of the program, occupying most of the code, makes the LOADs and SAVEs flexibly controllable and the operation convenient.

**Location and Machine-Dependent Features**

The program utilizes several routines from the Monitor and BASIC ROMs of the OSI C2 series. If you have a different machine, you may need to change the addresses of these routines and ports:

- \$BF15 serial output routine
- \$BF2D CRT display routine
- \$DF00 scanned keyboard port
- \$FC00, FC01 serial I/O port
- \$FD00 keyboard fetch routine

The ROM routines use locations in the first three pages of memory, so

storage of the machine-language program must be in page 3 or above. The program, as shown in listing 1, is written to occupy page 16 (\$1000 to \$10EA), with data storage beginning at page 17 (\$1100). Page zero locations \$E0, \$E1 are used. However, these locations are not affected by running BASIC, so the program can be called as aUSR function or loaded with a BASIC routine.

The program can be relocated with the Assembler/Editor, Extended Monitor, or with the BASIC loader presented below. If the program is to be relocated and directly entered into the computer with the ROM Monitor, change all occurrences of byte \$10 to the page number (hex) of the new location. You can change the location of data storage by entering the page number of the start of data storage at line 180 of listing 1.

Listing 2 is a BASIC program which will load and locate the machine language program. Upon RUN the program calls for the page (decimal) where the program is to be located. Data storage is set for the next page. This BASIC loader requires the first nine pages for operation, so the lowest page available for the main program is 10. After the loader has placed the main program in memory, control transfers to the main program via aUSR instruction in line 120 of the BASIC loader.

**Operation**

When you turn your machine on, the prompt "L/S?" is displayed. Enter L for LOAD or S for SAVE. The prompt "START?" will then be displayed. If a carriage return is entered, the program immediately begins to load and store whatever is coming into the serial input port, or output whatever is in memory — depending upon whether L or S was selected. If any other key is pressed in response to "START?" that character becomes a start mark.

In the LOAD mode the input is monitored until the start mark appears on the tape. The start mark is then stored in the first memory location, and all subsequent data are stored sequentially in the following memory. For example, machine language programs usually begin with a period to set the monitor in the address mode. If a period is entered as a start mark, any characters on the tape preceding a machine language program will be ignored. Likewise, a semi-colon could be used to select a CHECKSUM program, or you may use special characters for file separation.

**Listing 2: BASIC Loader and Relocater.**

```

10 REM --RELOCATE AND LOAD MACHINE LANGUAGE PROGRAM--
20 REM --J.D. BOUCHER, 8/31/81
30 PRINT "ENTER PAGE IN DECIMAL":INPUT P
40 IF P<10 THEN PRINT"TOO SMALL":GOTO30
50 X=P*256:POKE 133,256:POKE 134,P-1
60 FOR J=0 TO 239:Y=X+J
70 READ N:IF N=15 THEN N=P
80 IF J=29 THEN N=P+1
90 POKE Y,N
100 NEXTJ
120 POKE 11,0:POKE 12,P:X=USR(X)
1000 REM -- LOAD AND SAVE PROGRAM--
1001 DATA 76, 20, 16, 160, 8, 185, 210, 16, 32, 45
1002 DATA 191, 136, 200, 247, 32, 0, 253, 201, 127, 240
1003 DATA 249, 32, 45, 191, 201, 89, 200, 8, 169, 17
1004 DATA 133, 225, 169, 0, 133, 224, 160, 7, 185, 218
1005 DATA 16, 32, 45, 191, 136, 200, 247, 32, 0, 253
1006 DATA 32, 45, 191, 72, 160, 9, 185, 226, 16, 32
1007 DATA 45, 191, 136, 200, 247, 104, 201, 76, 240, 6
1008 DATA 201, 83, 240, 63, 200, 227, 32, 0, 253, 201
1009 DATA 13, 240, 27, 141, 101, 16, 32, 45, 191, 32
1010 DATA 173, 16, 32, 194, 16, 176, 162, 32, 184, 16
1011 DATA 201, 46, 200, 244, 145, 224, 32, 45, 191, 200
1012 DATA 32, 173, 16, 32, 194, 16, 176, 141, 32, 184
1013 DATA 16, 32, 45, 191, 145, 224, 209, 224, 200, 129
1014 DATA 200, 200, 236, 230, 225, 200, 232, 32, 0, 253
1015 DATA 201, 13, 240, 6, 32, 45, 191, 32, 21, 191
1016 DATA 32, 173, 16, 32, 194, 16, 176, 214, 177, 224
1017 DATA 32, 21, 191, 32, 45, 191, 200, 200, 240, 230
1018 DATA 225, 200, 236, 169, 10, 32, 45, 191, 169, 13
1019 DATA 32, 45, 191, 96, 173, 0, 252, 74, 144, 250
1020 DATA 173, 1, 252, 96, 169, 64, 141, 0, 223, 173
1021 DATA 0, 223, 201, 4, 240, 2, 24, 96, 56, 96
1022 DATA 32, 63, 90, 73, 70, 73, 13, 10, 32, 63
1023 DATA 83, 47, 76, 13, 10, 0, 32, 63, 84, 82
1024 DATA 85, 84, 83, 13, 10, 0, 0, 8, 0, 0

```

lines to listing 1 will return control to BASIC if "R" is pressed at "INIZ?":

```

161 BEQ S3
162 CMP #52 R FOR RETURN
171 RTS RETURN TO BASIC

```

This package has become a very useful addition to my program library. If you have difficulty getting things in and out of your machine you should give it a try.

Dr. Jerry D. Boucher is a Research Associate at the East-West Center in Honolulu, Hawaii, specializing in cross-cultural psychological problems. He uses his OSI C2-4P for statistical analysis, content-analysis of language, and text processing. Contact Dr. Boucher at East-West Center, 1777 East-West Rd., Honolulu, HI 96848.

**MICRO**

In the SAVE mode, the start mark is not used for control. If any character other than a carriage return is entered as a start mark, that character is output to the tape port before the data are dumped. This adds the start mark to the SAVED data for future use.

While operating in the SAVE or LOAD mode, the program may be interrupted by depressing the RUB-OUT key. On RUB-OUT, the prompt "INIZ?" appears. If "Y" for YES is entered, the memory will be reset to the beginning, and the L/S prompt will reappear. If any other key is depressed, memory will not be reset before moving to the L/S call. This function allows multiple data sets to be LOADED. After LOAD, the memory must be initialized before SAVE.

Neither SAVE nor LOAD has a termination point. The program will continue to LOAD or SAVE data until RUB-OUT or BREAK is entered. However, there is an echo-check at line 610 in listing 1. This will send control to the "INIZ?" point if the available RAM is exhausted. The program, as written, has no provision for return from a BASIC USR call. Adding the following



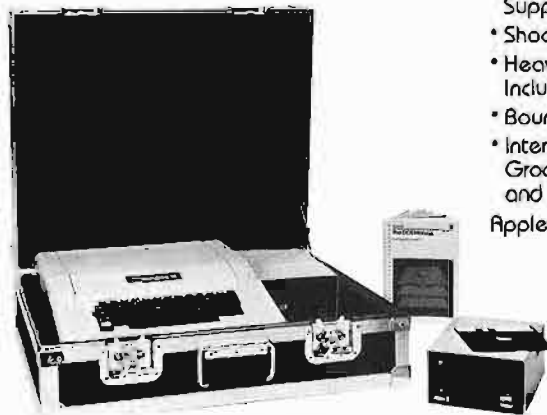
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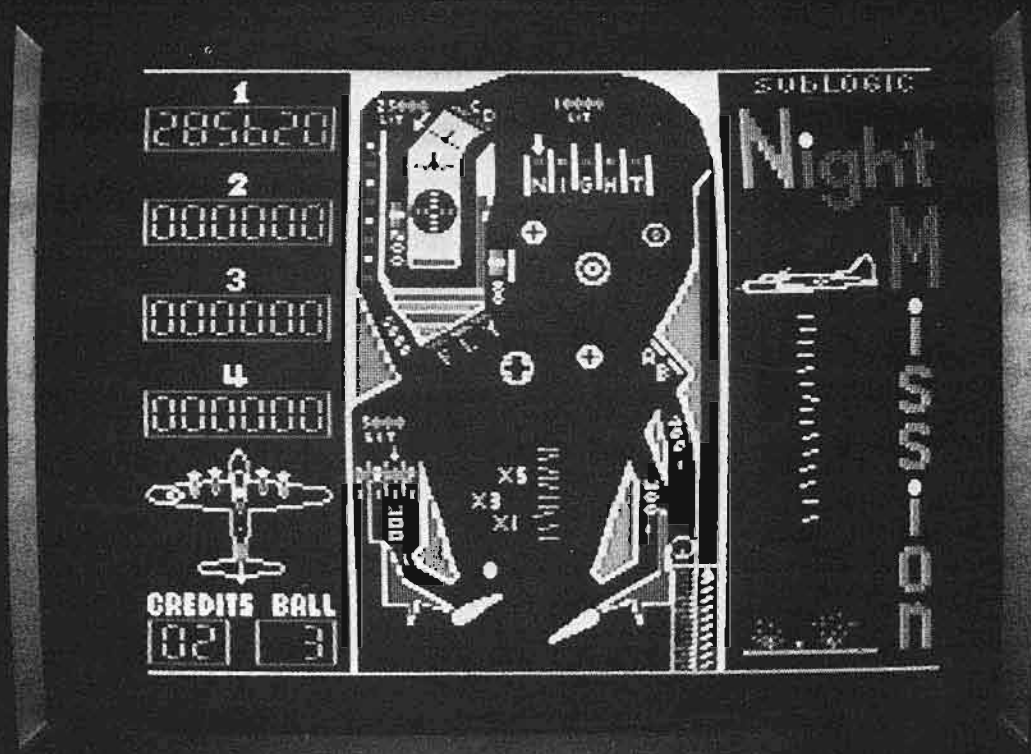
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# A Real Tape Operating System

by Dale De Priest

**The Commodore PET offers one of the most reliable cassette operating systems. This article describes how it works and offers tips on how to get the most in convenience and reliability from the system.**

When I was shopping for a home computer, one of my selection criteria was that the machine not require expensive add-on items, such as a disk drive, before I could use it. Therefore, I needed a suitable cassette system. Unfortunately most cassette systems are either unreliable or very difficult to operate. I decided on the Commodore PET because of its excellent cassette system. However, there are a few tricks to getting the most from the PET's cassette system.

So what makes the PET's system different? First, Commodore modified the standard audio cassette recorder especially for computer use. No tricky adjustment of volume is necessary to read (play) your programs into the machine. Although there is remote control of the cassette drive motor, Commodore's software allows you to regain control of the cassette for manual operation. Finally, an added switch can tell the computer when one of the motion control buttons has been depressed. We will explore each one of these features in detail.

## Dual Cassettes

A disk drive can read a block of data into the machine and then rewrite data out on disk. The PET provides two cassette interfaces for this kind of operation. One interface can be used in the read (play) mode to read in the old data. A second cassette can be placed in the write (record) mode to receive the new data. The computer can have complete control of this operation.

You could also use the second cassette to save a back-up copy of your program at the same time you save the

original, because the PET always sends the data to both cassette interfaces. Unfortunately, if your second drive came from Commodore you can't use this feature; Commodore designed the drive to shut off in the middle of the recording. If you are using another recorder without remote hook-up (a configuration not recommended by Commodore), simply set the second machine to record before you start the first. [Editor's note: A method of modifying standard (less expensive) cassette recorders for use with the PET was described by Jerry Froelich, MICRO 34:81.]

## Header Records

Commodore supports two types of files on the tape. You can store programs on your tape with a special header record that contains the name of your program, or you can store data that will also have a special header record. In addition, data files can be several records long. All header records and all data records are buffered in a special place in memory. Each cassette interface occupies a block of memory 192 bytes in length. The first byte of this buffer contains a code that lets the PET know what kind of record it is processing. The other 191 bytes are the record's actual data. The coding for this byte follows:

1. program header
2. data file
3. not used
4. data header
5. end of tape mark

Note that although program storage itself does not use this buffer, the header record containing the name of the program *does* use the buffer. The program name begins in byte 6 of the header and extends for at least 128 bytes, if needed. Searches (and the resulting displays) will only act upon the first 16 bytes. When I save a program I normally save the date out beyond the 16th position. Bytes 2 and 3 contain the start address for program loading. Bytes 3 and 4 contain the end

address + 1. The normal SAVE command will always default to a start address of 1024. However, SAVES done with the machine language monitor can have any address. Upgrade and 4.0 ROMs behave just a little differently in this area. The default save location is contained in the start-of-BASIC text pointer. This pointer is initialized to point to 1025.

Load commands always use the header data. On a load, the PET can distinguish between a program file and a data file even if they both have the same name. The PET will load your program where the header tells it to. The RUN command, however, always starts executing at the location pointed to by the start-of-BASIC text pointer.

If the PET encounters an end-of-tape header while searching, it will stop and display the "file not found" error message. I find this very useful — it avoids running down the whole length of tape when a program is not found. For this reason I always put an "end-of-tape" mark at the logical end of every tape. There are two ways to do this. One way is to add a 2 at the end of your SAVE command. For example, SAVE "NAME",1,2 will add an end-of-tape mark after saving the program "NAME" on tape number one. The second way is to specify that you want an end-of-tape mark with the OPEN command. Either method will work, but I prefer the second. I always end my tapes with the following command executed in the immediate mode.

```
OPEN 1, 1, 2, "END OF TAPE" : CLOSE 1
```

## Data Files

You can extend the amount of work that can be done with limited memory through the use of data files. Information that would normally occupy memory space in DATA statements can be kept on tape instead. The PET provides for data operations through OPEN statements followed by INPUT# or GET# statements. OPEN tells the computer what you want to do with the file, where the file is, the name of the

file, and the logical number of the file. This number eliminates the need for future commands to repeat all the foregoing data. When a file is opened to read from tape, the computer immediately searches for the file header and then stops. The PET is now positioned correctly in front of the data and knows that you want to read it in. The next INPUT# command to reference that logical file number will read in the first of the data. This command works exactly like the standard INPUT command and is subject to the same 80-character limitation. The GET# command lets you evade this limitation. Since the operating system provides for multiple records in the same file, there must be a special end-of-file indicator. When the file was originally closed, the PET wrote the last of the data on the tape and then added one byte of zero at the end. Since the data is written to tape in ASCII format, there shouldn't be a zero byte in the data. This then becomes the marker for the end of file.

The GET# command works just like the standard GET command except that its data comes from the cassette buffer instead of the keyboard buffer. Therefore, each of the 191 bytes will be read one byte at a time. Remember that the 192nd byte was reserved by the system to indicate that this is a data file. All of the carriage returns and the commas that would normally be ignored by the INPUT# command will be read by the GET# command. For this reason you cannot use the GET# command with numeric variables. Always use string variables for this command.

At this point I would like to take exception to the recommendation in the PET manual that you put the data first if you want to mix data and programs on the same tape. Doing as the manual advises means having to rewind the tape to read in the data after the program has loaded. I always put the data after the program so the program can find it without my help.

When I update files, I always have the program first save itself, and then the data files. I store only one such program and its associated data files on the tape. Therefore, when I open the data file, I set the secondary address so that an end-of-tape header will be written when the file is closed. Note that the SAVE command can be issued by the program. This will not return you to immediate mode, so your program will continue running. Each time I wish to save new data from a program run, I use a different tape. Actually, I alternate between two different tapes — one provides the backup for the other. In this manner, if there is a problem with the SAVE, I'll only lose the last update and not the whole file. I would also recommend that your program keep track of the revision level of the updates. This can be done by incrementing a counter stored as the first record. Revision information can also be stored as a part of the header record when you save it each time. This can be very important if you forget what your last tape was.

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Several data files can be maintained on the same tape. The OPEN statement will search for the proper file by name in the same manner as the LOAD command. The only problem is the time involved. The PET puts about a 13-second gap between files.

### Error Checking

Good error-checking is an essential component in the design of an adequate tape storage system. One approach to error-checking is to add a parity bit to each character as it is written to tape. The parity bit works by counting each bit as it is sent to the cassette and making sure that the total for each character is an odd number. When reading this data, a count can also be performed to verify that all the bits are read. Another way to check data is to count the number of bits in the whole block, then write a character representing this sum on the tape at the end of the block. This is called a "checksum." If you know how many characters were written on the tape, another check would be to insure that the same number is read back. How many of these checks are available on the PET? All of them! They are kept in a status word which may be examined at any time. This status word contains the result of the last input or output operation.

The PET takes error detection one step further because it includes error correction on the tape files. The PET actually stores two copies of every program on the tape. When the tape is read, it not only checks the parity but keeps track of any places with bad parity. When the second pass is reached, it simply substitutes the good data from the second pass for the bad data picked up on the first pass. The PET keeps track of up to 32 bad characters in each record. If this number is exceeded, the load results in an uncorrectable read error. You can check the number of read errors by dividing the number in location 630 by 2 (192 on upgrade and 4.0 PETS). The next location in memory repeats this for the second cassette.

The uncorrectable read error status bit is the only one that will cause a load error. If two data bits are bad in the same character, the correction circuit will miss it. A quick check of ST reveals that the checksum will usually catch this kind of error. For this reason, if you want to be very sure of a good load, insert the following line as the first line of your program:

```
1 IF ST THEN PRINT "ERROR" ST : END
```

You can still run the program by typing in CONT after it stops. A program is stored as one block of data on the tape. Therefore, exceptionally long programs should be avoided if maximum error checking/correcting is desired. Alternately, the monitor can be used to save programs in pieces. The last program piece saved should be the one with the highest address.

Even with all of these schemes we still are not guaranteed to have a good tape. The PET provides a way to make sure the tape can be read by using the VERIFY command. This command reads each character from the tape and compares it with the one in memory. This should insure that the tape was written correctly. Therefore you should always verify a program after you save it.

The VERIFY command can also be used to position the tape. Whenever this command is issued it starts the tape and reads in the next program (or the one specified). The comparison is made without disturbing whatever you have in core. The tape is left positioned just beyond the program — exactly the goal we were trying to achieve. This positioning capability allows us to add programs at the end of the tape, or to modify an existing program and rewrite it in the same place. The PET puts a long leader in between each program so that even if your new version is a little longer, it will still fit. But be careful!

The VIC uses a cassette system that is almost identical to the standard PET. There are only three major differences. First, the VIC only supports one cassette; address 2 is used to support the RS-232 interface. Second, the VIC contains a relocating loader that will automatically start the tape load at the location designated by the start-of-BASIC text pointer. The VIC uses the start and end addresses in the header to calculate the length of the program which is then added to the start-of-BASIC text pointer to arrive at a new end address. The third change is related to the second. Since you might not want a program to be relocated, a new header type has been created. If the first byte of the header contains a three, then the load will work by using the start and end pointers exactly from the program header. This is required when loading most machine language programs.

Please send any comments or questions to the author at the following address: 611 Galen Drive, San Jose, CA 95123.

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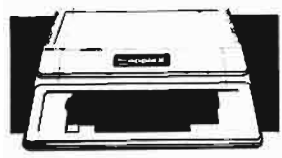
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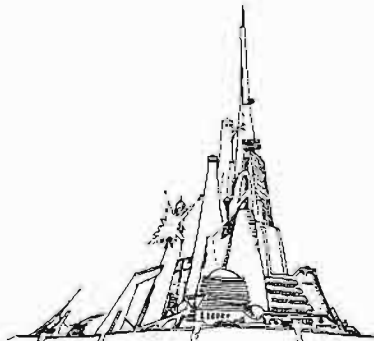
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# COPCOP Single Drive Copier

by Peter Kleijnjan

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requires:  
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A vital mechanism used in this program is the so-called "command file." OS-65D can get its input from a variety of input devices: device #1 is the serial terminal, #2 is the keyboard console, etc. What interests us is device #5 — use of memory as input. This means that you can POKE into memory any sequence of inputs to OS-65D. (Consequently, you can input to BASIC, EM, or even assembler, since they all use OS-65D routines.) Control can then be transferred to memory by giving the "IO 10,02" command.

COPCOP first collects the data it needs to copy a disk, and then builds a command file using these data. This

command file resides from \$4800 upwards (figure 1). It uses the "getkey" routine at \$252B to halt execution when you have to exchange diskettes.

What is the advantage of this technique over simple DOS commands embedded (with DISK!" ") in the BASIC program? After control has been transferred to the command file, the BASIC program itself isn't needed anymore! Nor is the 8K BASIC interpreter. This saves enough memory (about 10K) to enable copying of four more tracks at a time.

Listing 1 is the program itself. Lines 100-273 extract necessary information from both the operator and the source disk (the "original"). The latter is

achieved by use of the "DI xx" DOS-command, which prints a sector map of track xx. Lines 500-590 are a subroutine that prints a sector directory for all requested tracks.

Lines 1000-1280 contain the diskette copy subroutine. This routine calls 2000-2130, which adds a single pass (one series of CALLs and SAVEs) to the command file. 5000-5130 prints an appropriate CALL or SAVE command to the command file, and 7000-7060 converts a page number to a full hexadecimal address.

Please address correspondence to Kleijnjan Consultants BV, Kerkwetering 11, 3421 TS Oudewater, The Netherlands.

## Listing 1

```
1 REM COPCOP RELEASED 24-48K, 14.0. IN, RUNS ALSO IN V3.2MOD
2 POKE123,71:RUN14
3 FORI=1TO20:PRINT:NEXT
4 PRINT"**** COPY COPY ****":FORI=1TO7:PRINT:NEXT
5 PRINT"-----"
6 PRINT"Kleijnjan Consultants (c) 1980"
7 PRINT"-----":PRINT
8 PRINT"This program contains a FORMAT LISTER and a DISKETTE COPIER."
9 PRINT"The copier has facilities to copy track zero and to";
10 PRINT" initialize":PRINT:"before write."
11 PRINT
12 POKE2893,28:POKE2894,11:POKE2895,0:POKE2896,0
13 DIMD$(39,8):CR$=CHR$(13):MA=INT((PEEK(8950)-29)/8)
14 X$=""
15 PRINT:PRINT"Which "+X$+" tracks should NOT be copied or listed?"
16 INPUT"(XX-YY) (RETURN to continue)":K$:PRINT
17 IFK$=""THEN120
18 IFLEN(K$)()5THENPRINT:PRINT"--LENGTH ERROR--":GOTO112
19 FT=VAL(LEFT$(K$,2)):LT=VAL(RIGHT$(K$,2))
20 FORI=FTTOLT:D$(I,1)="N":NEXT
21 X$="other ":GOTO112
22 PRINT:PRINT"Insert the disk you want copied, then hit any key."
23 I=0:PRINT:DISK!"DO 252B":PRINT
24 I=I+1
25 IFI=40THEN280
26 IFD$(I,1)="N"THEN122
27 I$=STR$(I)
28 I$=RIGHT$(I$,"0")+RIGHT$(I$,LEN(I$)-1),2)
29 DISK!"ME D100,D100
30 DISK!"IO ,10
31 DISK!"DI "+I$
32 DISK!"IO ,02
33 PRINT#5:PRINT#5,"*"
34 DISK!"ME D100,D100
35 INPUT#5,A$
36 IFLEFT$(A$,3)="TRA"ORAS$=""THEN220
37 IFA$=""*THEN270
```

(Continued on next page)



Listing 1 (Continued)

```

250 SN=VAL(MID$(A$,2,2))
260 D$(1,SN)=RIGHT$(A$,1):GOTO220
270 DISK!"ME D100,D100"
271 X$="":FORK=1TOS:X$=X$+X$:NEXT
272 PRINT#5,X$;:PRINT#9
273 GOTO122
280 PRINT:INPUT"Format listing";X$:PRINT
290 IFLEFT$(X$,1)="Y"ORLEFT$(X$,1)="J"THENGOSUB500
300 PRINT:INPUT"Copy diskette";X$:PRINT
310 IFLEFT$(X$,1)() "N"THENX$="":GOSUB1000
320 END
500 PRINT:INPUT"List on printer";X$
501 IFLEFT$(X$,1)() "Y"THEN#2:GOTO503
502 D=1
503 FORJ=1TOS9
505 IFD$(J,1)="N"THENS80
510 PRINT#D,"Track";J;
520 IFD$(J,1)=""THENPRINT#D,TAB(12);"Missing header":GOTO580
530 K=0
540 K=K+1
550 IFD$(J,K)=""OR#9THENS80
560 PRINT#D,TAB(12);"sector";K;": ";D$(J,K);" page(s)"
570 GOTO540
580 NEXTJ
590 PRINT:PRINT:RETURN
998 DATA2,10,18,26,56,64,80,88,96,104,112,120,128,136,144
999 DATA152,160,168,176,184
1000 REM--COPY SUBROUTINE
1080 DISK!"ME F000,4800":PRINT#5,"EXIT":CR$;:PRINT#9
1090 TF=1:PRINT:INPUT"Initialize before write (Y/N)":IX$:PRINT
1092 PRINT"-Just a few seconds.":PRINT
1095 GOSUB2000
1096 TL=I-1:IFCN=0THEN1150
1097 PRINT#5,CR$;"Place original";CR$;:PRINT#9
1098 PRINT#5,"GO 252B";CR$;:PRINT#9
1100 X$="CALL":GOSUB5000
1105 PRINT#5,CR$;"Place copy";CR$;:PRINT#9
1110 PRINT#5,"GO 252B";CR$;:PRINT#9
1120 X$="SAVE":GOSUB5000
1135 TF=TL+1
1140 IFTF<40THEN1095
1150 INPUT"Track zero copy";IK$:IFLEFT$(K$,1)() "Y"THEN1240
1160 PRINT#5,CR$;"Place systemdisk";CR$;"GO 252B";CR$;
1164 PRINT#5,"CA 0200=13,1";CR$;CR$;"Place original";CR$;
1168 PRINT#5,"GO 252B";CR$;"GO 0200";CR$;"2";CR$;"R4000";CR$;
1170 PRINT#5,"E";CR$;CR$;"Place copy";CR$;:PRINT#9
1174 PRINT#5,"GO 252B";CR$;"GO 0200";CR$;"2";CR$;
1178 PRINT#5,"W4000/2200,8";CR$;"E";CR$;:PRINT#9
1240 POKE10944,78:POKE10945,81:POKE10946,42
1250 PRINT#5,"GO FFA0"
1260 PRINT:PRINT"Press any key to start and to continue."
1280 DISK!"ME 4800,F000":DISK!"IO 10,02":RETURN
2000 I=TF:CN=0
2005 IFI<39THEN2120
2010 IFD$(I,1)=""ORD$(I,1)="N"THENI=I+1:GOTO2005
2020 READFV
2030 K=1
2040 GOSUB7000:REM CONVERT FV TO F$: 10 BECOMES 0A00
2050 IFD$(I,K)=""OR#9THEN2100
2060 FV=FV+VAL(D$(I,K))
2070 D$(I,K)=F$+ "/" +D$(I,K)
2080 K=K+1
2090 GOTO2040
2100 I=I+1:CN=CN+1
2110 IFCN(MATHEN2005
2120 RESTORE
2130 RETURN
5000 FORJ=TFTOTL
5010 K=1
5020 IFD$(J,K)=""ORD$(J,K)="N"THENS120
5030 C$=LEFT$(D$(J,K),4)
5040 J$=STR$(J):J$=RIGHT$("0"+RIGHT$(J$,LEN(J$)-1),2)
5050 K$=RIGHT$(STR$(K),1)
5060 IFX$="CALL"THENS085
5070 IFIX$() "Y"OR#1ITHENS080
5075 PRINT#5,"IN "+J$;CR$;:PRINT#9
5080 PRINT#5,"SA "+J$+" "+K$+"="+D$(J,K);CR$;:PRINT#9:GOTO5090
5085 PRINT#5,"CA "+C$+"="+J$+" "+K$;CR$;:PRINT#9
5090 K=K+1
5110 IFK(MATHEN5020
5120 NEXT:RETURN
7000 X=INT(FV/16)+48
7010 IFX<57THENX=X+7
7020 LD%=CHR$(X)
7030 X=FV-16*INT(FV/16)+48
7040 IFX<57THENX=X+7
7050 F$=LD$+CHR$(X)+"00":RETURN

```

MICRO

```

EXIT
02 TRACK.
A*__
A*Place original
A*GO 252B
A*CA 0200 = 12,1
A*CA 0300 = 12,2
...
...
A*CA 3000 = 19,1
A*__
A*Place copy
A*GO 252B
A*SA 12,1 = 0200/1
A*SA 12,2 = 0300/1
...
...
A*SA 19,1 = 3000/8
A*__
A*Place original
(etc.)

```

Figure 1: OS-85D command file: Input from memory (from the actual command file) is underlined. The instructions ("Place copy") are only for the benefit of the operator.

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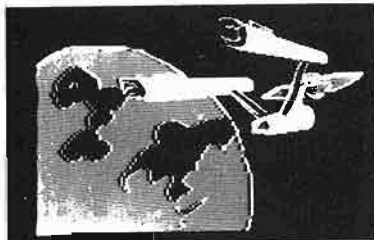
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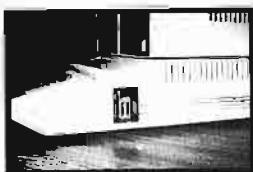
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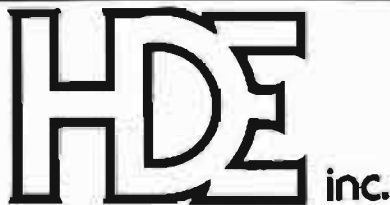
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# Votrax Interface for SYM

by John Valente

**Interface the Votrax Speech Synthesizer to your system's VIA. Although intended for a SYM-1, the techniques described are readily adaptable to other systems using a 6522.**

## VOTRAX DRIVER

requires:

SYM-1

Sweet Talker Votrax Interface Board

It is adaptable to other systems (such as AIM) with 6522 VIA.

The Votrax SC-01 Speech Synthesizer IC lets you experiment with computer-generated speech at a reasonable cost. The Sweet Talker board, which includes the Votrax IC, allows easy interfacing to most computers. It is available from The Micro Mint, Inc., 917 Midway, Woodmere, NY 11598. While I will be describing the interface of the Votrax to my SYM-1 6522 VIA, the programs can be readily adapted to other systems using the 6522. This article provides a machine language driver, followed by a BASIC program to convert the mnemonics for each phoneme of speech into the numerical codes needed by Votrax. (A phoneme is one of the smallest units of speech that distinguishes one word from another; i.e., the *m* in *mat* and *b* in *bat*.)

Communication with the Votrax IC resembles a parallel printer interface with handshaking. Figure 1 shows the connections between the 6522 and the Sweet Talker board. This example uses VIA #2, port A, accessed through the SYM's "AA" connector. Any other VIA port can be used as long as all eight data bits and the two control lines are available. Be sure the Sweet Talker is connected to your power supply.

Bits zero through five form the code which tells Votrax which phoneme to synthesize. Bits six and seven select

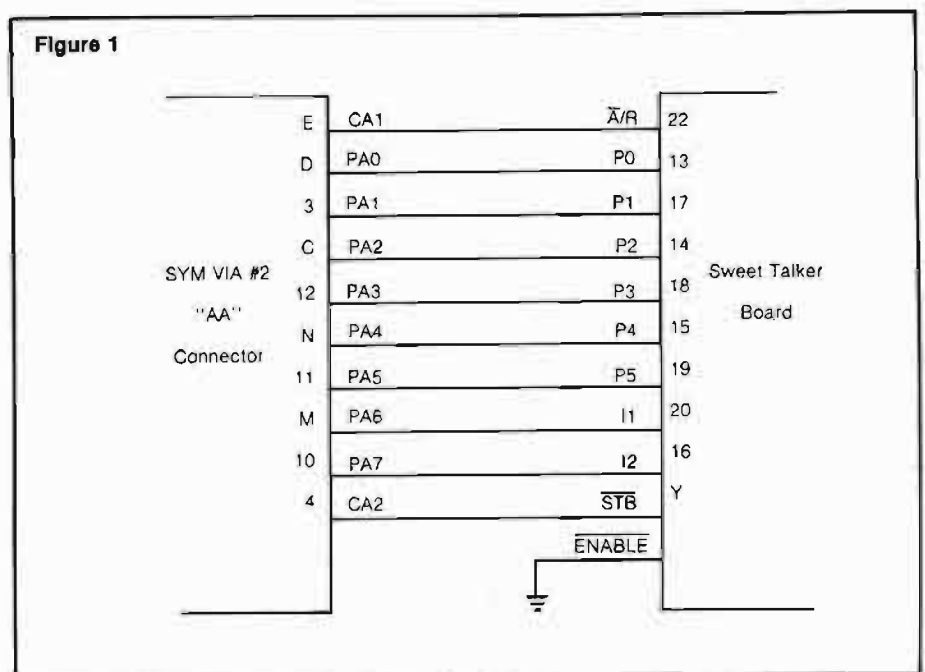
one of four pitch levels for the voice. Control line CA2 latches the data into the Votrax IC and starts synthesis. After the phoneme has sounded,  $\bar{A}/R$  goes high. The CA1 line on the 6522 senses this transition and generates an interrupt, causing the next phoneme code to be sent out. This process repeats until a "stop" code (\$3F) is sent. The  $\bar{ENABLE}$  line is not used and is grounded to allow the board to operate.

Listing 1 sends a sequence of phoneme codes to the Sweet Talker with the proper timing of control signals. It is written in RAE - 1 format (SYM's Resident Assembler and Editor). The sequence of phonemes is limited to 256, due to the eight-bit length of the X index register. A block of memory to store the values for PITCH and the sequence of phonemes starting at PHONEME is reserved following the program. If you relocate this routine, you need only change the references to these locations. If your 6522 is at a different location, the register addresses will have to be modified accordingly.

The program begins by pointing the IRQ vector to the INT routine. The SYM requires a JSR ACCESS before this operation. Then, interrupts are temporarily disabled and the 6522 Interrupt Enable Register (IER) is set up to generate an IRQ on the rising edge of CA1. The port is then configured for output.

You must send the first phoneme code manually. The X register, which is used to index into the PHONEME list, is set to zero. The next few lines of code are needed because of a timing restraint in the Votrax chip. After sending data to Votrax, wait at least 450 nsec before sending a strobe pulse to latch it. Since the 6522 normally waits only 300 nsec before pulsing, the handshake/strobe is first inhibited by sending a \$01 to the Peripheral Control Register (PCR). The phoneme data is fetched from the list, OR'ed with the value of PITCH to select the voice, and sent down the line. Now the handshake is enabled by sending a \$0B to the PCR. A dummy read of the port outputs the pulse, and by now much more than the required 450 nsec has elapsed.

Figure 1





After the phoneme has sounded, the CA1 line goes high and forces an interrupt. In the INT routine, the same manipulation of the handshake occurs to insure proper timing. The X register is incremented to point to the next phoneme code, and the data is fetched. But we don't want to OR the code with the value of PITCH if the "stop" code is encountered. After checking for this, the data and handshake are sent out as before. Conveniently, the dummy read at 1060 leaves the latest phoneme code in the accumulator.

As the program exits the INT routine, it loops continuously to IDLE until the "stop" code is found. Then the IER is altered to ignore further interrupts and the IRQ vector is restored to its original value. The address given is for the SYM's Supermon 1.1. Finally, control is restored to the calling program.

You can use this program directly by entering phoneme codes through the monitor, starting at address PHONEME and ending with \$3F to end the speech. A value of \$00, \$40, \$80 or \$C0 must be entered at location PITCH. Try using the random values in memory as a phoneme list; you will hear some very bizarre sounds.

To compose intelligible words, however, it is more convenient to use mnemonic codes for each phoneme because these are closer to English. Listing 2, a BASIC program, prompts for the standard Votrax mnemonics, translates them into the proper numerical code, then places them sequentially into the PHONEME block. A call to the machine language driver produces the speech. Remember to reserve space for the machine language routine plus 257 bytes before entering BASIC.

The program is written in Synertek Bas-1, but is easily translated into other BASICs. The &"xxxx" is Bas-1's convention for hexadecimal numbers, and X=USR (address,0) calls a machine language routine. Lines 10-40 list the standard Votrax mnemonics, and lines 130-150 READ them into an array for later comparison. Lines 105-115 assign the machine language addresses to variables; simply change these lines to conform to any relocation you have made. Lines 500-540 prompt for the desired phoneme, search for a match, and then POKe the corresponding code into the PHONEME list. When you enter STOP in answer to the prompt, the program asks you to select a pitch

### Listing 1: Votrax Driver — Assembly Language Listing

```

;          VOTRAX DRIVER
;
;          by John Valente   Box 9  Marlboro VT 05344
;          Written September 1981
;
;          The following addresses are for VIA #2 on the SYM-1.
;          Change as required for your system.
;
PAD        .DE $A801    ;Port A, VIA #2
PADD       .DE $A803    ;Port A data direction
PCR        .DE $A80C    ;Peripheral Control Register
IER        .DE $A80E    ;Interrupt Enable Register
;
;          The following are SYM Supermon 1.1 references:
;
ACCESS     .DE $8886    ;Needed to change vectors
IRQVEC     .DE $A67E    ;IRQ vector
IRQORIG    .DE $800F    ;Original IRQ service routine
           .BA $1000    ;Program origin
           .DS          ;Save object code
;
;          Program starts here:
;
1000- 20 B6 8E  START  JSR ACCESS    ;Change IRQVEC: point to INT
1003- A9 48          LDA #L,INT
1005- 8D 7E A6      STA IRQVEC
1008- A9 10          LDA #H,INT
100A- 8D 7F A6      STA IRQVEC+1
100D- 7B            SEI                ;Prevent interrupts for now
100E- A9 82          LDA #%10000010 Enable interrupts on CA1 edge
1010- BD 0E AB      STA IER
1013- A9 FF          LDA #0FF          ;Set VIA port A for output
1015- 8D 03 AB      STA PADD
1018- A2 00          FIRST  LDX #00          ;Initialize phoneme list pointer
101A- A9 01          LDA #%00000001 Disable handshake/strobe
101C- 8D 0C AB      STA PCR
101F- BD 85 10      LDA PHONEME,X Get first phoneme code
1022- 0D 64 10      ORA PITCH     ;Determine pitch
1025- 8D 01 AB      STA PAD        ;Send code to Votrax
1028- A9 08          LDA #%00001011 Now enable handshake/strobe
102A- 8D 0C AB      STA PCR
102D- AD 01 AB      LDA PAD        ;Dummy read: force handshake/strobe
1030- 58            CLI                ;Now allow interrupts
1031- C9 3F          IDLE   CMP #03F      ;Found STOP code yet?
1033- F0 03          BEQ RETURN    ;Yes, exit
1035- B8            CLV                ;No, loop until found
1036- 50 F9          BVC IDLE
1038- A9 02          RETURN  LDA #%00000010 Disable VIA interrupt
103A- 8D 0E AB      STA IER
103D- A9 0F          LDA #L,IRQORIG Restore original IRQ vector
103F- 8D 7E A6      STA IRQVEC
1042- A9 A6          LDA #H,IRQVEC
1044- 8D 7F A6      STA IRQVEC+1
1047- 60            RTS                ;Return to calling program
;
;          Interrupt Service Routine follows:
;
1048- A9 01          INT    LDA #%00000001 Disable handshake as before
104A- 8D 0C AB      STA PCR
104D- E8            INX                ;Increment pointer to phoneme list
104E- 8D 65 10      LDA PHONEME,X Get next phoneme code
1051- C9 3F          CMP #03F      ;Is it the STOP code?
1053- F0 03          BEQ NOMASK     ;Yes, leave it alone
1055- 0D 64 10      MASK  ORA PITCH     ;No, set the pitch
1058- 8D 01 AB      NOMASK STA PAD        ;Send code to Votrax
105B- A9 08          LDA #%00001011 Now enable handshake/strobe
105D- 8D 0C AB      STA PCR
1060- AD 01 AB      LDA PAD        ;Send strobe:phoneme code in Accum.
1063- 40            DONE   RTI                ;Go back and wait
;
1064-                PITCH  .DS 1          ;Reserve a space for pitch value
1065-                PHONEME .DS 256      ;Reserve a page for phoneme codes
           .EN

```

### Listing 2: Votrax Phoneme Translator — BASIC Listing and Sample Run

```
1 REM VOTRAX PHONEME TRANSLATOR
2 REM WRITTEN BY JOHN VALENTE BOX 9 MARLBORO VT 05344
3 REM SEPTEMBER 1981
10 DATA EH3,EH2,EH1,PA0,DT,A2,A1,ZH,AH2,I3,I2,I1,M,N,B,U
20 DATA CH,SH,Z,AW1,NG,AH1,OO1,OO,L,K,J,H,G,F,D,S
30 DATA A,AY,Y1,UH3,AH,P,O,I,U,Y,T,R,E,W,AE,AE1
40 DATA AW2,UH2,UH1,UH,O2,O1,IU,U1,THV,TH,ER,EH,E1,AW,PA1,STOP
100 DIM T$(63)
105 M=&"1000":REM ADDRESS OF MACHINE LANGUAGE ROUTINE
110 L=&"1065":REM ADDRESS OF START OF PHONEME LIST
115 V=&"1064":REM ADDRESS OF PITCH VALUE
120 FOR A=0 TO 63
130 READ P$
140 T$(A)=P$
150 NEXT A
500 Y=0:INPUT "PHONEME ? ";X$
510 IF X$="STOP" THEN 700
520 IF T$(Y)=X$ THEN POKE L,Y:L=L+1:GOTO 500
525 REM SUBSCRIPT OF MATCHED STRING IS CORRECT PHONEME CODE
530 Y=Y+1
535 IF Y>63 THEN PRINT "NOT A VALID PHONEME. TRY AGAIN. ":GOTO 500
540 GOTO 520
700 POKE L,63
710 PRINT "SELECT PITCH OF VOICE: "
712 PRINT "TYPE EITHER 0,64,128 OR 192 (LOWEST TO HIGHEST PITCH)"
714 INPUT P
715 POKE V,P
720 INPUT "TYPE ANY LETTER AND 'RETURN' TO HEAR YOUR WORD.":D$
730 X=USR(M,0)
740 END
```

OK  
RUN  
PHONEME ? H  
PHONEME ? EH1  
PHONEME ? EH3  
PHONEME ? LK  
NOT A VALID PHONEME. TRY AGAIN.  
PHONEME ? L  
PHONEME ? O  
PHONEME ? STOP  
SELECT PITCH OF VOICE:  
TYPE EITHER 0,64,128 OR 192 (LOWEST TO HIGHEST PITCH)  
? 64  
TYPE ANY LETTER AND 'RETURN' TO HEAR YOUR WORD.R

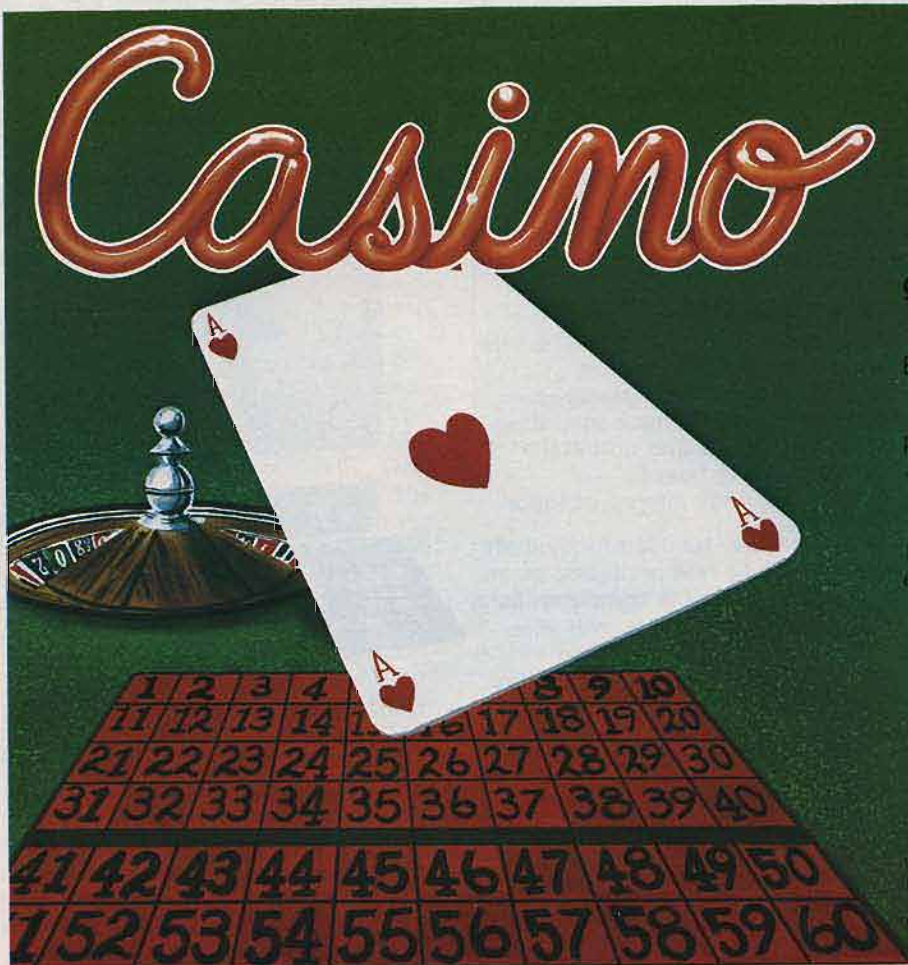
for the voice. After responding to line 720, the machine language driver is called and you will hear the result.

I suggest experimenting with single words before assembling long messages. I think you will find that the components of human speech are very complex. Two words which rhyme to our ears are often composed of different series of phonemes. What might seem to be a simple vowel sound is sometimes a series of two or even three different phonemes. Be sure to include pauses between words (two different pause mnemonics are available).

*VOTRAX is a trademark of Federal Screw Works, Inc.*

John Valente is interested in using the computer to generate sounds and musical structures unavailable in conventional instruments. He has been published in *Electronotes, Newsletter of the Musical Engineering Group*. You can write to Valente at Box 9, Marlboro, VT 05344.

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# 6508 — A New 6502 Configuration

by Ralph Tenny

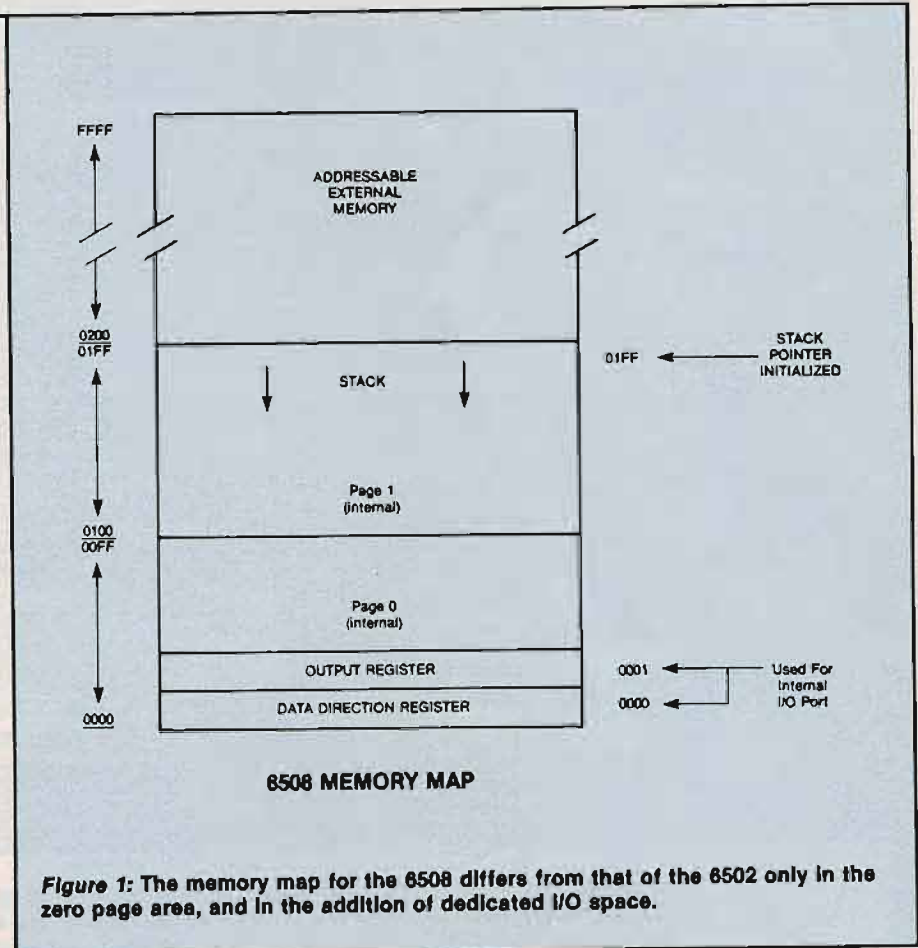
**This new configuration of the 6502 will stimulate a number of very innovative designs, including multiprocessing and two-chip designs.**

At long last, there is an improved version of the 6502. The Commodore Semiconductor Group (formerly MOS Technology) has produced the 6508 microcomputer without adding any new instructions.

This 40-pin IC is the familiar 6502 (actually, the 6512, which requires an off-chip clock) with 256 bytes of read/write memory, eight I/O pins and a full complement of address and data lines. In addition, the address lines can be tri-stated to facilitate DMA (Direct Memory Access) operations. Thus, with eight I/O lines and AEC (Address Enable Control) to control the address and data lines during DMA operations, a total of nine functions have been added to the package.

Because of necessary pinout changes, the following functions are no longer available: NMI, RDY, SYNC, S.O., Ø2 Out and DBE. Actually, DBE (Data Bus Available) is used on the 6512 to furnish compatibility with the 6800, and is replaced with AEC. The 6512 has three  $V_{ss}$  pins, two of which are on the 6508. The one remaining pin fills a formerly unused pin, thus giving a full eight pins for the I/O port.

The I/O port is situated at \$0000 (Data Direction Register) and \$0001 (Output Register). This location for the port has a number of advantages. I/O operations will be faster and have shorter drive routines, since zero page addressing can be used. However, setting the port to input can result in external hardware that enters data



**Figure 1: The memory map for the 6508 differs from that of the 6502 only in the zero page area, and in the addition of dedicated I/O space.**

directly into memory, with no intervention by the processor. A recent article detailed the following additional possibilities for the 6508:

1. Multi-processor operation with overlapped memory operations.
2. I/O lines used as segment addresses for over 1 megabyte addressing.
3. I/O lines used as vector inputs for vectored interrupts.
4. I/O lines used to arbitrate interrupt priorities.
5. Internal memory used to operate supervisory programs during DMA.

The following material has been adapted from the 6508 data sheet, and is used with permission of Commodore:

Figure 1 shows the 6508 memory map. Note that page 0 and page 1 overlap in the 256 bytes of on-board read/write memory. Also, the zero page area is further depleted by two addresses used by the I/O port. Otherwise, the entire 64K of memory space is available for typical 6502 uses.



Figure 2 is a block diagram of the 6508, showing the internal architecture of the processor. This is almost identical to the 6502, except for the obvious addition of I/O port and read/write memory.

Figure 2 is a block diagram of the 6508, showing the internal architecture of the processor. This is almost identical to the 6502, except for the obvious addition of I/O port and read/write memory.

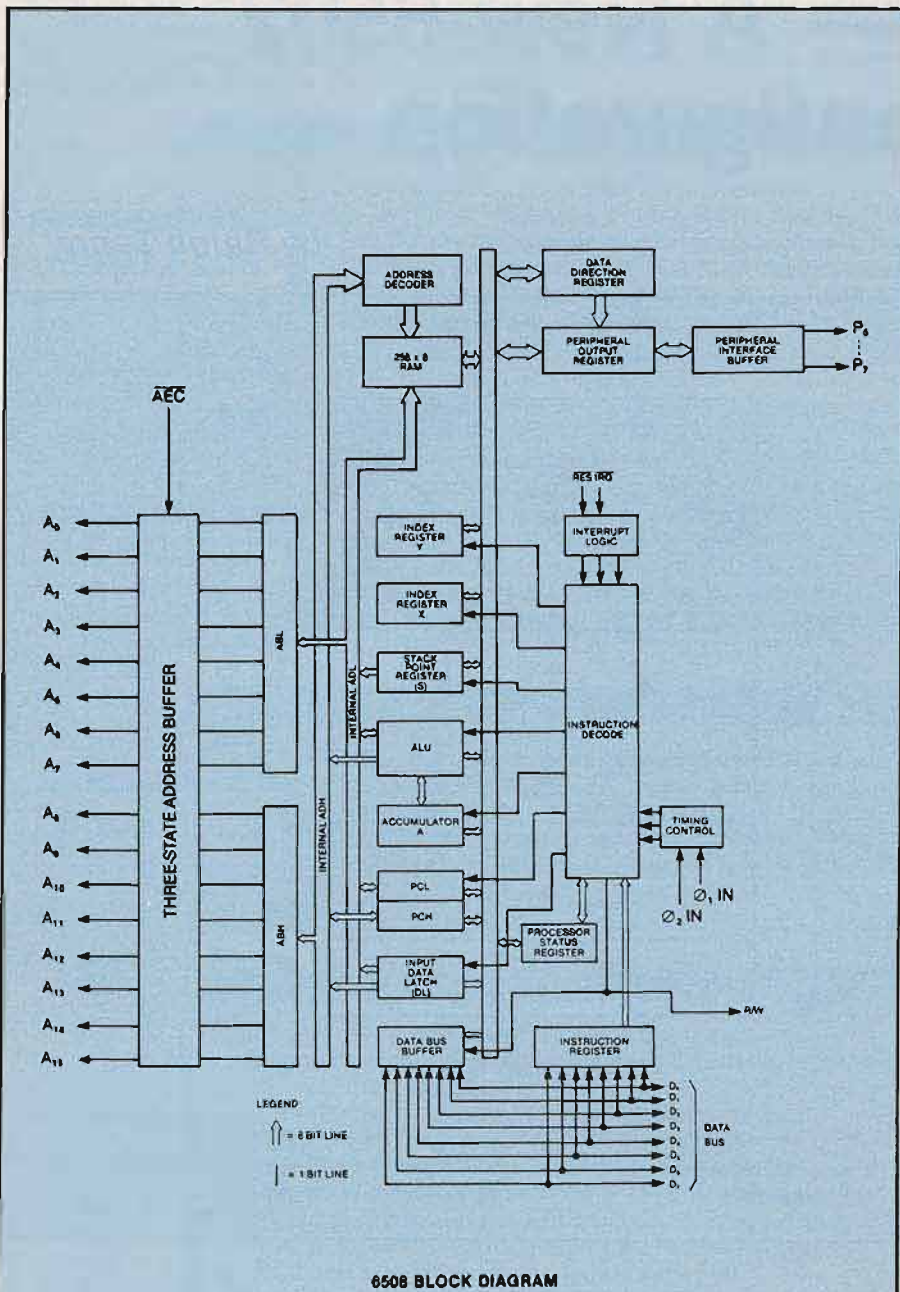


Figure 2: Block diagram for the 6508. Obvious additions — Data Direction Register, Peripheral Output Register and associated buffers, and page zero Read/Write memory.

RES	1	40	0, IN
0, IN	2	39	R/W
IRQ	3	38	DB <sub>0</sub>
AEC	4	37	DB <sub>1</sub>
VDD	5	36	DB <sub>2</sub>
A <sub>0</sub>	6	35	DB <sub>3</sub>
A <sub>1</sub>	7	34	DB <sub>4</sub>
A <sub>2</sub>	8	33	DB <sub>5</sub>
A <sub>3</sub>	9	32	DB <sub>6</sub>
A <sub>4</sub>	10	31	DB <sub>7</sub>
A <sub>5</sub>	11	30	P <sub>0</sub>
A <sub>6</sub>	12	29	P <sub>1</sub>
A <sub>7</sub>	13	28	P <sub>2</sub>
A <sub>8</sub>	14	27	P <sub>3</sub>
A <sub>9</sub>	15	26	P <sub>4</sub>
A <sub>10</sub>	16	25	P <sub>5</sub>
A <sub>11</sub>	17	24	P <sub>6</sub>
A <sub>12</sub>	18	23	P <sub>7</sub>
A <sub>13</sub>	19	22	A <sub>15</sub>
VSS	20	21	A <sub>14</sub>

Figure 3: New pinout assignments are quite different for the 6508; see text for additional details.

Figure 3 shows the pinout of the 6508.

I expect the 6508 to be used in innovative designs, both in controller-type applications, and in more sophisticated data communications projects. The greatest advance I see for the controller field is that two-chip designs are possible, if eight or fewer I/O lines are required. In the past, nearly every single-chip processor implementation has required at least three ICs. With the 6508, you need add only an EPROM!

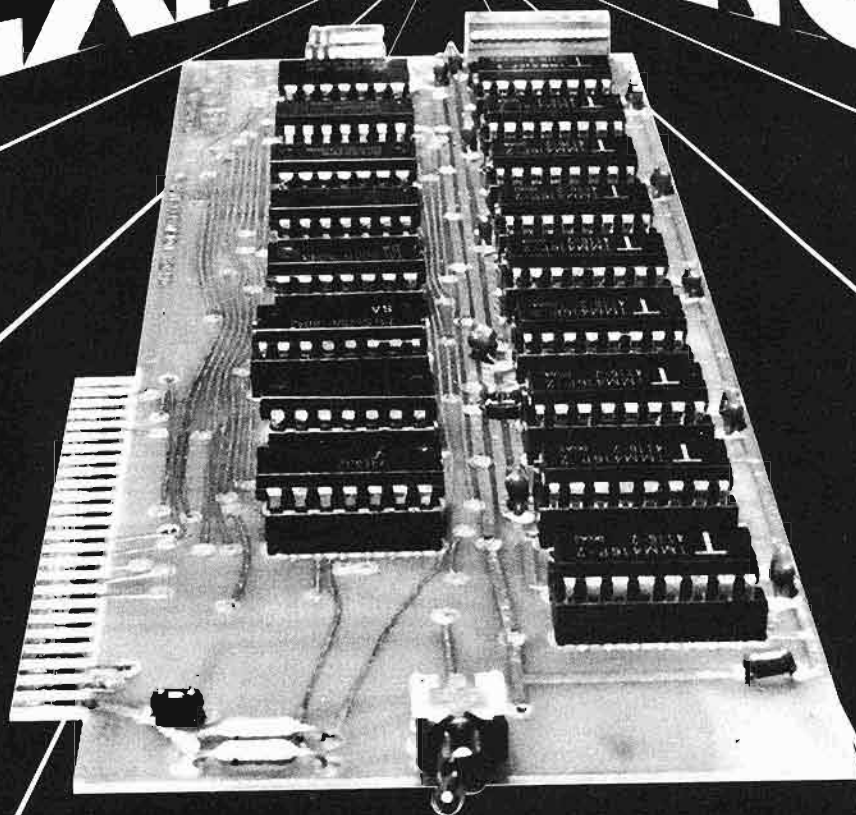
### Reference

- Enhanced CPU's memory, I/O expand its applications; *Electronic Design News*, August 19, 1981, G. Venkatesh, Commodore Semiconductor Group.

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# Time of Day the Easy Way

by Martin De George

If you add the new 6526 Complex Interface Adaptor chip to your computer, you'll have processor-independent real time available. You may also substitute the 6526 for an existing 6522.

The demonstration program included is written for OSI. The hardware is applicable to any 6502 computer.

Until now I have been reluctant to implement a real-time clock (RTC) on my system because it was just too much bother, both from software and hardware standpoints. With my OSI system I need a chain of dividers to divide the system clock down and interrupt the system periodically, say every second, so that a routine is executed which updates a counter. It is then necessary to check the counter for rollover at 60, or convert an N-bit number to TOD each time you would like to know the time. Besides this chore, there is the not so trivial problem of ruining a disk access if you allow interrupts during these times. If you disable interrupts during disk access, it is very possible that you will miss an interrupt if you do a lot of disk access. I wanted a TOD chip that was easy to install and access without tying up my system with unnecessary overhead.

Just recently the people at Commodore introduced a gem of a chip called the 6526 Complex Interface Adapter (CIA). Don't let the name scare you; it's only complex in what it can do, not in how to do it.

Basically this device is a sophisticated 6522 like those found on the AIM and many other computers. The one major difference is that it contains a time-of-day clock function which reads

Table 1: Register Functions of 6526

Register Address	Name	Use
0	PRA	Peripheral Data Register A
1	PRB	Peripheral Data Register B
2	DDRA	Data Direction Register A
3	DDRB	Data Direction Register B
4	TA LO	Timer A LO
5	TA HI	Timer A HI
6	TB LO	Timer B LO
7	TB HI	Timer B HI
8	TOD 10ths	Time of Day Tenths of a Second
9	TOD SEC	Time of Day Seconds
A	TOD MIN	Time of Day Minutes
B	TOD HR	Time of Day Hours
C	SRD	Serial Data Register
D	ICR	Interrupt Control Register
E	CRA	Control Register A
F	CRB	Control Register B

out TOD in Hours, Minutes, Seconds, and Tenths of Seconds. It is only a 12-hour timer, but it has an AM/PM bit so you can easily convert to 24-hour time as well. Much to the credit of the people at Commodore, the pin-outs of the 6526 are nearly identical to those of the 6522. Figure 1 shows the pin-outs for the 6526 and the 6522 where there is a difference. In a system which does not make heavy use of the hand-shaking functions, a 6526 is directly hardware-replaceable for a 6522. Also, most of the internal workings of the 6526 are nearly identical to the 6522. Many of the registers have the same names and functions, although different addresses. Table 1 is a listing of the register names and functions of the 6526.

I would like to concentrate on the time-of-day clock. This clock consists of four time registers with addresses \$08-\$0B for tenths of a second, seconds, minutes, and hours respectively. There are also two control registers, CRA and CRB (see table 2), which are used for initialization of the TOD clock and other functions. Each time register is written to and read out in BCD (binary coded decimal) which makes it easy for driving displays, but a slight

problem for BASIC. The TOD clock requires an external TTL signal of 50 or 60 Hz to operate. The choice of 50 or 60 Hz is programmable by bit 7 of CRA.

Besides the TOD function there is also an alarm mode which allows an interrupt to be generated at any given time. The alarm time is written into the same registers that the TOD is written to, except that bit 7 of CRB is set to 1 for setting the alarm. CRB 7 set to 0 allows access of the time registers.

As previously mentioned, proper function of the TOD clock requires an external TTL level clock on pin 19 (labelled TOD). The TOD pin on the 6526 is where CB2 is on the 6522. There are a number of ways to generate a reference signal for the TOD clock: 1. divide the processor clock down with counters, 2. use the 16-bit counters on the 6526 to divide the system clock, and 3. pick off the 60 Hz AC line voltage and convert it to TTL levels. I don't like number one because it involves adding too many extra chips to my system. Number 2 wastes the counters in the 6526, which are more useful in other applications. Therefore, I have chosen number 3.

You'll see two ways to implement a 60 Hz clock for the AC line in figure 2. I use the circuit in figure 2a since I have a transformer in my system with a secondary voltage less than 60V peak-to-peak (the limit for the inputs of the 1489 receiver). This circuit works because all of the power supplies in my OSI system have a common ground. If you don't have a spare 1489 in your system, the circuit in figure 2b will work just as well. Here you are not as limited to input voltages; just pick the resistor value that keeps the current into the base of the transistor and diode within the limits for the components used. Almost any transistor will work. I use a 2N2222. Whatever method you use, make sure you *never* connect directly to the 100V AC lines. Use a transformer or opto-isolator. You will keep yourself and computer from an untimely end.

To provide a clearer idea of how to use the 6526, I have included a simple program written in BASIC (see listing 1). This program lets you set the time of day and display the time in an endless loop. It merely serves as a guide to set up the 6526 in the time mode. To achieve the proper setting and reading of the time registers, the Hours register must be written to or read first. On a write to Hours the TOD clock is stopped and not restarted until there is a write to the Tenths of a Second register. This assures that the clock starts at the intended instant. Reading from the Hours register causes all data to be latched until the Tenths register is read. If it is not necessary to read the hours, the other registers may be read but the data will not be latched.

The 6526 is so easy to use that I was able to unplug my 6522, plug in the 6526, and make the necessary connections in about ten minutes. Shortly thereafter I had a real system TOD clock complete with interrupts. Not only do I have a TOD clock in my system with no processor overhead to keep track of the time, but I have also retained all of the major functions of the 6522 which I was previously using. Not bad for the few hours I invested to bring it up.

At the time I wrote this article, the 6526 was not yet widely available. The price should be about \$10 for the 1 MHz version.

---

Martin DeGeorge may be contacted at Threshold Technology, 1829 Underwood Blvd., Delran, New Jersey 08075.

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### Listing 1

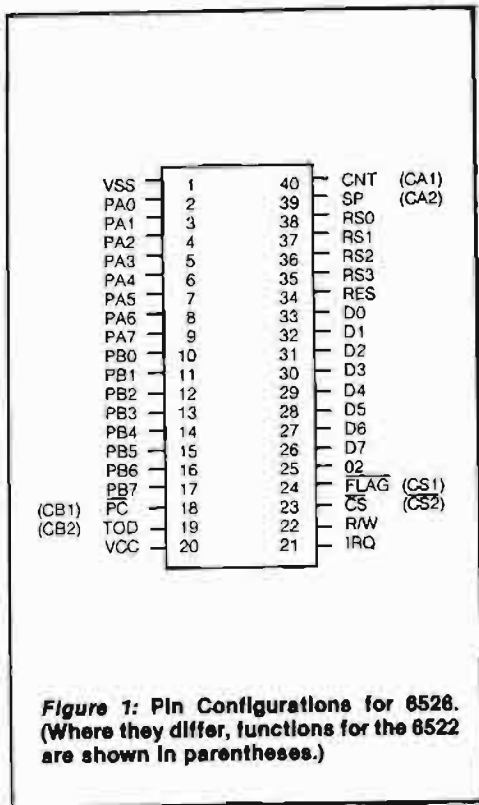
```

10 REM 6526 ROUTINES
20 CIA=63232 : REM BASE ADDRESS OF 6526 = $F700
30 POKE CIA+2,00 : POKE CIA+3,00 : REM SET ALL I/O AS INPUT
40 REM
50 REM SET UP TIME OF DAY CLOCK
60 POKE CIA+14,0 : REM 60 HZ MODE
70 POKE CIA+15,0 : REM TOD ALARM OFF
80 INPUT "ENTER TIME OF DAY HH,MM,SS "; HH,MM,SS
90 IF HH>24 THEN PRINT "IMPROPER HOURS": GOTO 80
100 UH=0: PM=0
110 IF HH>11 THEN HH=HH-12 : PM=1 : REM CHECK IF AFTER NOON
120 IF HH>? THEN HH=HH-10:UH=1: REM IF HOURS>10 SPLIT 10'S & 1'S
130 HH=128*PM+16*UH+HH: REM SET PM BIT IF AFTER NOON PM=BIT 7
140 IF MM>60 THEN PRINT "IMPROPER MINUTES": GOTO 80
150 REM BREAK MINUTES INTO 10'S AND 1'S
160 MM=MM/10
170 UM=INT(MM) : REM 10'S OF MINUTES (UPPER NIBBLE)
180 XN=(MM-UM)*10
190 XN=XN+00000001
200 LM=INT(XN) : REM 1'S OF MINUTES (LOWER NIBBLE)
210 MM=UM*16+LM : REM MAKE UM AND LM NIBBLES INTO BYTE
220 REM
230 IF SS>60 THEN PRINT "IMPROPER SECONDS": GOTO 80
240 SS=SS/10
250 US=INT(SS) : REM 10'S OF SECONDS (UPPER NIBBLE)
260 XN=(SS-US)*10
270 XN=XN+00000001
280 LS=INT(XN) : REM 1'S OF SECONDS (LOWER NIBBLE)
290 SS=US*16+LS : REM MAKE US AND LS NIBBLES INTO BYTE
300 REM
310 REM PUT VALUES INTO 6526
320 POKE CIA+11,HH
330 POKE CIA+10,MM
340 POKE CIA+9,SS
350 POKE CIA+8,00 : REM TENTHS WHICH START CLOCK
360 REM
370 REM READ OUT CLOCK
380 HH=PEEK(CIA+11) : REM READ HOURS - LATCH TIME REGISTERS
390 MM=PEEK(CIA+10) : REM READ MINUTES
400 SS=PEEK(CIA+9) : REM READ SECONDS
410 TS=PEEK(CIA+8) : REM READ TENTHS OF SECONDS
420 TH=0: TT=0
430 IF (HH AND 128)>0 THEN TH=1: REM CHECK PM BIT 1=AFTER 12:00
440 IF (HH AND 16)>0 THEN TT=1: REM HOURS > 10 ?
450 HH=12*TH+10*TT+(HH AND 15): REM ADD ALL HOURS
460 REM CONVERT MINUTES
470 UM=MM AND 112: REM MASK OUT 10'S OF MINUTES
480 UM=UM/16 : REM CONVERT 10'S OF MINUTES
490 LM=MM AND 15 : REM MASK OUT 1'S OF MINUTES
500 MM=LM*10+LM : REM ADD 10'S *10 + 1' OF MINUTES
510 REM CONVERT SECONDS SAME AS MINUTES
520 US=SS AND 112
530 US=US/16
540 LS=SS AND 15
550 SS=US*10+LS
560 TS=TS AND 15 : GET TENTHS OF SECONDS
570 PRINT HH; MM; SS; TS
580 GOTO 380 : REM ENDLESS LOOP
590 END

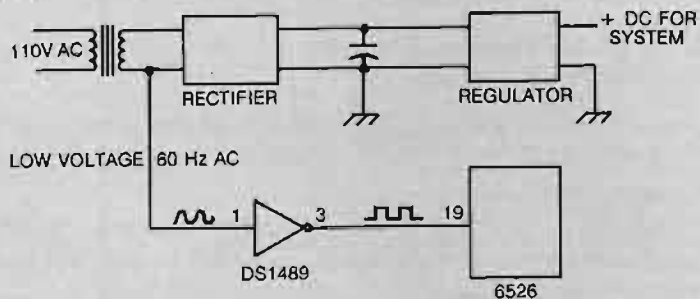
```

**Editor's Note:** The value assigned to CIA in line 20 applies to the author's system. Use a value appropriate for your installation.

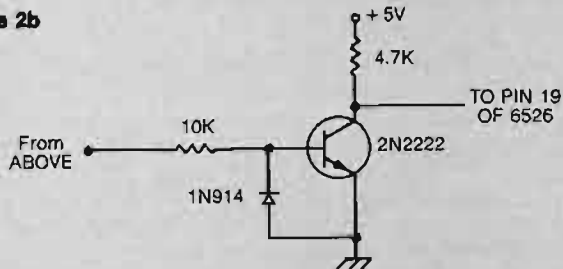




**Figure 2a**



**Figure 2b**



**Figure 2: 60 Hz TTL Signal Generation from Low Voltage ac.**

**Table 2: Control Register Bit Actions**

Bit Position	Name	Function for bit = 1 or 0
CRA7	START CLOCK	1 = start timer A 0 = start timer B
CRA6	SPMODE	1 = serial output on pin 39 0 = serial input on pin 39
CRA5	INMODE	1 = timer A counts on negative transition of 39 0 = timer A counts on 02 pulses
CRA4	LOAD	1 = force load of timer prescaler 0 = no effect
CRA3	RUN MODE	1 = timer countdown to 0 generates interrupt and stops 0 = timer countdown to 0 generates interrupt and continues
CRA2	OUT MODE	1 = toggle of output to port B on timer underflow 0 = pulse output of port B on timer underflow
CRA1	PBON	1 = timer A output to PB6 0 = PB6 normal I/O
CRA0	START	1 = start timer A 0 = stop timer A
CRB0-CRB4		Similar function as CRA0-CRA4 for timer B except CRB1 which controls timer B out to PB7
CRB5,6	INMODE	Bits on CRB5 and CRB6 select input mode of timer B
CRB7	ALARM	1 = set alarm time on write to TOD registers 0 = set TOD on write to TOD registers

**CRB6 CRB5 Timer B Counts On:**

0	0	02 pulses
0	1	negative transitions on CNT
1	0	timer A underflow
1	1	timer A underflow while CNT = 0

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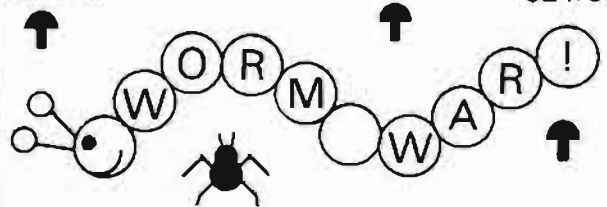


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# Programmable Reverse Video for the C1P

by Charles L. Stanford

**This article shows you how to add programmable reverse video to your C1P. The modification involves some programming, and adding circuitry to your computer.**

## REVERSE VIDEO requires:

OSI C1P or Superboard (600 Board)

The reverse video option requires modification to your C1P, some additional circuitry and some software. This modification requires above-average skills in electronic construction, as well as substantial programming ability. While I've tried to make the actual changes on the main board as easy and risk-free as possible, it's still very close to the equivalent of minor brain surgery on your best friend.

## OSI's Video System

Unlike many other machines, the C1P video refresh is completely hardware-based. In other words, the microprocessor devotes no time or effort toward keeping a proper display on the screen, but modifies the video RAM only when required to do so by the program. As a result, the video display has no undesirable streaks caused by software timesharing. We are, however, unable to make relatively simple program changes to achieve full control of the image.

## Programmable Reverse Circuit Description

The circuit is relatively simple. It requires only three chips, can fit on a very small add-on board, and allows you to convert your computer back

almost instantly to its original hardware configuration. It does cost a little in lost versatility: the upper 128 graphics characters are "lost" to use while the video reverse switch is closed. I have found that to be no inconvenience since we generally use the reverse video to enhance programs that use alpha-numerics only.

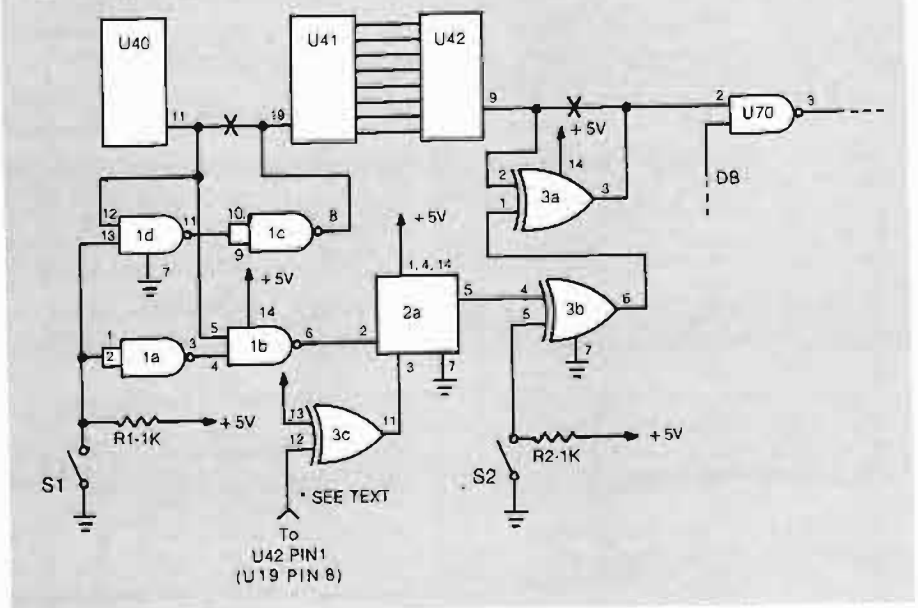
The add-on circuit primarily consists of three elements: the detector, the latch, and the inverter. The detector is connected, in series, with the most significant bit of the video data. As shown in figure 1, NAND gates 1b and 1d each detect the status of the bit. Treatment of the bit is also conditioned by the status of switch S1. IC1d either inverts it or ignores it; IC1b either detects it or ignores it. If S1a is open, the bit is passed along through IC1c and appears unchanged to character generator U41. Likewise, IC1b ignores it and its output remains high.

IC2a, half of a dual-D flip-flop, acts as a latch. It is clocked by the same latching signal used by U42, the parallel-serial shift register, and retains the status throughout the time needed to send one character to the screen.

The inverter uses two gates of a very versatile IC — the 7486 "exclusive OR" chip. In this circuit, it acts as both an inverter and a non-inverting gate. IC3a passes the serial video signal unchanged as long as pin 1 is held high, but pulling that pin low causes the signal to invert! In a similar manner, IC3b is used to condition the signal from the detector and the latch circuits. Holding switch S2 high allows the signal from the latch to pass. Closing the switch inverts the output, effectively causing the image to be inverted constantly.

The net result of this circuit is to allow four conditions. When both

Figure 1: Reverse Video Modification





switches are open, the computer acts normally. Closing S1 inverts those characters which have a "1" in the left-most bit position (bit 7). Closing S2 inverts the entire screen. Closing both causes the characters which have bit 7 high to be normal, and the remainder to be inverted.

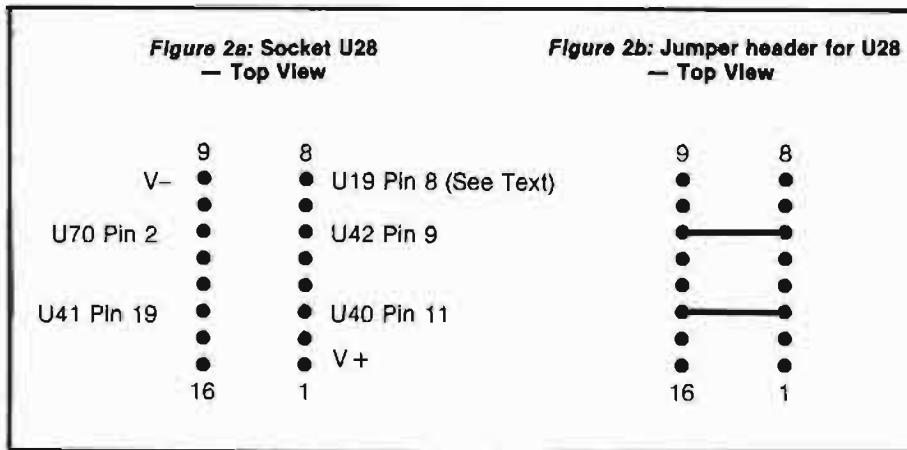
As I mentioned before, the price of this reverse video capability is the loss of the top 128 graphics characters. As long as switch S1 is open, the entire 256-character font of the character generator ROM is available. But closing that switch causes any character with a code greater than 127 (7F hex) to have the most significant bit detected and changed to low. Then the lower 128 show up on the screen normally, and the upper half show up as their inverted complements. For example, POKEing the graphics character 51 (\$33) to a screen location will cause the character "3" to appear. POKEing the character 179 (\$B3) with switch S1 closed will cause an inverted "3" to show. Essentially, the top bit is checked, stripped off, and changed to "0". If the same sequence is performed with S1 open, the graphics character normally corresponding to 179 will appear.

### Modifying the 600 Board

Since I am always leery of damaging the PC board while making additions and modifications, I used an "add-on" board for this project. In addition, I devised a plug-in method that restores the main board almost instantly to its original configuration. As shown in figure 1, only two traces on the main board need to be cut. These are marked by an "X". Then wires are run from either side of the cuts to prototype socket U28. By connecting the leads as shown in figure 2a, a properly jumpered DIP header can be used as a shunt in place of the plug from the add-on board, restoring normal operation.

Start by installing a 16-pin solder-tail IC socket at U28. Be sure to use a low-wattage pencil-type iron, and practice on an old board if you're rusty. Next, cut the traces. It's best to use a jeweler's loupe or other magnifying lens, and carefully scratch away about 1/8 inch of the trace with a sharp knife blade. First, cut the line on the top of the board (component side) between U40 pin 11 and U41 pin 19. It starts at U40, but soon runs under U41's socket. Cut it about 1/4 inch from pin 11 of U40.

Now, find the trace that leaves U70 pin 2 and heads for the keyboard. It only runs one inch before passing through



the board. [Remember the location of this plated-through hole. It will be used later.] The trace now runs on the bottom toward the right, and again passes through to the top. It runs from there toward the front again, ending at U42 pin 9. Cut the trace on the bottom of the board near the hole by U70.

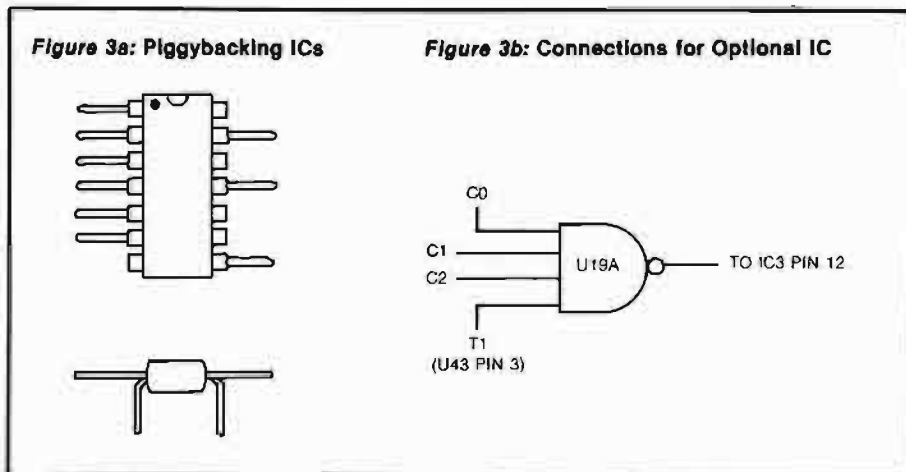
Next, connect the socket at U28. Using fine-gauge insulated wire, connect each pin as shown in figure 2. It's easier to connect U40 and U41 by slipping the wire down into the sockets at the proper pin, than to try to solder to the small bit of PC board trace showing. If necessary, remove the ICs, exercising great care. For the other jumpers, use the two holes where the trace passes to the bottom of the board for your wire connections. Note that a connection to U42 pin 1 is marked "see text." I suggest that you use figures 1 and 2 as they appear until the new display reveals timing problems serious enough to require the fourth IC shown in figure 3. So for now, hook U42 pin 1 (which also connects to U19 pin 8) to U28 pin 8. Connect the positive and negative buses to pins 1 and 9, respectively.

Finally, solder jumper wires across a 16-pin DIP header as shown in figure 2b. Install the header, and try your computer. It should work normally. If not, troubleshooting should be easy since you've only made minimal changes.

### Building the PC Board

Several techniques can be used to build your board. In this case, wirewrap is probably the best option. Equipment and supplies are readily available and are easy to use. It is essential to use a check list or schematic, and carefully check all connections when finished. Check the board under power first *without* ICs, and then *with* ICs, and measure current drain with a good volt/ohmmeter. Insert the ICs correctly. These TTL ICs will take a lot, but they cannot stand even a short period of inverse voltage, so make sure they get inserted properly.

The switch(es) can be mounted on your keyboard near either the left or right rear (just below the nameplate). When drilling, be very careful not to



mar the finish or get metallic cuttings in the works. Use stranded insulated wire to connect the small board with the switch and on the second IC header. It's not a bad idea to use some sort of socket/plug in the leads to the switch if you expect to disassemble your machine very often; it cuts down the stretching and bending of the wires.

## Testing the Add-On

Have the TV or monitor warmed up before the computer is powered. Then, if the screen doesn't show a reasonable display, turn the power off immediately and check all wiring very carefully. Using an ohmmeter, make sure every point is properly connected to, and *only* to, the proper other points.

Since your machine will have been without power for some time, the RAM will probably be well-scrambled, and at least a few graphics characters will appear. Don't hit Break at this time; try the switches, and get a feel for the way they work.

This is also the time to look for any timing problems. Compare the reversed characters with the OSI *Graphics Reference Manual*. If the timing from U19 pin 8 is delayed too much by passing through ICs 2 and 3, the screen will reverse a bit late, and change back a bit late. Reversal of characters in a row will only be noticeable at the beginning of the first row and the end of the last. This phenomenon occurs when the signal from U42 is reversed just slightly out of sync with the latch trigger from NAND gate U19. Two solutions are possible. Since the cause of the delay is the extra gate transmission time in IC2a, IC3b, and IC3a, using faster gates will help. The very fast throughput of 74S-ICs reduces differential delay to the point that it is virtually unnoticeable on the screen.

The disadvantages here are extra cost, the difficulty of finding Schottky chips, and additional power drain. Since I couldn't wait for a mail-order delivery taking several weeks, another solution seemed practical — equalize the delay. This was done by installing another 74LS20 on top of U19 with all but pins 7, 9, 10, 12, and 14 bent out so they don't make contact. This is called "piggybacking" and is a neat and effective way to add additional circuits to an existing board.

As shown on the 600 board schematic, U19 uses the gating of C0, C1, C2, and T3 to trigger the latch in the parallel-serial shift register U42. T3 is merely the clock signal delayed through three gates to match delays already present in the video circuits. It's obvious that a lesser delay in the trigger to latch IC3 might even things out. Accordingly, U19A piggybacked to U19 can use three of the signals, and pin 13 can be connected to U43 pin 1, the T1 signal (clock with only one gate of delay). Use pin 8 of U19A instead of pin 8 of U19 to trigger latch IC2a. U43 has some solder pads that make connection of the jumper very convenient. To prevent damage to the ICs, be sure to put a dab of solder on each of the pins common to U19 and U19A. Again, a good magnifying glass is invaluable. Pins 1 through 6 are left unconnected.

When you test the computer again, carefully check the reversed characters

### Listing 1

```

10 REM -VIDEO REVERSE DEMO
20 INPUT "ENTER A STRING";X$
30 A$ = X$: GOSUB 220:X$ = A$
40 PRINT X$
50 INPUT "ENTER A NUMBER";X
60 A = X: GOSUB 200:X$ = A$
70 PRINT X$
99 END
200 REM -REVERSE NUMBERS
210 A$ = STR$(A)
220 REM -REVERSE STRINGS
230 B$ = "": FOR X = 1 TO LEN(A$)
240 C$ = CHR$(ASC(MID$(A$,X,1)) OR 128)
250 B$ = B$ + C$: NEXT X
260 A$ = B$: RETURN

```

### Listing 2

```

;REVERSE VIDEO ROUTINE
;
;BY CHARLES STANFORD
;
CTRLI EPZ $09 ;CONTROL I CHARACTER
LF EPZ $0A ;LINE FEED
CR EPZ $0D ;CARRIAGE RETURN
ESC EPZ $1B ;ESCAPE CHARACTER
BRANCH EPZ $F7 ;LBLE + 1
;
OUTPUT EQU $FF69 ;MONITOR OUTPUT ROUTINE
GETCHR EQU $FFBA ;GET CHARACTER ROUTINE
;
ORG $D8
;
00D8 20 BA FF JSR GETCHR ;GET A CHARACTER
00DB C9 09 CMP #CTRLI ;IS IT A CONTROL-I?
00DD D0 05 BNE LBLE
00DF A2 00 LDX #$00 ;IF YES, MODIFY BRANCH
00E1 86 F7 STX BRANCH ; TO REVERSE CHARACTERS
00E3 60 RTS
00E4 C9 1B LBLE CMP #ESC ;IS IT ESCAPE?
00E6 D0 04 BNE LBLE
00E8 A2 02 LDX #$02 ;IF YES, RESET BRANCH TO
00EA 86 F7 STX BRANCH ; TO DISPLAY NORMAL CHARACTERS
00EC 60 LBLE RTS
00ED C9 0D CMP #CR ;IS OUTPUT CHAR A CR?
00EF F0 09 BEQ LBLE
00F1 C9 0A CMP #LF ;LINE FEED?
00F3 F0 05 BEQ LBLE
00F5 18 CLC
00F6 90 02 LBLE BCC LBLE ;BRANCH ALWAYS (MODIFIED ABOVE)
)
00FB 09 80 ORA #$80 ;SET HIGH BIT ONLY IF CTRL-I
00FA 4C 69 FF LBLE JMP OUTPUT ;TO MONITOR OUTPUT ROUTINE
00FD FND

```

### Listing 3

```

3000 REM -MACH LANG REVERSE VIDEO ROUTINE
3010 POKE 536,216: POKE 537,0
3020 POKE 538,237: POKE 539,0
3030 FOR M = 216 TO 252: READ D: POKE M,D: NEXT
3040 DATA 32,186,255,201,9,208,5,162,0,134,247,96,201,27,208,4
3050 DATA 162,2,134,247,96,201,13,240,9,201,10,240,5,24,144,2
3060 DATA 9,128,76,105,255

```

to be sure that they are completely in sync with the reversing circuit. You may find it necessary to use the clock itself, or T2, but T1 seems to be just about right.

## Programming Techniques

There are at least half a dozen ways to use BASIC or machine language software to capitalize on your new character reversing capability. Using the CHR\$, ASC, LEN, and MID\$ functions, entire strings can be readily inverted by a relatively short and straightforward subroutine. The demonstration program in listing 1 can also be used in a game or financial planning program to highlight certain inputs or headings. Either inputs or internal strings will reverse, and numeric variables can also be reversed by using the STR\$ function.

The machine language program in listing 2 is quite a bit more sophisticated. It can reside in the unused (by BASIC) RAM at the top of page zero, but remember that the monitor does use the space when you break. The program intercepts both the "character-get" and the "screen-write" routines of

BASIC by changing the indirect addresses at \$0218 and \$021A. Then the data can be processed as needed for reverse video.

When the routine is in place, the first five lines get the character from the keyboard as usual, and only act if either the control-I or escape key is detected. The control-I causes the routine starting at \$00E4 to force a "1" into the left bit of the character. Once the control-I is pressed, every character coming from either the keyboard or the ACIA will be inverted before being passed to the screen output or program storage. Hitting the escape key will return action to normal.

Notice that the routine is set to ignore carriage returns and line feeds. All other characters get the "reverse" treatment. Thus, be careful to use it only for those items which go to the screen or are within quotes. Trying to invert characters involved in program entry will badly confuse the BASIC interpreter, and lead to a program crash.

If you are familiar with the method Microsoft uses to store BASIC Source

Code starting at \$0300, you will be able to devise methods of actually changing the characters by modifying the program itself. Without going into details, it isn't too hard to write a BASIC program that will scan the source code for a particular line number, and then invert any characters between quotation marks within that line. I'm sure that you will find many creative ways to use this new capability.

## Parts List

R1, R2 — 1KOhm ¼ watt  
 IC1 — 74LS00  
 IC2 — 74LS74 (option 74S74, see text)  
 IC3 — 74LS86 (option 74S86, see text)  
 IC4 — (optional — 74LS20)  
 S1, S2 — SPST miniature toggle switches (Radio Shack 275-324)  
 S1A — optional in place of S1 and S2 SPDT center off min toggle switch (Radio Shack 275-325)  
 Misc. — PC board, IC sockets, IC header, Molex connector, wire, etc.

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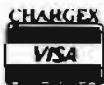
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# Structured Programming in BASIC09

by Brian Capouch

**The BASIC09 programming language, designed after the beginning of the microcomputer revolution, fully exploits the advantages to be gained from both structured programming techniques and user interaction. BASIC09 is available for the 6800/6809-based OS-9 operating systems.**

Here where I live, in the heart of the country, my digital computer, with its busy little clock ticking away two million times in a second, provides an interesting counterpoint to the natural processes that go on around me. Many of these processes exist in geologic time that is measured in eons. In an attempt to teach the youth of my community to program computers, I encourage them to avoid getting their psyches all wrapped up in those 500-nanosecond ticks. Many programmers I know treat each upcoming software deadline as if it were the end of the world as they know it. I propose that programming should be approached in the casual manner of the old-time mechanic, who feels that sitting down under a tree and thinking about a problem for a few minutes every once in a while speeds the hand when the actual work must get done.

It is certain that many points of common ground exist between practitioners of our local homey arts and computer programmers. All concerned find themselves engaged in behavior that revolves around cyclic processes. Crops are planted and harvested, motors run, break down and are repaired, and, alas, the same programs are written, with minor variations, again and again. Farmers and mechanics have always seemed to me to be more inured to this cycling than programmers — and with good reason. The programmer should not be compared to the farmer but to the blacksmith, since his job is to create tools for others to use. It would be a poor blacksmith who blindly returned to his drawing-boards to design each successive plowshare from scratch.

## Elements of Structure in Programs

To alleviate this problem, recent history has seen the rise of "structured programming." Although this term has been overused, it nonetheless suggests an attempt to program scientifically, and thus is to be welcomed.

Although there are almost as many definitions of the meaning of structured programming as there are practitioners of it, several points of agreement exist regarding its essential elements. The first is *modularity*. Decomposing a problem into its elemental parts makes it easier to define separate problem-solving stages, or modules, for each problem segment. It is surprising that programmers have been so slow to acknowledge explicitly the value of this common sense approach.

Modularity also has another virtue, given a powerful enough language. Routine modules can be maintained in libraries and used as building blocks in programs. It is impossible to discuss this topic without mentioning a classic work in this field, *Software Tools*, by Brian Kernighan and P.J. Plauger. This book takes the topic of modularity from theory into practice, providing hundreds of examples of simple tools that can be combined into very complex and powerful programs. Their original book, which features examples written in the psuedo-language Ratfor, has been augmented by a recent edition in Pascal. I like to challenge my students who are just experiencing the heady transition from neophyte into programmer to "come back and talk to me when you can discuss *Software Tools*."

Another important structuring technique is that of *blocking*, which simply means writing an easy-to-read program. More than one sage programmer has ranked readability as the most indispensable characteristic of top-quality code. It is this aspect of structuring that is most likely to be ignored by the beginner, as he reassures himself

that "I'll be the only one reading this program anyway, and I will be able to remember what it was I was doing." Beginners are almost always romantics, and after shooting himself in the foot often enough anyone will begin looking at either his gun or his trigger finger.

Both of these aspects of structured programming imply that computer programs must be regarded as tools and thus treated as capital goods that will be maintained, instead of expendable consumption items that will be used once and then discarded. I could handily retire on the wages paid each year to programmers to refamiliarize themselves with programs that they had thought finished at some earlier point in time. The basis of structured programming, then, is the belief that software tools should be built in logical increments and that these modules should be self-documenting.

## Man and Machine Interacting

An editorial column that appeared in the newspaper *Infoworld* last summer has provided me with fodder for hours of introspection. That column spent several inches wondering about how the hardware practice of having terminal displays with 80-character lines had ever evolved. A number of theories were presented and examined before the writer admitted that he just plain didn't know. As I was reading, I noticed an IBM punch card grinning at me furiously from a box of old college mementos. "These kids," it seemed to say.

This anecdote points up a fact about the modern computer world that is every bit as novel as the microcomputer: The idea of real-time interaction between user and machine. My students find it as hard to believe my recollections of the "submit cards-get printout-change cards-submit cards" cycle that programming used to require, as they do my bragging about having to use a crank-style telephone during my youth. And all credulity vanishes when they find out that people still program like that today.



Microcomputers are set apart from previous computers by the accessibility they provide to an interactive experience. These topics are discussed thoroughly in a recent book by P.J. Brown entitled *Writing Interactive Compilers and Interpreters*. In it, Dr. Brown examines the concept of interactivity in general, and discusses how compilers and interpreters can be constructed to enhance interactivity. This book is interesting even if you are not planning to write a compiler. It offers incredibly keen insight into the process of programming.

Dr. Brown's observations are valuable in two respects. First, his advice on writing interactive processors is as applicable to applications programmers as it is to systems programmers. Second, he specifies what he considers to be an ideal, yet practical, interactive language.

### Enter BASIC09

Almost every ideal function that Dr. Brown discusses in his excellent book is actually available in a real programming language, BASIC09. This language was written for the 6809 microprocessor by the Microware Corporation to run on their OS-9 operating system. Although I had been using BASIC09 for a year before I came upon Dr. Brown's book, and was thus well acquainted with the amazing power that the language possesses, it wasn't until I read his description of "ideals" that the rationale behind many of its features became fully apparent.

BASIC09 is more than a programming language, and it is certainly much more than BASIC. It consists of an integrated package of processors that includes a multi-pass compiler, a powerful text editor, and a run-time debugger that is entered automatically on the generation of an error. Technically speaking, it is both a compiler and interpreter, as it compiles source code into an optimized I-code which is then interpreted by a run-time processor. Syntactic features give it the programming power found in many modern, highly structured languages, while it retains compatibility with almost all standard-syntax BASICs. What follows is a brief description of those features, although it is impossible within the space of this article to provide more than a whirlwind tour of its spectacular power.

Note that the operating system under which BASIC09 runs is every bit as advanced and wondrous as the language I am about to describe. Readers are referred to an earlier article in MICRO (42:81) for an overview of this multi-user, multi-tasking, Unix-like operating system.

### Listing 1

```
PROCEDURE multiply
0000 (* Program to demonstrate "EXITIF-ENDEXIT" and "LOOP-ENDLOOP"
003D (* Multiplies two real numbers input by user; prints product
0079 DIM multiplier,multiplicand,product:REAL
0088 PRINT "Enter numbers to be multiplied"
00AA PRINT "(Second number '0' to quit"
00C8 LOOP
00CA INPUT multiplicand,multiplier
00D3 EXITIF multiplier=0 THEN
00E4 PRINT "It was nice working for you"
00FF PRINT "Goodbye"
010A ENDEXIT
010E product=multiplicand*multiplier
011A PRINT product
011F ENDLOOP
0123 END
```

### Listing 2

```
PROCEDURE powers
0000 (* Procedure to demonstrate nested "IF-THEN-(ELSE)-ENDIF" construct
0043 (* Takes input value to given power
0066 DIM value,result:REAL
0071 DIM power:INTEGER
0078 PRINT "Program to print powers of real numbers"
00A3 PRINT "Maximum=3; Enter '0' for power to quit"
00C0 LOOP
00CF INPUT "Enter value ",value
00E3 INPUT "Enter power ",power
00F7 EXITIF power=0 THEN
0103 PRINT "Nice working for you--goodbyte!!"
0127 ENDEXIT
012B IF power=1 THEN
0137 result=value
013F ELSE
0143 IF power=2 THEN
014F result=value*value
015B ELSE
015F IF power=3 THEN
016B result=value*value*value
017B ELSE
017F PRINT "ILLEGAL VALUE!!!"
0193 result=0
019B ENDIF
019D ENDIF
019F ENDIF
01A1 PRINT result
01A6 ENDLOOP
01AA END
```

### Listing 3

```
PROCEDURE getname
0000 (* Demonstrate complex data types
0021 (* Input data into a complex name-address structure
0054 TYPE item=name,address(2):STRING(40); zip:REAL
0073 DIM record:item
007C PRINT "Please enter items as requested"
009F PRINT "Enter 'RETURN' for name to end session"
00C9 LOOP
00CB INPUT "Enter name ",record.name
00E2 EXITIF record.name="" THEN
00F1 ENDEXIT
00F5 INPUT "Line 1 Address ",record.address(1)
0112 INPUT "Line 2 Address ",record.address(2)
012F INPUT "Zip Code ",record.zip
0144 RUN displayname(record)
014E ENDLOOP
0152 END
```

### Listing 4

```
PROCEDURE convert
0000 (* Example of implicit type conversion
0026 (* Converts input string into equivalent ASCII decimal codes
0062 TYPE simple=item:STRING(32)
0072 TYPE complex=ascii_code(32):BYTE
0082 DIM first:simple
008B DIM second:complex
0094 PRINT "This procedure converts strings to decimal ASCII values"
00CF INPUT "Enter a string <32 characters ",first.item
00F9 second=first
0101 FOR index=1 TO LEN(first.item)
0118 PRINT second,ascii_code(index); " -";
012A NEXT index
0135 PRINT
0137 END
```

## Syntactic Features

Syntactically, BASIC09 is a hybrid language. Based on BASIC, it borrows many structuring elements from Pascal. For instance, the following is a legal BASIC09 program:

```
0010 PRINT "ENTER NUMBER OF
      TIMES TO LOOP"
0020 INPUT A
0030 FOR I = 1 TO A
0040 PRINT "CRETIN LOOP PASS NO. ";
0050 NEXT I
0060 END
```

In this simple example, which all BASIC programmers should understand, the user inputs a number which is then used to control the execution of a loop. Two variables are used, both of which, since they are not explicitly defined, are of the real or floating-point data type. This conforms to standard BASIC programming practice. String variables, with a default length of 32 characters, are defined similarly by appending a dollar sign ("\$\$") to a variable name. However, other types of data are allowed in BASIC09, those of *byte*, *integer*, and *Boolean*. Variables of these types must be explicitly allocated using the "DIM" statement. In the example program listed above, if we assume that the user will keep his request to a quantity that can be stored as a signed integer (+32767 to -32768), we can take advantage of integer math routines and make execution of our program much faster. Another significant gain can be realized by omitting line numbers. They are not required by BASIC09, and are wasteful of program memory space. We can re-do our program, explicitly dimensioning our data types, and jet-tisoning the line numbers:

```
DIM loopindex,topcount:INTEGER
PRINT "Enter desired number of passes "
INPUT topcount
FOR loopindex = 1 TO topcount
  PRINT "Smarter loop pass No. ";
  loopindex
NEXT loopindex
END
```

In this version of the program, further features of the language also appear. One nice protocol that we have adopted is to use descriptive names for our variables, and to always keep them in lower case. This is because the BASIC09 "decompiler" automatically capitalizes keywords when a source program is listed. If you keep variable names in lower case, they become easy to distinguish. This helps fulfill our structuring goal of making programs self-documenting. The listing above

also displays BASIC09's automatic "prettyprinting." This facility, which indents program lines according to their logical hierarchy, provides an easy way to grasp program structure, and aids debugging.

From this point forward all of our examples will be actual output by BASIC09's listing mechanism. Two features bear some explanation. First, the hexadecimal numbers on the left-hand side represent the relative *I-code addresses* into which the corresponding program source lines compile. They show the programmer the amount of memory being consumed by his program, and serve as pointers into the compiled code for tracking down errors during the debugging process.

## Procedure Orientation

Another feature of the language seen in our examples is its *procedure organization*. BASIC09 allows programs (called procedures) to call other procedures by name, and allows them to be separately compiled — a feature lacking even in standard Pascal. This permits users to build libraries of procedures that perform standard and often-used functions, which is an important step toward the modularity requirement for structured programs. Parameters can be passed to procedures in much the same manner as in Pascal, which is to say both by reference (by using the name of a variable), and by value (by using a constant value or expression). Thus, in the manner advocated by Kernighan and Plauger, procedures can "hide" the details of their operation from other procedures that call them. Therefore, data linkage is loosely done through easy-to-spot, explicit parameters.

## Loops and Conditional Statements

Loops in BASIC09 can be done using the familiar FOR-NEXT duo, the Pascal loops of WHILE...DO and REPEAT...UNTIL, or a loop-forever construct called LOOP...ENDLOOP. Any of these loops may be exited in a gentlemanly fashion by using the conditional EXITIF statement. The example procedure "multiply" uses the loop-forever construct, printing a "goodbye message" when the user has finished using the program's logic. (See listing 1. Note that the first two lines in the program listing are remarks, which can be signified using the "(" characters as the first characters in a line.)

The full complement of looping structures allows the BASIC09 programmer to use the loop that will get

the job done, and, at the same time, adds structure to his code.

Other logical features adding to BASIC09's power are two conditional branching statements: a "meat and potatoes" IF-THEN- (line number), and a structured IF-THEN-(ELSE)-ENDIF construct. The latter is indented in listings for logical clarity and will enable most programs to be written entirely without line numbers. IF statements can be nested to any required depth so that complex state selections can be made. The procedure "powers" demonstrates a four-way branch on an input value. (See listing 2.)

## Data Type Definition

Again borrowing from Pascal, BASIC09 allows programmers to define unique data types built up from the "atomic" standard data types mentioned above. These user-defined types may themselves be part of further type definitions, and so on, forever. Thus arbitrarily complex, non-rectangular types may be constructed to fit the nature of data at hand. Advantages of this method include mnemonic naming of fields in a complex type, elimination of array-index calculation at run time, and simplified passing of parameters to outboard procedures and I/O routines. The procedure "getname" (see listing 3) illustrates the principles of complex typing. It calls a mythical procedure called "displayname" (not shown here) that prints name and address information on a line printer.

## Implicit Type Conversion

Complex data types possess another significant attribute, although it could be argued that it belongs in the "giving razors to the baby" class. Data stored in complex type variables may be transferred to other complex variables of equal size with a simple assignment operation, regardless of the makeup of the respective types. This means type conversions can be done as simply as typing "=" . For example, the procedure *convert* converts a string into its equivalent ASCII code values and displays those values. (See listing 4.) This listing is supplemented by a sample run.

Implicit type conversion is a built-in method of accomplishing things that were formerly done only with much anguish on the part of programmers. As with all extremely powerful tools, it is a double-edged sword, and must be used with caution.

When math is performed using variables dimensioned to different numeric

# ELCOMP

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types, type conversion is done automatically by BASIC09's math routines to correspond with the data type of the variable receiving the result. Note that overflows and underflows for integer and byte data types do not result in an error - they merely wrap around zero. Programmers should therefore be careful to make sure they anticipate numeric ranges carefully, lest an unanticipated variable value lead to mysterious results at some unforeseen point in the future.

BASIC09's syntactic repertoire also includes full Boolean logical operations, bit twiddling, standard transcendental functions, and an extremely powerful PRINT USING function.

## The Procedure Editor

Program development is by nature a cyclic process. In most compiled languages an outboard text editor is used to assemble program statements, which are then run through the compiler. Then, if bugs are found, the text editor must be reloaded, changes made, and another compile cycle initiated. This process continues until the program is debugged and running properly. This begins to sound like the old "punch-submit-debug-punch" routine, because of the two-stage nature of interacting with the computer.

To circumvent the problem, BASIC09 employs two interrelated techniques. The first of these is *incremental compilation*, which means that each line is compiled from source at the time that it is entered. In this way, most syntactic errors can be immediately detected and reported to the user. This precludes the annoyance of a simple typographical mistake slipping undetected through to the compiler. Lines containing these errors are also marked so that procedures containing them can not be run. This avoids the delay caused by the run-time system processing "good" lines as it ambles towards a syntactic error lurking deep within a procedure.

The second tactic employed by BASIC09 to decrease program development delay is to incorporate a text editor into the compiler. The two-stage process now becomes integrated, interactive, and much faster. The editor is both content and line-number oriented, so that the program segments can be accessed whether or not they fall within a numbered line.

Editor commands, which can apply either locally (i.e., to the currently displayed line) or globally (to all lines)

include: search, change, list, delete, and renumber, and there are also commands to position the edit pointer within a procedure. The convenience of using this procedure editor has kept me consistently using BASIC09 in favor of Microware's powerful ISO-standard Pascal, because of the tremendous time savings it brings to program development.

## User Workspace

BASIC09 employs what is called the "workspace" concept for managing user memory. At the time a user logs onto the system, he is assigned a workspace of arbitrary size. All procedures that exist in the source code form are required to reside in a user's workspace, where they are maintained by BASIC09 and its associated processors. Information is available to the user at all times regarding the quantity of program memory in use, the amount of data memory required by his programs, and the amount of remaining workspace. A typical workspace directory is given in figure 4 for the procedures listed above. It lists the procedures currently resident within the workspace, along with their memory requirements (in decimal). These requirements pertain to the source code; I-code is more compact. The asterisk ("\*") marks the "current working procedure," which is accepted as a default argument by commands such as those that control disk I/O.

## Debugging

An integral debugger, entered whenever the run-time processor detects an error, provides the final link in the BASIC09 program development chain. While in this mode, values of all variables can be displayed or changed, and the currently running procedure can be listed, as can the "procedure stack" or list of currently invoked procedures. While in this mode a tracing command can be employed to begin displaying each line as it is executed. A single-step command can execute statements one at a time.

Program flow can be interrupted by the programmer at any point in his source code by the addition of the "PAUSE" statement. This statement causes processing to stop and the debug mode to be entered. At this time any of the operations mentioned above can be performed, and the program resumed by typing "CONT". This function gets my nomination as the most valuable single feature of BASIC09; it is a painless way to debug complex code in easy stages.

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## Packing Procedures

Once a procedure has been written and debugged, there is no logical reason for the system to allocate memory for full variable names, comments, and other space-hogging constructs that are not germane to its actual running. Towards this end an optional extra pass of the compiler may be generated, packing the procedure to remove them. Once this has been done a procedure can be loaded into system memory *outside of the user workspace*, therefore making it available for multiple users via the OS-9 timesharing system. The only workspace memory overhead for this procedure then becomes the data memory required, which obviously cannot be shared safely by all users.

As an additional bonus, procedures which have been packed cannot be edited or listed, which means that for all practical purposes their source code is inaccessible. This can be very important to software developers who cannot afford wanton copying of source code. However, let me advise potential users to *always be sure you have a source*

*code copy of a procedure already saved on disk before invoking the packing pass!* Otherwise even the programmer is locked out from his own source code.

## Conclusion

I have illustrated those features of BASIO9 which I believe make it excellent for the construction of applications tools. It provides the means for a programmer to systematize his undertakings so that he is not constantly writing the same code again and again. Structure provided by the language replaces structure provided by the programmer, freeing him for the more rewarding tasks of problem analysis and daydreaming. Readers who are interested in learning more about BASIC09 should contact Microware and order a programmer's manual, which contains a complete description of the language as well as numerous source code examples.

## References

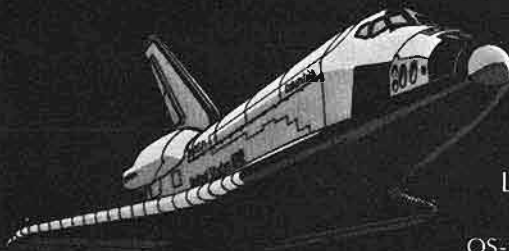
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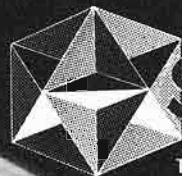
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by Ralph Tenny

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As users dig further into the Color Computer's guts, they'll find that many internal provisions have been made for expansion, both in the hardware and software.

The Micro Works, Inc., of Del Mar, California, brought out CBUG, an assembly language utility for the TRS-80C. The two programs included here are both supported by CBUG. The first program, BKP, is entered using CBUG's J command, which transfers control to BKP long enough to type in a location where you want the breakpoint to happen. (If you haven't used a breakpoint program before, note that this address must point only to an opcode, and not to an operand or a data byte.) BKP then grabs the code pointed to, saves it, and replaces it with the 6809 opcode for SWI2. This code forces a full interrupt, stacking the entire machine contents and fetching an interrupt vector from \$FFF4. Since the

## Listing 1

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\*REVISED 6/81 BY RALPH TENNY  
\*REFERENCE: CBUG, COPYRIGHT 1981 BY  
\*THE MICRO WORKS, INC.  
\*THIS PROGRAM SEGMENT SUPPLEMENTS CBUG, GIVING IT  
\*BREAKPOINT, PATCH, CHARACTER SEARCH, AND KEYBOARD  
\*DECODING CAPABILITY, PLUS OTHER HANDY SUBROUTINES.

\*\*\*\*\*REFERENCES FROM CBUG\*\*\*\*\*

\*NOTE: CHECK THESE LOCATIONS WITH THE VERSION OF  
\*CBUG THIS EXTENSION WILL BE USED WITH!

0088	CURPTR	EQU	\$88	CURSOR POINTER
00FB	PARAM	EQU	\$FB	BUFFER FOR OUTHEX
05FF	SCREND	EQU	\$05FF	END OF DISPLAY BUFFER
0618	ENTRY	EQU	\$618	IN TO CBUG INNEY
0627	HEX	EQU	\$627	IN TO CBUG OUTHEX
0651	BADDR	EQU	\$651	READ BINARY ADDRESS
0661	BYTE	EQU	\$661	GET A BYTE FROM KEYBOARD
067F	PCRLF	EQU	\$67F	PRINT CRLF
068D	PDATA	EQU	\$68D	PRINT A STRING
06AE	OUTHEX	EQU	\$6AE	PRINT A BYTE
068D	OUTS	EQU	\$68D	PRINT A SPACE
077D	HSTART	EQU	\$77D	HARD START ENTRY
07A5	INT	EQU	\$7A5	INTERRUPT ENTRY
07A9	WARMS	EQU	\$7A9	WARM START ENTRY
07C9	GETADR	EQU	\$7C9	GET TWO ADDRESSES
07D0	ECHO	EQU	\$7D0	GET A KEY AND ECHO TO SCREEN
07D9	REG	EQU	\$7D9	PRINT STACK

\*\*\*\*\*EQUATES AND BUFFER DEFINITIONS FOR CBUG\*\*\*\*\*

0010		ORG	\$0010	
0010 00	DFLCH	FCB	0	STORAGE FOR DISPLAY CHARACTER
0011 00	MEMLN	FCB	0	COUNTER FOR MEMORY CHARACTERS
0012 00	TXTCHR	FCB	0	BUFFER FOR INPUT CHARACTERS
0013 00	SPARE	FCB	0	RESERVE BUFFER
0014 0000	TXTEND	FDB	0	END OF TEXT BUFFER
0016 0000	MEMPTR	FDB	0	NEXT MEMORY LOCATION
0018 0000	DXBFR	FDB	0	TWO-BYTE SPARES
001A 0000	DBBFR	FDB	0	
001C 0000	DYBFR	FDB	0	
001E 0000	DUBFR	FDB	0	
0020 0000	DSBFR	FDB	0	
0103	SWI2	EQU	\$103	VECTOR FOR SWI2
0100	SWI3	EQU	\$100	VECTOR FOR SWI3
0D30		ORG	\$D30	NEXT TO CBUG END

\*ENTER HERE FROM CBUG USING \*J\* COMMAND

0D30 34	40	GOIN	PSHS	U	SAVE CBUG ENVIRONMENT
0D32 36	36		FSHU	A,B,X,Y	HERE, TOO
0D34 17	F948	IN2	LBSR	PCRLF	RESET THE DISPLAY
0D37 30	6D 0193		LEAX	XPMP1,PCR	FIND THE PROMPT
0D38 17	F94F		LBSR	PDATA	AND PRINT IT
0D3E 17	FABF		LBSR	ECHO	AND GET A KEY
0D41 1F	89		TFR	A,B	SAVE THE DATA
0D43 17	F977		LBSR	OUTS	PRINT A SPACE
0D46 30	8D 0011		LEAX	XTBL,PCR	FIND LOOKUP TABLE
0D4A 86	08		LDA	*TABND/3	COMPUTE TABLE LENGTH
0D4C E1	84	SEEN	CMFB	,X	FIND THE COMMAND
0D4E 27	05		BEQ	GOTIT	THERE IT IS!
0D50 30	03		LEAX	*03,X	SKIP OVER ADDRESS
0D52 4A			DECA		AND COUNT LOOKUPS
0D53 26	F7		BNE	SEEK	KEEP LOOKING
0D55 30	01	GOTIT	LEAX	,X	SKIP TO ADDRESS
0D57 EC	84		LDD	,X	AND READ IT
0D59 6E	8B		JMP	D,X	AND GO THERE

(Continued)



Color Computer has already arranged for this fetch to be diverted to \$103, BKP stuffs the address of it's own service routine at \$103. When all this "paperwork" is finished, BKP hands control back to CBUG, allowing you to inspect or modify anything before CBUG is instructed to jump to the routine being tested.

Note that the program execution may or may not reach the specified address. Since SWI2 is a maskable interrupt, you must be sure that the 6809 interrupt mask is cleared. Also, if your program bug bites before program execution reaches the breakpoint, then you won't learn anything except new words and another way to recover from a crash! If the breakpoint isn't reached, you must manually clear the breakpoint by replacing the code BKP grabbed, using CBUG's M command.

If the breakpoint is reached, BKP restores the code, prints the stack contents by calling CBUG's R command, then returns control to CBUG. You are then free to inspect memory and registers, trying to decide just why your "perfect" code doesn't do what you thought you told it to do. If all is well at the first breakpoint, you can continue from that location, or restart the program operation at the beginning, using a breakpoint further into the program. In the latter case, simply set a new breakpoint a few locations deeper into the program, and execute as before. If you want to follow a single piece of the action through, step by step, simply set a breakpoint for the next logical stop, and 'J' to the location of the first breakpoint. Since BKP has already replaced this code, operation proceeds as if it hadn't been stopped, unless you stopped in the middle of a time-critical segment of code. With a little diligence and care, you can locate almost any bug using this general technique.

The second program is longer, and furnishes a version of BKP that operates under control of CBUGP. It extends CBUG's abilities by jumping to a second look-up table which allows selection of a precise move routine (used to patch code), a byte search routine, and a program which prints out all single-key codes developed by the Color Computer's keyboard. (Some two-key functions are available.) Also, three "hooks" are furnished to facilitate addition of more special-purpose additions to CBUG. Finally, three sub-routines, SHOW, PRTSCN, and CLRSC, can be called by your own programs to light the cursor at the current location, print a character to the screen, and

### Listing 1 (Continued)

```

*COMMAND VECTORS
*
005B 42          XTBL   FCC   'B'
005C 002B       FDB   BKP-*   BREAKPOINT ROUTINE
005E 4B         FCC   'K'
005F 013C       FDB   KYTST-*  MAP KEYBOARD
0061 50         FCC   'P'
0062 007F       FDB   MVBK-*   PRECISE MOVE ROUTINE
0064 53         FCC   'S'
0065 00C3       FDB   SRCHB-*  BYTE SEARCH
0067 58         FCC   'X'
0068 000E       FDB   OOPS-*   HOOK1
006A 59         FCC   'Y'
006B 000B       FDB   OOPS-*   HOOK2
006D 5A         FCC   'Z'
006E 0008       FDB   OOPS-*   HOOK3
0070 4F         FCC   'H'
0071 000F       FDB   EXITP-*  RETURN TO CBUG
                                EQU   *-XTBL   END OF DATA
0073 20
007A FFC0
                                FCC   ' '
                                FDB   IN2-*   REJECT ALL OTHERS

*****PRINT MESSAGE*****

0076 17   F904   OOPS   LBSR   PCRLF   RESET THE DISPLAY
0079 30   BD 0141 LEAX   MSG1,PCR OOPS MESSAGE
007D 17   F90D   LBSR   PDATA

-
*BACK TO CBUG
*
0080 37   36     EXITP  PULU  A,B,X,Y  RETRIEVE REGISTERS
0082 35   40     PULS  U      AND THIS ONE
0084 16   FA09   LBRA  HSTART+19 AND SNEAK BACK

*THIS ROUTINE IMPLEMENTS A BREAKPOINT ROUTINE.
*AFTER ENTRY, IT WILL PROMPT FOR THE BREAKPOINT
*ADDRESS WITH A '?', THEN RETURN TO CBUGP FOR
*FURTHER INSTRUCTIONS

0087 36   36     BKP    PSHU  A,B,X,Y  SAVE REGISTERS
0089 8E   0103   LDX   #SWI2  GET A POINTER
008C 84   7E     LDA   #47E  JUMP OF CODE
008E A7   80     STA   ,X+    AND BUILD A JUMP
0090 CC   0DC3   LDD   #BKPFIN TO THIS ROUTINE
0093 ED   81     STD   ,X++   WITH THIS VECTOR
0095 86   3F     LDA   #'?'  SEND THE PROMPT
0097 17   011F   LBSR  WRT    AND WRITE IT DOWN
009A 86   60     LDA   #60    GET A SPACE CHARACTER
009C 17   011A   LBSR  WRT    THEN PRINT IT
009F 8D   0651   JSR   BADDR  GET AN ADDRESS
00A2 9F   18     STX   DXBFR  SAVE THE ADDRESS
00A4 1F   10     TFR   X,D    MOVE IT HERE, TOO
00A6 17   0110   LBSR  WRT    PRINT CONTENTS OF A REGISTER
00A9 1F   9B     TFR   R,A    SHUFFLE AND THEN
00AB 17   010B   LBSR  WRT    WRITE CONTENTS OF B REG
00AE EC   9F 0018 LDD   [DXBFR] GET THE BREAKPOINT CODE
00B2 DD   1A     STD   DBBFR  AND SAVE IT
00B4 CC   103F   LDD   #103F  STUFF THE SWI2 OPCODE
00B7 ED   9F 0018 STD   [DXBFR] HERE TO APPLY THE BRAKES
00BB 17   00C5   LBSR  CLRSC  ERASE THE DISPLAY
00BE 37   36     PULU  A,B,X,Y GET 'EM BACK
00C0 7E   07AD   JMP   WARMS+4 AND RETURN TO MONITOR
00C3 1F   43     BKPFIN TFR   S,U  SAVE HARDWARE STACK POINTER
00C5 8D   07D9   JSR   REG    PRINT THE STACK
00C8 36   06     PSHU  D      SAVE D
00CA DC   1A     LDD   DBBFR  RETRIEVE BREAKPOINT CODE
00CC ED   9F 0018 STD   [DXBFR] AND SEND IT HOME
00D0 37   06     PULU  D      GET D BACK
00D2 7E   07A9   JMP   WARMS  RETURN TO MONITOR

*THIS ROUTINE COMPUTES A CHECKSUM IN X; EACH BYTE
*SHOULD BE PASSED IN TXTCHR AND THE UPDATED CHECKSUM
*RETURNED IN DSBFR. USE AS SUBROUTINE ONLY.

00D5 36   34     CHKSM PSHU  R,X,Y  SAVE REGISTERS
00D7 9E   20     LDX   DSBFR  GET CURRENT CHECKSUM
00D9 04   12     LDB  TXTCHR  AND THE CURRENT BYTE
00DB 3A         ABX                     GET THE SUM AND
00DD 9F   20     STX   DSBFR  THEN SAVE IT
00DE 37   34     PULU  R,X,Y  RESTORE REGISTERS
00E0 39         RTS                     AND GO HOME

*THIS ROUTINE WILL MOVE A BLOCK OF DATA TO ANOTHER
*LOCATION. PASS THE BLOCK LENGTH (BYTES) IN DSBFR,
*THE SOURCE ADDRESS IN DYBFR, AND THE DESTINATION
*ADDRESS IN DUBFR. ALLOWANCE MADE FOR BUFFER OVERLAP.

*****SETUP*****

00E1 34   76     MVBK  PSHS  A,B,U,X,Y SAVE REGISTERS
00E3 17   F9E3   LBSR  GETADR  GET TWO ADDRESSES
00E6 9F   1E     STX   DUBFR  END ADDRESS
00E8 109F  1C     STY  DYBFR  START ADDRESS
00EB 17   F843   LBSR  BADDR  GET # OF REPEATS
00EE 9F   20     STX  DSBFR  AND SAVE IT

```

Listing 1 (Continued) \*\*\*\*\* DO IT! \*\*\*\*\*

```

*ALLOW FOR POSSIBLE BUFFER OVERLAP

0DF0 DC 1C          LDD  DYBFR  GET START ADDRESS
0DF2 93 1E          SUBD  DUBFR  GET DISTANCE BETWEEN BLOCKS
0DF4 27 11          BEQ  EXIT2  SAME ADDRESS, WHY BOTHER?
0DF6 2D 14          BLT  REV    MOVE CODE FROM BOTTOM FIRST

*NOTE! THIS MOVE ALLOWS UNWANTED CODE TO BE
*OVERWRITTEN. USE WITH CARE!

0E08 9E 20          LDX  DSBFR  GET NUMBER OF BYTES TO MOVE
0E0A 109E 1C        LDY  DYBFR  ALSO START ADDRESS
0E0C DE 1E          LDU  DUBFR  AND DESTINATION START
0E0E A6 A0          B1   LDA  ,Y+  LOAD ONE BYTE
0E10 A7 C0          STA  ,U+  AND PUT IT DOWN
0E12 30 1F          LEAX -1,X  COUNT THE OPERATIONS
0E14 26 FB          BNE  R1    LOOP UNTIL DONE
0E16 35 76          EXIT2 PULS A,B,U,X,Y RESTORE REGISTERS
0E18 7E 0DB0       JMP  EXITP  AND RETURN TO GO

*THIS MOVE ALLOWS CODE TO BE OPENED UP TO INSERT
*ONE OR MORE OP CODES FOR A PATCH.

0E0C DC 20          REV  LDD  DSBFR  GET NUMBER OF BYTES TO MOVE
0E0E 03 1C          ADDD DYBFR  MOVE POINTER TO BOTTOM OF BUFFER
0E10 1F 02          TFR  D,Y   AND LOAD SOURCE POINTER
0E12 DC 20          LDD  DSBFR  GET BYTE COUNT AGAIN
0E14 03 1E          ADDD DUBFR  COMPUTE DESTINATION BUFFER END
0E16 1F 03          TFR  D,U   AND LOAD DESTINATION POINTER
0E18 9E 20          LDX  DSBFR  ONE MORE TIME!
0E1A 31 3F          B2   LEAY -1,Y POINT TO FIRST BYTE
0E1C A6 A4          LDA  0,Y   GET ONE BYTE
0E1E 33 5F          LEAU -1,U  POINT TO NEXT TARGET
0E20 A7 C4          STA  0,U  AND SHOOT
0E22 30 1F          LEAX -1,X  COUNT THE PASSES
0E24 26 FB          BNE  R2    LOOP UNTIL DONE
0E26 20 DF          BRA  EXIT2 THEN BLOW THE JOINT

*THIS ROUTINE SEARCHES FOR A SPECIFIED BYTE
*PASSED IN TXTCHR; PASS THE STRING LENGTH TO
*SEARCH IN DYBFR, AND THE BUFFER START ADDRESS
*IN DSBFR. RECORD THE BYTE LOCATION IN
*DSBFR. RETURN #FFFF IN DSBFR FOR TEST FAILURE.

0E28 36 36          SRCHR PSHU  A,B,X,Y  SAVE FOUR
0E2A BD 0661        JSR  BYTE  GET CHARACTER
0E2C 97 12          STA  TXTCHR PUT IT UP SAFELY
0E2E BD 06BD        JSR  OUTS  PRINT A SPACE
0E30 BD 07C9        JSR  GETADR THEN GET STRING PARAMETERS
0E32 BD 07C9        STY  DSBFR  SAVE THE ADDRESS
0E34 109F 20        STX  DYBFR  AND THE STRING LENGTH
0E36 9F 1C          LDA  TXTCHR  CHARACTER TO FIND
0E38 96 12          LDX  DSBFR  AND THE START ADDRESS
0E3A 9E 20          LDY  DYBFR  STRING LENGTH
0E3C 109E 1C        CS1  CMPA  ,X+  LOOK FOR IT
0E3E 27 18          BEQ  CS2   GOT IT, SET POINTER
0E40 31 3F          LEAY -1,Y NOT IT, COUNT IT ANYWAY
0E42 26 FB          BNE  CS1  LOOP UNTIL DONE
0E44 26 FB          LDD  00-1  NOT FOUND, SET A FLAG
0E46 CC FFFF        SAVFLG STD  DSBFR  PLANT THE FLAG HERE
0E48 DD 20          STA  PARAM SORT OUT MS BYTE
0E4A 97 FB          JSR  OUTHEX PRINT MS BYTE OF ADDRESS
0E4C BD 06AE        STB  PARAM  DO THE SAME
0E4E BD 06AE        JSR  OUTHEX  FOR THE REST
0E50 BD 06AE        EXIT1 PULU  A,B,X,Y  RESTORE REGISTERS
0E52 37 36          JMP  IN2   AND ASK FOR MORE
0E54 7E 0034       CS2  LEAX  -1,X  POINT AT THE TARGET
0E56 30 1F          TFR  X,D   STUFF LOCATION IN D
0E58 1F 10          BRA  SAVFLG CLEAN UP AND LEAVE
0E60 20 E9

*THIS ROUTINE LIGHTS THE CURSOR AND SAVES THE
*CHARACTER CURRENTLY POINTED TO.

0E63 36 02          SHOW  PSHU  A          SAVE A
0E65 A6 9F 008B    LDA  [CURPTR] GET THE CHARACTER POINTED TO
0E67 97 10          STA  DPLCH  AND SAVE IT, JUST IN CASE
0E69 8A BF          ORA  04BF  MAKE IT A GRAPHICS CHARACTER
0E6B A7 9F 008B    STA  [CURPTR] SO IT WILL SHOW UP
0E6D 37 02          PULU  A          GET A BACK
0E6F 39             RTS          GO BACK

*THIS ROUTINE WRITES TO THE DISPLAY BUFFER AND
*TURNS ON THE CURSOR BY A CALL TO SHOW. PASS
*THE CHARACTER TO BE DISPLAYED IN PARAM.

0E74 36 36          PRTSCN PSHU  A,B,X,Y  SAVE REGISTERS
0E76 9E 88          LUX  CURPTR  GET PRESENT CURSOR LOCATION
0E78 96 FB          LDA  PARAM  GET THE OUTPUT CHARACTER
0E7A A7 80          STA  ,X+  WRITE IT WITH ELECTRODS
0E7C 9F 88          STX  CURPTR  TELL THE NEW CURSOR LOCATION
0E7E BD E3          BSR  SHOW   AND TURN ON THE CURSOR
0E80 37 36          PULU  A,B,X,Y  RETRIEVE THE REGISTERS,
0E82 39             RTS          THEN RESUME OPERATION (Continued)

```

clear the screen, respectively. These features are available from CBUG, but not in the same form.

This extension of CBUG operates very much like CBUG, except that it is entered via a "J" command from CBUG, and some of the routines bounce back after one pass. Here's a brief summary:

**BKP** (Breakpoint routine), entered from CBUG via "B": Sets up the breakpoint and then bounces back to CBUG and lets CBUG enter the routine under test. Entry form: B XXXX, where XXXX is the hex address of the breakpoint.

**MVBLK**: Allows the program code to be sliced down the middle to insert any number of bytes of missing code, or closed up to delete any number of bytes of superfluous code. Entry form: P XXXX YYYY ZZZZ, where XXXX is the address of the first byte to be moved, YYYY is the target location for that byte, and ZZZZ is the number of bytes to be moved. In the latter case, if you need to open up a 200-byte program to insert new code immediately after the 50th byte, (convert numbers to hex, assuming the program begins at 1000) then XXXX = 1033 and ZZZZ = 0032. If the needed patch is three bytes long, then YYYY = 1035. After execution of one complete move, MVBLK returns to CBUG.

**SRCHB**: Searches for any single-byte value and reports the location if found, or FFFF, if not found. Enter from CBUG using S XX YYYY ZZZZ, where XX is the value sought, YYYY is the address where to start searching, and ZZZZ is the number of bytes to search. Returns to CBUG for further searches.

"M" command: Returns to CBUG.

**CBUG — An Assembly Language Monitor for the Color Computer**

One of the very first pieces of assembly language software available for the TRS-80C™ Color Computer was CBUG®, sold for \$29.95 by The Micro Works, P.O. Box 1110, Del Mar CA 92014. This well-documented, assembly language monitor has a number of excellent and useful features, especially for those who wish to preserve the essential character of the Color Computer and still learn about assembly language programming on Motorola's "super" 8-bit processor, the MC6809.

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(Continued)

## Listing 1 (Continued)

```

0E83 36 32 CLRSC PSHU A,X,Y SAVE THREE
0E85 8E 05FF LDX #SCREND TAIL END CHARLIE
0E88 108E 0200 LDY ##200 NUMBER OF DISPLAY CELLS
0E8C 86 60 LDA ##60 SCREEN BLANK CHARACTER
0EBE A7 B2 OUTSC STA , -X BLANK THE CELLS
0E90 31 3F LEAY -1,Y AND COUNT THEM
0E92 26 FA BNE OUTSC SPIN UNTIL DONE
0E94 9F 88 STX CURPTR REMEMBER THE CURSOR LOCATION
0E96 8D CB BSR SHOW LIGHT THE CURSOR
0E98 37 32 PULU A,X,Y GET 'EM BACK
0E9A 39 RTS DO THE NEXT MAGIC TRICK
    
```

\*THIS ROUTINE CLEARS THE SCREEN AND SETS THE \*CURSOR AT THE TOP OF THE SCREEN.

\*A RESEARCH PROGRAM TO MAP KEYBOARD CODES.  
\*WARNING--CALL IT ONLY FROM CRUGP!!

```

0E9B 36 36 KYTST PSHU A,B,X,Y
0E9D 8D 067F JSR PCRLF RESET THE DISPLAY
0EA0 8D 0618 READ JSR ENTRY GET A KEY
0EA3 81 5E CMPA ##5E TEST FOR A KNOWN ONE
0EA5 27 0D BEQ STOP2 AND USE IT TO ABORT
0EA7 8D 10 BSR WRT OTHERWISE, OUTPUT TO SCREEN
0EA9 8D 068D JSR OUTS PRINT A SPACE
0EAC 8D 0627 JSR HEX PRINT HEX VALUE OF CHARACTER
0EAF 8D 067F JSR PCRLF RESET THE DISPLAY
0EB2 20 EC BRA READ THE GO GET ANOTHER KEY
0EB4 37 36 STOP2 PULU A,B,X,Y GET 'EM BACK
0EB6 7E 0B34 JMP IN2 MAMA IS CALLING!
0EB9 97 FB WRT STA PARAM SAVE THE CHARACTER
0EBB 8D B7 BSR PRNCHN AND GO PRINT IT
0EBD 39 RTS RETURN TO THE BOSS
    
```

\*\*\*\*\*TEXT FOR DOPS MESSAGE\*\*\*\*\*

```

0EBE 4E 4F 54 20 MSG1 FCC 'NOT IMPLEMENTED'
0EC2 49 4D 50 4C
0EC6 45 4D 45 4E
0ECA 54 45 44
0ECD 00 FCB 0 DELIMITER
    
```

\*\*\*\*\*TEXT FOR PROMPT\*\*\*\*\*

```

0ECE 0D 0A XFMPT FCB $D,$A RESET THE DISPLAY
0ED0 43 42 55 47 FCC 'CRUGP ?' PROMPT
0ED4 50 20 3F FCB $20 AND A SPACE
0ED7 20 FCB 0 DELIMITER
0ED8 00 FCB 0 DELIMITER
0ED9 0000 END
    
```

## Listing 2

\*BKP: COPYRIGHT 1981 BY RALPH TENNY  
\*REFERENCE: CRUG, COPYRIGHT 1981 BY  
\*THE MICRO WORKS, INC.

\*\*\*\*\*REFERENCES FROM CRUG\*\*\*\*\*

\*NOTE: CHECK THESE LOCATIONS WITH THE VERSION OF \*CRUG THIS EXTENSION WILL BE USED WITH!

```

0088 CURPTR EQU $88 CURSOR POINTER
061E SWRT EQU $61E ENTRY FOR DUTEY
0651 BADDR EQU $651 READ BINARY ADDRESS
077D HSTART EQU $77D HARD START ENTRY
07A9 WARMS EQU $7A9 WARM START ENTRY
07D9 REG EQU $7D9 PRINT STACK
    
```

\*\*\*\*\*EQUATES AND BUFFER DEFINITIONS FOR BKP\*\*\*\*\*

```

0030 ORG $0030
0030 0000 CODE FDB 0 LOCATION FOR CODE AT
BREAKPOINT
0032 0000 0103 PNTR FDB 0 LOCATION OF BREAKPOINT
SWI2 EQU $103 VECTOR FOR SWI2
    
```

\*\*\*\*\*REFERENCE TO TRS80C ROM\*\*\*\*\*

```

A92B CLS EQU $A92B BASIC CLS COMMAND
    
```

\*THIS ROUTINE IMPLEMENTS A BREAKPOINT ROUTINE.  
\*AFTER ENTRY, IT WILL PROMPT FOR THE BREAKPOINT  
\*ADDRESS WITH A '?', THEN RETURN TO CRUG FOR  
\*FURTHER INSTRUCTIONS

```

0EE0 ORG $EE0
*ENTER HERE FROM CRUG USING 'J' COMMAND
    
```

```

0EE0 34 40 BKP PSHS U SAVE CRUG ENVIRONMENT
0EE2 36 36 PSHU A,B,X,Y SAVE REGISTERS
    
```

(Continued)



Keystroke	Command Description
G	Returns command to the calling program.
R	Displays register list.
M 1234	For memory examine and change, beginning at \$1234.
I 1234 2345 67	Inserts \$67 in memory from \$1234 to \$2345.
T 0123 1234 2345	Transfers block of memory from \$0123 through \$1234 to new location beginning at \$2345.
J 1234	Jumps to user machine language subroutine at \$1234.
C	Changes register list.
S 1234 2345 1357	MYFILE creates a machine language file on cassette tape, recording the code which appears between addresses \$1234 and \$2345; \$1357 is the program entry point.
B 1200 X	Sets baud rate. X = C or P specifies the configuration of the printer port.
L	Loads hex data to memory.
\$ 1234	Converts hex to decimal.
.12345	Converts decimal to hex.
P 0000	Moves display page.
U 1234 2345	Uploads. Transmits data to the screen and to the communications port.
D	Downloads. Data can be received from communications port.
!	Takes over SWI. Until this command is executed, the 6809 SWI instruction will cause undefined operation. After using this command, substitution of the code for SWI (\$3F) for op-codes in a program will cause a break which returns control to CBUG.
AU	Auto mode. After the baud rate has been set and this command is entered, the computer emulates an intelligent terminal connected to a host system.
X	Terminal mode. This command causes the computer to emulate a CRT terminal.
R	Reset; causes a return to BASIC.

CBUG is available in a tape-based version, which loads at the start of the BASIC workspace (\$0600), and a 2K ROM, which occupies either the Color Computer's socket for Advanced Color BASIC (addressed at \$9000), or installed in a modified program pack (addressed at \$C000). It is apparent that the program's flexibility of location stems from the fact that it is written entirely in position-independent code. Since the monitor is completely documented, including a well-commented source listing, a detailed study of the Owner's Manual constitutes an excellent self-taught course in programming the 6809.

The adjacent list of commands provides an idea of the capability of the monitor.

**MICRO**

## MICRObits (continued)

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### Listing 2 (Continued)

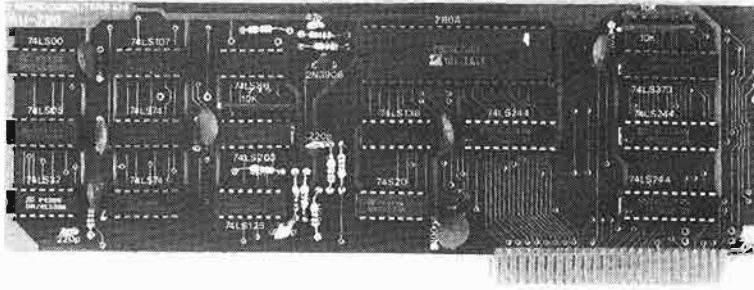
0EE4 8E 0103	LDX	0SWI2	GET A POINTER
0EE7 84 7E	LDA	07E	JUMP OF CODE
0EE9 A7 80	STA	,X+	AND BUILD A JUMF
0EEB CC 0F1A	LDD	0BKPFIN	TO THIS ROUTINE
0EEE ED 81	STD	,X++	WITH THIS VECTOR
0EF0 84 3F	LDA	0?	GET THE PROMPT
0EF2 8D 38	BSR	WRT	AND WRITE IT DOWN
0EF4 84 60	LDA	060	GET A SPACE CHARACTER
0EF6 8D 34	BSR	WRT	THEN PRINT IT
0EF8 8D 0651	JSR	BADDR	GET AN ADDRESS
0EFB 9F 32	STX	PNTR	SAVE THE ADDRESS
0EFD 1F 10	TFR	X,D	MOVE IT HERE, TOO
0EFF 8D 2B	BSR	WRT	PRINT CONTENTS OF 'A' REG
0F01 1F 98	TFR	B,A	SHUFFLE AND THEN
0F03 8D 27	BSR	WRT	WRITE CONTENTS OF 'B' REG
0F05 EC 9F 0032	LDD	[PNTR]	GET THE BREAKPOINT CODE
0F09 8D 30	STD	CODE	AND SAVE IT
0F0B CC 103F	LDD	0103F	STUFF THE SWI2 OPCODE
0F0E ED 9F 0032	STD	[PNTR]	HERE TO APPLY THE BRAKES
0F12 8D A928	JSR	CLS	ERASE THE DISPLAY
0F15 37 36	PULU	A,B,X,Y	GET 'EM BACK
0F17 7E 07AD	JMP	WARMS+4	AND RETURN TO MONITOR
0F1A 1F 43	TFR	S,U	SAVE HARDWARE STACK POINTER
0F1C 8D 07D9	JSR	REG	PRINT THE STACK
0F1F 36 06	PSHU	D	SAVE D
0F21 DC 30	LDD	CODE	RETRIEVE BREAKPOINT CODE
0F23 ED 9F 0032	STD	[PNTR]	AND SEND IT HOME
0F27 37 06	PULU	D	GET D BACK
0F29 7E 0787	JMP	HSTART+10	RETURN TO MONITOR
0F2C 36 36	PSHU	A,B,X,Y	SAVE REGISTERS
0F2E 9E 88	LDX	CURPTR	GET PRESENT CURSOR LOCATION
0F30 A7 80	STA	,X+	PRINT IT OUT
0F32 9F 88	STX	CURPTR	AND SAVE NEW LOCATION
0F34 37 36	PULU	A,B,X,Y	GET 'EM BACK
0F36 39	RTS		AND RESUME OPERATION
0F37 0000	FDB	0	DELIMITER
	END		

(Continued on page 85)

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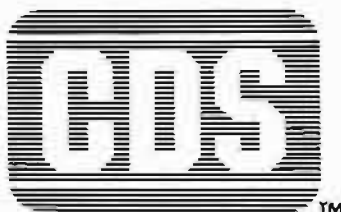
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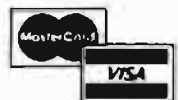
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# Multiprecision Addition — A Comparison of 6809 and 6502 Programming

by Gregory Walker and Tom Whiteside

The authors use 32-bit addition routines to demonstrate several advantages of programming the MC6809 over the 6502. The final routines are designed to be called as subroutines from another program.

Much attention has focused recently on switching from the 6502 to the MC6809. Since the MC6809 is architecturally similar (and, we believe, superior) to the 6502, the transition is both easy and worth the effort. Robert Tripp's four-part series "It's Time to Stop Dreaming" (June, July, August, September issues of MICRO) was a good overview of the similarities and differences of the 6502 and the MC6809. In this article, we will carry the description further with some concrete programming examples. Every attempt was made to squeeze every bit of performance out of the 6502 in these comparison runs. Less effort was needed for the MC6809 since its 16-bit registers and powerful instructions and addressing modes make "trickery" unnecessary (but unfortunately still possible).

A 32-bit addition subroutine was chosen because providing multiprecision arithmetic capability is a common problem on eight-bit microcomputers. Like the byte-move problem, it can be solved in several different ways by trading off between code size, execution speed, and generality. We will present a 32-bit addition subroutine programmed in two different ways and see how our two processors compare.

It is often possible to trade off efficiency for generality in writing a subroutine. It is necessary to keep in mind how a subroutine will be called by the larger system. One major source of errors in large assembly language

programs comes from destroying the contents of processor registers. We have added the restriction that these subroutines must leave all processor registers unchanged, but an exception is made in the case of the condition code register. The condition flag register is not preserved, so that the carry flag may reflect the result of the addition.

Figure 1 shows a 6502 program that adds two 32-bit numbers together. The numbers and result are stored at fixed locations on the zero page. The bytes for each number are stored in the same order as 6502 addresses, least significant byte first. The actual addition is the fastest that can be written: each consecutive byte is added by a separate set of in-line instructions.

Figure 1: 6502 program to add 32-bit numbers in-line. (Time = 63 cycles.)

## SAMPLE SETUP FOR ONE OPERAND FOR 32-BIT ADD ON ZERO PAGE

...		(SIZ)	(TIM)	
LDA	OPR1	2	3	MOVE ALL FOUR BYTES OF OPERAND "OPR1" INTO SIMULATED 32-BIT REGISTER "A1"
STA	A1	2	3	
LDA	OPR1+1	2	3	
STA	A1+1	2	3	
LDA	OPR1+2	2	3	
STA	A1+2	2	3	
LDA	OPR1+3	2	3	
STA	A1+3	2	3	
...		16	24	CYCLES

## 6502 ROUTINE TO ADD 32-BIT NUMBERS WITH ADDENDS IN ZERO PAGE AND ALL CODE IN-LINE

ADD32	EQU	*	(SIZ)	(TIM)	
	PHA		1	3	SAVE A-REGISTER
	CLC		1	2	
	LDA	A1	2	4	ADD LEAST-SIGNIFICANT PAIR OF BYTES
	ADC	A2	2	4	
	STA	RESULT	2	4	
	LDA	A1+1	2	4	ADD SECOND PAIR OF BYTES
	ADC	A2+1	2	4	
	STA	RESULT+1	2	4	
	LDA	A1+2	2	4	ADD THIRD PAIR OF BYTES
	ADC	A2+2	2	4	
	STA	RESULT+2	2	4	
	LDA	A1+3	2	4	ADD MOST-SIGNIFICANT PAIR OF BYTES
	ADC	A2+3	2	4	
	STA	RESULT+3	2	4	
	PLA		1	4	RESTORE A-REGISTER
	RTS		1	6	
			28	63	CYCLES



Figure 2 shows the corresponding MC6809 subroutine. Many of the MC6809 instructions should be familiar to 6502 programmers. In reading the MC6809 program, note that the MC6809 stores its multi-precision values in the opposite order from the 6502: the most-significant byte is stored in the lower memory address.

The MC6809 performs the addition in two 16-bit chunks. Two instructions are used to add the most-significant 16-bits because the MC6809 lacks a 16-bit add-with-carry instruction. The final instruction pulls the old contents of the D accumulator and the program counter from the stack, which conveniently restores the processor state and returns from the subroutine in one fell swoop.

We can see from figures 1 and 2 that the MC6809 subroutine is both smaller and faster than the 6502 version. Each single MC6809 instruction tends to require more bytes and more machine cycles than a similar 6502 instruction, but the more powerful MC6809 instruction set allows the problem to be solved with fewer instructions overall.

As we said before, a subroutine exists within a larger system. From a systems point of view, the above two subroutines suffer several problems. Most important is the use of fixed storage on the direct page. In essence, the locations labelled A1, A2, and RESULT, are simulated 32-bit registers that the 6502 and MC6809 both lack.

These addition routines operate very quickly, but a significant amount of time is needed to set up the operand values before each subroutine call. Four loads and four stores are required just to move one of the values into a simulated register.

A second problem is that these routines cannot easily be adapted to solve other, similar problems. A general multi-precision addition subroutine would be written using an iterative loop, so that different length operands could be handled just by changing the loop counter.

Figure 3 shows a 6502 subroutine that answers both these problems. It uses a loop to add the consecutive bytes together and it uses indirect addressing to allow operands to reside anywhere in the 6502's address space. The Y register acts as the loop counter and as an index into the multi-precision operands. It is

**Figure 2: 6809 program to add 32-bit numbers in-line on the direct page.  
(Time = 50 cycles.)**

**SAMPLE OPERAND SET-UP FOR 32-BIT ADD ON DIRECT PAGE**

...		(SIZ	TIM)	
LDD	OPR1	2	5	MOVE FOUR BYTES OF
STD	A1	2	5	"OPR1" INTO SIMULATED
LDD	OPR1 + 2	2	5	32-BIT REGISTER "A1"
STD	A1 + 2	2	5	
...				
		8	20	CYCLES

**MC6809 ROUTINE TO ADD 32-BIT NUMBERS WITH ADDENDS IN ZERO PAGE AND ALL CODE IN-LINE**

ADD32	EQU		(SIZ	TIM)	
PSHS	D	2	7	SAVE D-ACCUMULATOR	
LDD	A1 + 2	2	5	ADD LEAST-SIGNIFICANT	
ADDD	A2 + 2	2	6	16-BIT QUANTITIES	
STD	RESULT + 2	2	5		
LDD	A1	2	5	ADD MOST-SIGNIFICANT	
ADCB	A2 + 1	2	4	16-BIT QUANTITIES	
ADCA	A2	2	4		
STD	RESULT	2	5		
PULS	D, PC	2	9	RESTORE D AND RETURN	
		18	50	CYCLES	

initialized with a value of 3, which causes the loop to be executed four times. Since the operands are stored most-significant byte first, the index is a positive number which is decremented to zero. Unfortunately, this usage is not consistent with the order of address storage on the 6502. It was forced on us because the 6502 does not have an instruction that causes a branch when a negative index is incremented through zero.

This subroutine is somewhat shorter than the previous 6502 routine, but requires almost twice the execution time. The decrease in set-up time needed before calling the subroutine partially compensates for this extra time. In this case it is only necessary to initialize three 16-bit pointers on the zero page, instead of initializing three 32-bit operands.

This subroutine provides a more general solution to the problem of multi-precision arithmetic. It is easily modified to use operands of different sizes by changing the loop count. Even the calling sequence, manipulating pointers as it does, would not have to be changed for different length operands.

Figure 4 shows the corresponding MC6809 program. Here we use the MC6809's 16-bit index registers to hold pointers to the operands. Each byte of

the operands is added in the 8-bit A accumulator, while the B accumulator serves as a loop counter and index into the operands.

Once again, the MC6809 program is smaller in size and executes faster than the equivalent 6502 program. The main advantage of the MC6809 proves to be its 16-bit-long index registers and the instructions that manipulate 16-bit data. They remove the extra memory cycles needed for indirect addressing on the 6502 and greatly simplify the programmer's task. The MC6809 handles address calculations as easily as the 6502 handles calculations with eight-bit integers.

**Conclusion**

In this article we have used actual programming examples to compare the 6502 and the MC6809 in solving real-world problems. The MC6809 outperforms the 6502 in this and nearly every other application.

While speed of execution and program size are always important measures, we have also tried to show ways that the MC6809 eases the task of programming. In particular, we have seen that a major limitation of the 6502 is its dependence upon zero-page addressing. As programs increase in complexity, there is an increased demand for the limited zero-page space. Complex 6502 systems such as disk operating systems and high level languages

compete heavily for zero-page locations. Bookkeeping becomes necessary to track which routines clobber which zero-page variables, and it becomes more difficult to control routine "interaction" through the zero page.

Byte efficiency and speed are reduced as it becomes necessary to reinitialize "temporaries" and to use absolute addressing. With the MC6809's 16-bit index registers, there is no zero-page demand for storing indirect pointers. Furthermore, the MC6809 makes storing temporary variables on the stack easy and efficient so there is less reason to use zero-page space. Finally, the MC6809 has a direct page register. Even if the zero page does clog up, it is easy to switch to another page in memory.

We believe the MC6809 is a worthy successor to the 6502. Applications that used the 6502 will find a new vitality on the MC6809.

### Acknowledgement

We want to express our thanks to Tony Fourcroy for testing the programing examples.

Tom Whiteside is a 6-year Motorola and works with the Microprocessor design group. Gregory Walker likes to program computers, especially the MC6809. They may be contacted at Motorola, Inc., Microprocessor Design, Maildrop MZ880, 3501 Ed Bluestein Blvd., Austin, Texas 78721.

**Figure 3: 6502 program to add 32-bit numbers with loop and indirection. (Time = (21\*4) + 28 = 84 + 28 = 112 cycles.)**

#### CALLING SEQUENCE FOR 6502 INDIRECT-ADDRESSING ADDITION ROUTINE

...			(SIZ TIM)	
LDA	#OPR1_L	2	2	PUT POINTER TO FIRST
STA	A1	2	3	OPERAND INTO A1 ON
				ZERO PAGE
LDA	#OPR1_H	2	2	
STA	A1+1	2	3	
LDA	#OPR2_L	2	2	PUT POINTER TO SECOND
STA	A2	2	3	OPERAND INTO A2 ON
				ZERO PAGE
LDA	#OPR2_H	2	2	
STA	A2+1	2	3	
LDA	#RSLT_L	2	2	PUT POINTER TO RESULT
STA	RSLT	2	3	INTO RSLT ON ZERO PAGE
LDA	#RSLT_H	2	2	
STA	RSLT+1	2	3	
JSR	ADD32	3	6	CALL 32-BIT ADD
				SUBROUTINE
		27	36	CYCLES

#### 6502 SUBROUTINE TO ADD 32-BIT NUMBERS WITH A LOOP AND POINTERS TO OPERANDS ON ZERO PAGE

			(SIZ TIM)	
ADD32	EQU	*		
	PHA		1	3
	TYA		1	2
	PHA		1	3
	LDY	#3	2	2
	CLC		1	2
				LOOP COUNT-1 AND INDEX
				IN Y
L1	LDA	{A1}, Y	2	5
	ADC	{A2}, Y	2	5
	STA	{RESULT}, Y	2	6
	DEY		1	2
	BPL	L1	3	3
	PLA		1	4
	TAY		1	2
	PLA		1	4
	RTS		1	6
			20	

**Figure 4: 6809 add of 32-bit numbers in byte-wise loop. (Time = (20\*4) + 21 = 80 + 21 = 101 cycles.)**

#### MC6809 CALLING SEQUENCE FOR 32-BIT ADD

...			(SIZ TIM)	
LEAX	A1,PCR	3	5	ADDRESS OF A1 INTO X INDEX REGISTER
LEAY	A2,PCR	3	5	ADDRESS OF A2 INTO Y INDEX REGISTER
LEAU	RSLT,PCR	3	5	ADDRESS OF RSLT INTO U INDEX REGISTER
LBSR	ADD32	3	9	CALL SUBROUTINE ADD32

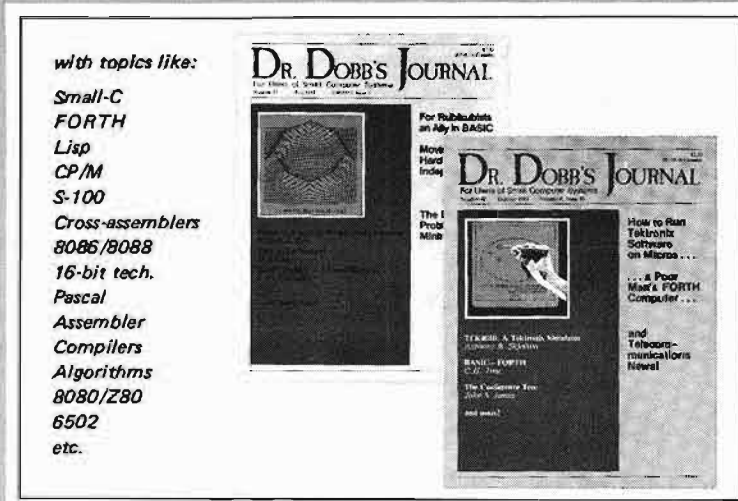
#### MC6809 ADD OF 32-BIT NUMBERS USING A LOOP

			(SIZ TIM)	
ADD32	EQU	*		
	PSHS	D	2	7
	LIDB	#3	2	2
	ANDCC	#\$FE	2	3
				CLEAR CARRY BIT
L1	LDA	B, X	2	5
	ADCA	B, Y	2	5
	STA	B, U	2	5
	DECB		1	2
				DECREMENT LOOP COUNT
	BGE	L1	2	3
				LOOP UNTIL COUNT IS NEGATIVE
	PULS	D, PC	2	9
				RESTORE D AND RETURN
			17	

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# FLEX: An Operating System for the 6809

by Dale Puckett

**FLEX is a widely supported operating system for 6800- and 6809-based microcomputers. Its history, features, and applications are discussed.**

I was shocked, yet pleasantly surprised last month while reading a journal that reports only news about the SS-50 bus. There was an advertisement for a new plug-in board. Nothing unusual, but this board was designed to plug into an Apple. Why would any company run an ad for an Apple board in the flagship publication of the 68XX family?

The advertisement for the EXCEL-9 made sense when I read on. The board uses a 6809 microprocessor and has its own monitor. It lets the Apple owner switch between the 6809 or 6502 from either machine language or BASIC programs.

Its hardware features were interesting too — printer spooling, multi-tasking, 64K of RAM, programmable timers, etc. — but it was the software side of the advertisement that really caught my eye.

## Software Comes First

The ad's first selling point, listed above all of the hardware details, read: "EXCEL-9 FLEX, a famous DOS, Assembler and Editor included." Later in the list it mentioned that TSC 6809 BASIC, Extended BASIC, Precompiler, Sort/Merge, etc., were coming soon. As an extra selling point, ESD Labs Co., LTD of Mission Hills, California, the board's manufacturer, had included the FLEX DOS in the price of the board.

Although the EXCEL-9 isn't the subject of this article, it's appearance spurred me to do some additional research. Looking through the ads in a recent issue of MICRO, I noticed several other pro-FLEX movements.

The Computerist of Chelmsford, Massachusetts, was offering FLEXI Plus, a 6809-based single board micro-computer. It, too, runs under TSC's FLEX. The same company was also advertising FOCUS, a 6809-based micro with commercial quality keyboard, dual double-sided, double-density disks with more than 640K of storage on line, and memory-mapped video featuring bit-mapped graphics, user-definable character sets, reverse video, etc. Its operating system? FLEX.

Stellation Two was offering a plug-in board for the Apple called The Mill. It gives you a 6809 microprocessor with multi-tasking and multi-user capability. Microware of Des Moines, Iowa, is busy installing OS-9 on this board. I believe that it will only be a matter of time before someone brings FLEX up on The Mill.

Owners of the Radio Shack Color Computer, which already sports a 6809E microprocessor, will soon be able to run the FLEX operating system. Frank Hogg Labs of Syracuse, New York, has it on the market now. This version runs on the standard Radio Shack controller so Color Computer owners can have the best of both worlds: fantastic color graphics made possible by Microsoft's Extended Color BASIC, and the ever-growing library of sophisticated systems and applications software written to run under the FLEX operating system.

## Ability to Run on Many Machines Pays Off

All of this hardware information makes me stop and think. How can these manufacturers offer new processors and operating systems for microcomputers that have been around for several years — machines that already have their own established operating systems and hundreds of satisfied users?

In an attempt to answer that question, this article will look at FLEX from Technical Systems Consultants, Inc., (TCS) of Lafayette, Indiana, in great detail.

## FLEX — Its Roots

Almost every piece of software available for the 68XX family of processors is supplied on a FLEX-formatted disk. The trend started back in 1977 with mini-FLEX, a 4K operating system that resided from \$7000 to \$7FFF on SWTPC's 6800 box. But soon that 4K system gave way to FLEX 2.0, an 8K system which lived in high memory between \$A000 and \$BFFF. We had something going for us that no one else had — a disk operating system that would run on every 68XX machine. As a bonus, FLEX was versatile, reliable and easy to use from a high level language like BASIC or from our own assembly code.

Frank Hogg Laboratory went into business during 1979 to fill the demand for high quality FLEX-based software. The firm has since become the leading international distributor of systems and applications software for the 6809.

A look at a recent ad revealed that the company handles software from the major houses, TSC and Microware, as well as several dozen programs from independent authors. Application programs include: Dataman, a random database management system; SPELL-TEST, an extremely versatile spelling checker; READTEST, a program that tests the readability of English prose; DynaStar, a cursor-based editor that is extremely easy to use; The Bill Payer System, a series of 28 programs that automate the drudgery of paying the bills; and XFORTH, an interpreter that is totally FLEX-compatible and which supports an entire family of applications software including the Osborne General Ledger, etc.

## A Closer Look

The FLEX operating system gives you a powerful set of system commands which allow you to control all disk operations directly from the terminal. Yet, at the same time, it lets the system's programmer use a smorgasbord of disk access and file management routines. And each routine is thoroughly documented.

To the casual user the Utility Command Set is probably the most important part of the FLEX system. This set of more than two dozen highly useful commands resides on a system disk. Individual commands are loaded into memory when needed. They allow you to save, load, copy, rename, delete, append or list disk files. And these simple English words are actually the commands that you type. A complete listing of the supplied utilities is shown in table 1.

There are two other major parts of the FLEX system: The File Management System and the Disk Operating System. Together they give you fully dynamic file space allocation, automatic removal of bad sectors on a disk, automatic space compression and the ability to match the system to your terminal.

## Standard System Requirements

FLEX requires 8K of high memory and a minimum of 12K of low memory. The 6809 version runs at \$C000 to \$DFFF. The 6800 versions still reside at \$A000. A minimum of two disk drives is required by most utilities. Although it is possible to operate with one drive, it isn't much fun.

On the majority of the SS-50 computers, FLEX is booted into memory by a single-letter command in the monitor. In about two seconds a banner is printed and you are asked for a date. After this is entered you will see the famous FLEX prompt, "+ + +." The three plus signs mean that the operating system is ready to accept your command.

Your files are put into sectors on the disk. Each sector holds 256 bytes of information. Four of these are used to tell FLEX where to read or write its next sector, and the remaining 252 hold your data. When you delete a file, the sectors you had been using are automatically released to the system and become available for use by new files. This is known as dynamic allocation.

Your FLEX files will have filenames containing up to eight alphanumeric characters plus a three-character extension. The extension lets you and the system know what type of information is in the file. APPEND.COMD, for example, is a command which allows you to combine two files together into a third file. STARS.BAS is usually a BASIC source file which runs on one of the many BASIC interpreters available to FLEX users.

It is possible to specify the drive on which you want the system to search for a file. However, most of us use the default system, or work, drives, a FLEX convention that makes life easy. A utility command lets us change the drive assignments at any time. For example, "ASN S=0, W=1" will assign drive zero as the system drive and drive one as the work drive. Then, if "LIST THISFILE" were typed, FLEX would go to drive zero and read in the command

Table 1

Name	Function
APPEND	Append two or more files into a third file
ASN	Assign the System or Work drives
BUILD	Place a short text file on a disk
CAT	List a catalog of the files on a disk to the terminal
COPY	Copy one file to another
DATE	Print or change the system date
DELETE	Delete a file from the disk
EXEC	Use lines of text in a file as command lines
GET	Load a file from the disk into memory
I	Get the input from specified file instead of terminal
JUMP	Execute machine code at Hex address
LINK	Point boot routine to a specific file for start up
LIST	Print a text file on the terminal
MON	Return to the system monitor ROM
NEWDISK	Initialize a new disk in the proper format
O	Re-direct output to the specified file
P	Re-direct output to the printer
PRINT	Spool output from the file to the printer
PROT	Set the protection status of a file
QCHECK	Check status of file in print queue
RENAME	Change the name of a file on the disk
SAVE	Save memory to disk
TTYSET	Set terminal parameters
VERIFY	Turn verify mode on or off
VERSION	Print version of program on terminal
XOUT	Delete all files with an .OUT extension

The Utilities above are standard with FLEX. Many vendors supply additional commands which use their hardware. For example, GIMIX of Chicago, Illinois, has a command which reads the time from the clock chip on their CPU card, etc. The Utilities below come in an extra package and may be purchased from TSC.

Name	Function
CHECK	Compare two disk files and report to terminal
CMPMEM	Compare binary file on disk to memory
CONTIN	Used to repeat complex EXEC command files
DIR	Similar to CAT, but it prints all directory information
DUMP	Dump a disk file in Hex and ASCII
ECHO	Echo an ASCII string to the terminal
EXTRACT	Take specific lines from one file and put them in another
FILES	Similar to CAT, but not as detailed
FIND	Find a string of characters in a disk file
FREE	Report free space remaining on a disk
HECHO	Echo a hex character to the terminal
MAP	Print the load addresses and transfer address of a file
MEMEND	Read the FLEX MEMEND address and report or change
PDEL	A prompting delete
RUN	Load and execute a position-independent program
SPLIT	Split a text file into two new files
ZAP	Delete files in a match list without prompting

Table 2

Address	Contents
\$C080-\$C0FF	Line Buffer
\$CC00	TTYSET Backspace Character
\$CC01	TTYSET Delete Character
\$CC02	TTYSET End of Line Character
\$CC03	TTYSET Depth Count
\$CC04	TTYSET Width Count
\$CC05	TTYSET Null Count
\$CC06	TTYSET Tab Character
\$CC07	TTYSET Backspace Echo Character
\$CC08	TTYSET Eject Count
\$CC09	TTYSET Pause Control
\$CC0A	TTYSET Escape Character
\$CC0B	System Drive Number
\$CC0C	Working Drive Number
\$CC0E-\$CC10	System Date Registers
\$CC11	Last non-ASCII character
\$CC12	User Command Table Address
\$CC14-\$CC15	Line Buffer Pointer
\$CC16-\$CC17	Escape Return Register
\$CC18	Current Character
\$CC19	Previous Character
\$CC1A	Current Line Number
\$CC1B-\$CC1C	Loader Address Offset
\$CC1D	Transfer Flag
\$CC1E-\$CC1F	Transfer Address
\$CC20	Error Type
\$CC21	Special I/O Flag
\$CC22	Output Switch
\$CC23	Input Switch
\$CC24-\$CC25	File Output Address
\$CC26-\$CC27	File Input Address
\$CC28	Command Flag
\$CC29	Current Output Column
\$CC2B-\$CC2C	Memory End
\$CC2D-\$CC2E	Error Name Vector
\$CC2F	File Input Echo Flag
\$CCC0	Printer Initialize
\$CCD8	Printer Ready Check
\$CCE4	Printer Output

The information above is listed to give you an idea of the magnitude of the information the FLEX programmer has available about his operating system. The actual documentation that comes with the system gives complete details.

file LIST. It would then go to drive one and open the file THISFILE.TXT and list it on the terminal.

### Redirect the Output

Now let's assume that you would like to list THISFILE on the printer instead of the terminal. You would simply type: P LIST THISFILE. If you wanted to build a disk file that contained a catalog of all the command files on the disk in your work drive, you would type: O CATALOG CAT.COMD. This would open the output file CATALOG.OUT and then direct the output of CAT to this file instead of the terminal. Later you could LIST the output file. Or you could PRINT it while you are working

on something else. This very handy process is known as spooling. Spooling makes it possible to print a 45-page listing from an assembler while you edit a new source file.

Any errors you make are reported to you in English. FLEX does this by maintaining a file of error messages on your system disk. If the file management system or DOS generates an error, the system reads the error number, finds the corresponding record on the file, and prints it on your terminal.

### The FLEX Memory Map

One of the best features of this operating system is the fact that everything is completely documented. For example,

the programmer's manual lists every memory location that contains any information of interest. You can check a handy chart and know just where to PEEK to find the character used by the system as its backspace symbol, how many columns the user has on his terminal, etc. Table 2 lists this information.

TSC has completely documented 22 individual routines that may be called by the systems programmer. They are vectored from a jump table so the calls are always at the same location, even though the user's version of FLEX may be different. This feature saves you a lot of work.

For example, I frequently check SPELLTEST, my spelling checker program for FLEX systems, to see if a character is alphanumeric or not. With FLEX it is easy.

```
JSR FMS      get a character from file
JSR CLASS    alphanumeric?
BCS NONAL    it's not, go
```

I get a character by calling the FMS. I check it by calling a routine called CLASS. In two lines of code I have accomplished what could have taken many, if I'd had to write my own CLASS routine.

Another example comes from READ-TEST, my readability tester.

```
LEAX NUMPW,PCR  point to personal
                  word count
LDB #1          tell FLEX to use
                  leading spaces
JSR OUTDEC      print the number
                  in decimal
LEAX NUMMSG,PCR point to message
JSR PSTRNG      let FLEX print it
```

Here, to tell the user how many personal words he used in his text, I simply pointed the 6809's X register to the location of the two-byte (16-bit) word, set the B register not equal to zero, and called the FLEX routine OUTDEC to print it. I then pointed the X register to an English language message and called another FLEX routine to print it. Again, if I had to write a routine to output a decimal number and another to output a string of characters, it would have taken a lot more code. Table 3 shows the routines that are available to programmers using the FLEX operating system



## The File Management System

This is the part of the system that lets your DOS talk to your disk hardware. It allocates all file space and removes it when a file is deleted.

You communicate with the FMS by using a file control block (FCB). These 320-byte blocks of RAM memory tell the FMS the name of a file, which drive it is located on, its length, etc. To talk to a disk file, you either read or write one character at a time through the FCB. Instead of calling an output routine such as the famous MIKBUG OUTEEE, you call the FMS.

LDA #A	put the character in A register
LEAX FCB,PCR	point X register to the FCB
JSR FMS	send it out to disk
BNE ERROR	go on error

The code above would send the character "A" out to a disk file. In practice it is actually a little simpler since you usually leave the X register pointing to the FCB for the duration of an output routine.

Table 3

Address	Function
\$CD00	Coldstart address
\$CD03	Warmstart address
\$CD06	DOS main Loop Re-entry point
\$CD09	Input Character
\$CD0F	Output Character
\$CD15	Get Character, honors TTYSET parameters
\$CD18	Put Character, honors TTYSET parameters
\$CD1B	Input into line buffer
\$CD1E	Print a String
\$CD21	Classify a Character: alpha or no
\$CD24	Print a Carriage return/line feed
\$CD27	Get Next Character from Buffer
\$CD2A	Restore I/O vectors
\$CD2D	Get a File specification
\$CD30	Load a File
\$CD33	Set an Extension code
\$CD36	Add B Register to X Register
\$CD39	Output a Decimal Number
\$CD3C	Output a Hex Number
\$CD3F	Report an Error
\$CD42	Get a Hex Number
\$CD45	Output a Hex Address
\$CD48	Input a Decimal Number
\$CD4B	Call DOS as a subroutine
\$CD4E	Check Terminal Input Status

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#### Talbot Microsystems

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(TM) FLEX is a trademark of Technical Systems Consultants.

## C Compiler for 6809

Adapted from Ron Cain's SMALL-C. FLEX9 version requires RLOAD (included on separate disk). Full C to come in three steps: 1.0 now; 2.0 - 3Q/82; 3.0 - 1Q/83. Upgrade policy and prices to be announced. Run-time library source included. 48K recommended.

- For FLEX9 (with loader) \$52.50
- (If you already have RLOAD) \$47.50
- RLOAD 3.0 separately \$17.50
- For DOS69D (specify assembler) \$47.50

Shipping included. Prices good until July '82. Add \$2/disk for 8". Add \$2 handling for Visa/MasterCard. Allow 4 weeks for non-certified check. Please do not send cash. Texas residents: add \$0.25 sales tax per 5" disk, \$0.35 per 8" disk.

FLEX is a trademark of Technical Systems Consultants. DOS69D is a trademark of Smoke Signal Broadcasting.

## word's worth

P.O. Box 28954  
Dallas, Texas 75228

Used in this way, the disk looks no different to your program than a computer terminal. You may have one file open for reading and another open for writing. In fact, you may have as many files as you need open at one time, as long as you have assigned a separate file control block to each one.

As a programmer, you communicate with the File Management System by using function codes. For example, the number "1" is to open a file for read. To perform this operation you need only store "1" in the first byte of the file control block, point the X register to the block, and call FMS as a subroutine. If the operation is successful, FMS will return with the carry clear. If not, the carry bit will be set and the number code of the error will be in the second byte of the FCB. You can then read that byte and see if it is something you expected, such as end-of-file. After reading this byte you can take the appropriate action. Table 4 provides a look at function codes available to FLEX programmers.

### Summary

FLEX supports random files and can reach any sector in a file after no more than two disk reads. It is also easy to reach a specific character in a file by doing a small calculation using the number of bytes in a sector.

This operating system has many other features that make it a dream to program at the assembly level. But, more importantly, it is user-friendly and its syntax is simple. In fact, you'll find it much easier to use at the command level than CP/M (the popular Z-80-based operating system). When you consider this and couple it with the fact that a large base of very sophisticated application programs already runs under this operating system, it is easy to see why the hardware firms mentioned earlier made the choice to offer the FLEX operating system.

The author may be contacted at 14753 Endsley Turn, Woodbridge, Virginia 22193.

**MICRO**

Table 4

Number Code (decimal)	Function
1	Open For Read
2	Open For Write
3	Open for Update
4	Close File
5	Rewind File
6	Open Director
7	Get Information Record
8	Put Information Record
9	Read Single Sector
10	Write Single Sector
11	Reserved
12	Delete a File
13	Rename a File
14	Reserved
15	Next Sequential Sector
16	Open System Information Record
17	Get Random Byte from Sector
18	Put Random Byte in Sector
19	Reserved
20	Find Next Drive
21	Position to Record N
22	Backup One Record

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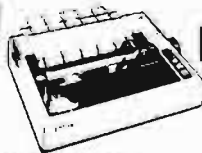
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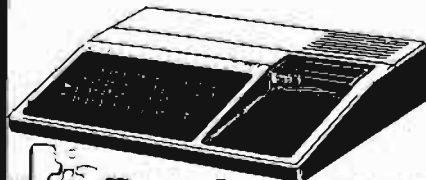
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# MICRO

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## Reviews in Brief

---

**Product Name:** Color Scripsit  
**Equip. req'd:** TRS-80 Color Computer, 4K minimum; line printer  
**Price:** \$40.00  
**Manufacturer:** Tandy Radio Shack  
P.O. Box 2625  
Fort Worth, TX 76113

**Description:** Color Scripsit is the TRS-80C version of Tandy's word processors. It consists of a text editor and formatter and is designed for the home computer market. The text editor is screen-oriented and uses the four arrow keys for cursor movement. The 23 functions include: tab control; character and word delete; block delete; move and copy; global search and change; and a routine that allows you to hyphenate words. The formatter allows lines up to 132 characters long. The screen will scroll to the right as entered, and text is viewed through the 32-character window when line lengths longer than 32 characters are selected. Pagination, headers and footers are also supported. Lines may be centered, or aligned left or right. Multiple line spacing and variable page lengths are also allowed. File storage is cassette-based.

**Pluses:** The program is in a ROM PAK, therefore nearly all RAM is available for text storage, 31,528 bytes in the 32K machine. Global search ignores upper/lower case differences unless otherwise specified. Keys are repeating when held down and text can be changed by just typing over the undesired text. Merging from cassette files is allowed, and ASCII files from other sources or programs in ASCII format are accepted. Text files are saved either in ASCII or in a compact form. Format standards are saved to tape with the text. Print options include single line, partial, or entire document.

**Minuses:** Lack of lower case display generator sometimes makes it hard to tell whether a letter is upper case or lower case. Right justification is not supported. Some keyboard characters are not available; e.g., brackets, arrows, and back slash. The right scrolling display is sometimes disconcerting, though text can be entered and formatted later in some cases. No indication of page length or number of pages is given until the document is printed.

**Documentation:** A well-written 8½" × 11," 40-page manual is provided, and includes many examples of text to enter and process. I located no errors in the manual, and the only part I had trouble understanding was on setting up headers and footers.

**Skill level req'd:** This program is for the average consumer who wants a word processor for his TRS-80C. Good quality copy can be produced with only an evening's study.

**Reviewer:** John Steiner

**Product Name:** AIM Language ROM Switcher (ALRS)  
**Equip. req'd:** Rockwell AIM 65 Computer  
**Price:** \$55.00  
**Manufacturer:** Forethought Products  
87070 Dukbobor Road  
Eugene, OR 97402

**Description:** The ALRS is a small printed circuit board which plugs into AIM 65 ROM sockets Z25 and Z26. On board the ALRS are six ROM sockets which accept 2332-type ROMs. The ROM sockets are organized as three pairs of two sockets each. Each pair occupies the address range of \$B000 through \$CFFF. An on-board switch (there are provisions for a remote switch) determines which ROM pair is active at any given time. As a bonus, one of three small LEDs lights to provide a visual indication of the active ROM pair.

**Pluses:** The ALRS is ideal for switching between Rockwell BASIC, PL/65, and FORTH. It saves a lot of wear and tear on the AIM sockets. It also minimizes damage to the language ROMs themselves from static discharge and mechanical stress.

**Minuses:** The top of the ALRS board is not solder-masked. Thus, the traces for the address lines are exposed. Exercise the normal precautions, especially if your AIM 65 is not enclosed, against letting specks of solder and wire clippings foul the computer.

**Documentation:** Three pages of documentation include installation and operating instructions, a schematic, and a parts list. Due to the nature of the product, the instructions are brief, but they are thorough and clear.

**Installation:** Consists of plugging the ALRS board into the AIM ROM sockets. The ALRS plugs are perfectly aligned with the AIM sockets, making this operation a snap. Once installed, a rubber foot on the bottom of the ALRS board provides the only other mechanical support needed.

**Notes:** The ALRS board is not designed to work with Rockwell's Pascal ROMs since Pascal is not available as a two-ROM chip set. Having six ROMs connected to sockets Z25 and Z26 will obviously consume more current than would two ROMs. Normally this should not cause a problem, but you may wish to verify that your power supply can handle the extra load anyway.

**Reviewer:** Christopher J. Flynn

**Product Name:** Hi-res Secrets  
**Equip. req'd:** Apple II with Applesoft in ROM  
**Price:** \$125.00  
**Manufacturer:** Avante-Garde Creations  
P.O. Box 30160  
Eugene, OR 97403  
(503) 345-3043

**Author:** Don Fudge  
**Copy Protection:** 2 disks, yes; 2 disks, no  
**Language:** Applesoft, 6502 machine language with commented source provided

**Description:** An educational graphics utility package for the generation of hi-res shapes using novel techniques. Contains commented machine language utilities with source code and extensive teaching material.

**Pluses:** This four-disk package contains a 263-page book on hi-res graphics. Its purpose is to teach several novel approaches to hi-res shape creation and motion. Two of the "secrets" are the use of block graphics and Hplot shapes. Block graphics moves the binary data defining the shape around the hi-res memory, thereby providing motion to the shape. Many utilities are provided for creating block shapes from scratch, "scanning" them from already existing hi-res screens, and creating shape tables from existing

*(Continued on next page)*

## Reviews *(Continued)*

block graphics. Hplot shapes are machine language versions of graphics normally created through the use of the Applesoft HPLLOT command. These perform much more rapidly and allow for smoother action. The manual and disks contain many other secrets covering subjects such as: page flipping, sounds, font creation and 560-point resolution, color fill-in and color filtering.

Don Fudge has an objective of conveying information to Apple users. This package is not just a series of utilities; rather it is an attempt at educating on the use of hi-res graphics and related subjects. Don's sense of humor and light style make for easy reading of a fairly technical subject.

Minuses: The manual is an extensive collection of ideas which may seem overwhelming at times, especially to the less-experienced programmer. Constant references to other software packages sold by Avante-Garde detract somewhat from the presentation. Although the manual is in its third printing, the first meaty chapter, "Shapes and Other Mysteries," contained several errors. Two addresses are referred to as \$3001 and \$3000, which should be \$3C01 and \$3C00 (top of page 22). I would like to have seen a brief summary of the block shape and Hplot shape idea early in the manual just to clarify the most basic concepts used.

One of the most interesting utilities, Instant Graphics, is not well documented. While a reference card is provided, no overview of the utility is given. The manual indicates that an 88-page document can be obtained from AG.

Skill level required: introductory knowledge of machine language. Familiarity with machine language generation of graphics will permit more use of the utilities provided.

Reviewer: David R. Morganstein

**Product Name:** **Grafix SEB-1 and SEB-2 Color Hi-res Graphics Boards**  
**Equip. req'd:** OSI SEB-1 for 1P and Superboard; SEB-2 for 48-pin bus systems  
**Price:** \$59/\$199/\$239 for bare board/kit/assembled  
**Manufacturer:** Grafix  
911 Columbia Avenue  
N. Bergen, NJ 07047

Description: Grafix boards use the 6847 video display generator to produce color graphics with up to 256 x 192 resolution. The highest resolution mode has only one color while lower resolution modes can have up to eight different colors. Upper case alphanumeric characters (not OSI character set) are also displayed. In addition to graphics, the SEB-1 contains 16K of 2114 type memory for program storage. The SEB-2 adds a floppy disk controller to OSI bus machines.

Pluses: Guard bands are provided, thus all dots are visible with none lost to monitor overscan. Many different modes of color graphics are available. Colors appear as shades of gray on a B&W monitor. Output can be video or R.F. Connection is made to your present machine only through 40-pin expansion port or 48-pin bus.

Minuses: The graphics memory is only 6K leaving a 2K hole in the memory map. Output cannot be combined with OSI video. A second monitor or a switch to select outputs is required. The color oscillator causes a slight herringbone pattern in the displayed picture. The many different graphics modes are really a plus, but tend to confuse the beginning programmer.

Documentation: Assembly instructions, demonstration programs, 6847 data sheets.

Skill level required: Experienced builder for kit, assembled unit plugs in.

Reviewer: Earl D. Morris

**Product Name:** **Cer-Comp Co-Resident Editor/Assembler for the Color Computer**  
**Equip. req'd:** TRS-80C Color Computer with 16K  
**Price:** \$39.95  
**Manufacturer:** Cer-Comp  
5566 Ricochet Avenue  
Las Vegas, NV

Description: The Cer-Comp Color Computer Editor is coupled with an assembler, runs in R/W memory, and is distributed on cassette tape in the Color Computer tape format. Besides having 21 Editor commands, it supports 12 assembler directives, six assembly options, and seven options for two- and three-pass assembly. Assembly can be to screen or printer, and it is possible to go directly from assembly to the machine code to test the program just assembled. It is compatible with either BASIC or an assembly-language monitor. It produces compatible 6809 object code from either 6809 or 6800 mnemonics, with some syntax restrictions.

Pluses: Exceptional low price, does not require Extended BASIC, excellent flexibility, short learning curve, very versatile.

Minuses: Skimpy documentation, no listing, screen format of assembly listing difficult to read, uses too much memory by not being available in ROM.

Skill level required: Normal typing skills, familiarity with standard 6809 assembly-language conventions and understanding of advanced assembler directives.

Reviewer: Ralph Tenny

**Product Name:** **Epson to Color Computer Interface**  
**Equip. req'd:** TRS-80 and Epson MX-80 or MX-80/FT  
**Price:** \$60.00  
**Manufacturer:** Texas Computer Systems  
Box 951  
Brady, TX 76825

Description: Interfaces the TRS-80 Color Computer to the Epson MX-80 series printers. Plugs directly into a connector inside the printer, and terminates in the four-pin DIN plug that fits the TRS-80C. Operates the MX-80 at the normal TRS-80C 600 baud.

Pluses: Provides an easily installed connection between the computer and peripheral. Eliminates the need for special serial-to-parallel interface hardware. Allows the sending of all special control codes to format the printer via CHR\$ commands.

Minuses: The Epson graphics set is not accessible, even when using the PTFX system tape, or the 1.1 ROM. TCS is working on this to verify if it is printer- or interface-related.

Documentation: None provided, though the Epson manual provides all instructions necessary for installation.

Skill level required: Simple installation, if you are not afraid of opening electronic equipment.

Reviewer: John Steiner

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ANIX is the start of a complete line of system software tools available from Lazer MicroSystems, Inc. All new languages and applications programs available from Lazer will run under the ANIX operating system. Lazer Pascal is available now. Other languages and systems are in the works. Productive programmers are already using ANIX, are you?

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Lazer Pascal supports BYTE, CHAR, BOOLEAN, INTEGER, LONG, pointer, string, array, static, and dynamic data types. Lazer Pascal was created to replace 6502 machine language as the choice of systems and game programmers. Included with Lazer Pascal are several sample programs demonstrating the use of Lazer Pascal including: ANIX.P, TSTPARMS.P, LINECOUNT.P, WORDCOUNT.P, CHARCNT.P, EXPAND.P, COMPRESS.P, CRYPT.P, and TRANSLIT.P. Better yet, the source listings for the compiler, P-code interpreter, and other utilities are included.

D  
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## A High-Powered 6502 Disassembler for the Apple II

DISASM/65 produces a 6502 assembly language source listing from machine code and a set of input commands. Only DISASM/65 supports all the commonly used data types found in machine language programs. We used DISASM/65 to disassemble DOS 3.3 for our popular DOSOURCE 3.3 product-- that should describe DISASM/65's power! DISASM/65 is provided with our popular LISA V2.5 assembler. Several users, however, have reported considerable success using DISASM/65 with the Toolkit assembler, the SC Assembler, TED, and others; so we are offering DISASM/65 separately for these users.

## p-SOURCE

### The Internals of the Apple P-code Interpreter Explained

p-SOURCE is a technical manual that describes the internal operation of the Apple Pascal P-code interpreter. Included are descriptions of programming techniques used within the interpreter, hints on how to speed up the interpreter, add your own routines to it, and incorporate hardware floating point. p-SOURCE is absolutely essential to the Pascal programmer.

ANIX, Lazer Pascal, p-SOURCE and DISASM/65 were all written by Randy Hyde, the author of "USING 6502 ASSEMBLY LANGUAGE", LISA, SPEED/ASM, DOSOURCE 3.3, and other fine software products. Additional information on Lazer's software products can be obtained by calling or writing Lazer MicroSystems, Inc.

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# MICRO

## PET Vet

By Loren Wright

With this issue of MICRO centering on the 6809, it seems appropriate to cover the 6809 aspect of the SuperPET in a little more depth.

The SuperPET is a new computer from Commodore, aimed especially at the educational market. Included with the computer are interpreted versions of APL, BASIC, Pascal, and FORTRAN. COBOL, and compiled versions of some of these languages, are on the way (at extra cost, of course!). Also included is a serial interface, which allows files to be sent from the SuperPET to a mainframe with the same interpreter.

### SuperPET Architecture

The SuperPET looks just like an 8032 from the outside, but on the inside there are a few differences. Two circuit boards are stacked on top of the main board. The lower one includes the 6502 (moved up from the main board), a 6809, and the circuitry for the serial (RS-232C) interface. The upper board contains 64K of additional RAM. This may be write-protected under either switch or program control. There is also a switch to determine on power-up whether the machine is under 6502, 6809, or program control.

Since neither the 6502 nor the 6809 can address more than 64K, the extra 64K of RAM is divided into 16 banks of 4K, and a mechanism called "bank-switching" is used to put one bank at a time into the \$9000 block of the address space.

The 6809 has its own processor-dependent set of ROMs, just like the 6502 has its PET-BASIC ROMs. The rest of the SuperPET is shared — available directly to the current processor. Address ranges \$A000-\$E7FF and \$F000-\$FFFF are processor-dependent, while everything else, including the bank-switched RAM, is available to either processor.

When the SuperPET is running one of its interpreters, the 6809 is in control, the interpreter is stored in the bank-switched RAM, and the user's program is stored in the lower 32K of RAM. Most people will use the SuperPET in this configuration. However, it is possible to use the SuperPET as an 8032, running Wordcraft, OZZ, and other business software. These programs do not utilize the extra RAM, however, and it is unlikely that future versions of these programs will, either. The business market is supported by the 8096.

You can also write your own 6809 programs using the included Assembler/Linker package. The rest of this discussion covers the features and use of this powerful package.

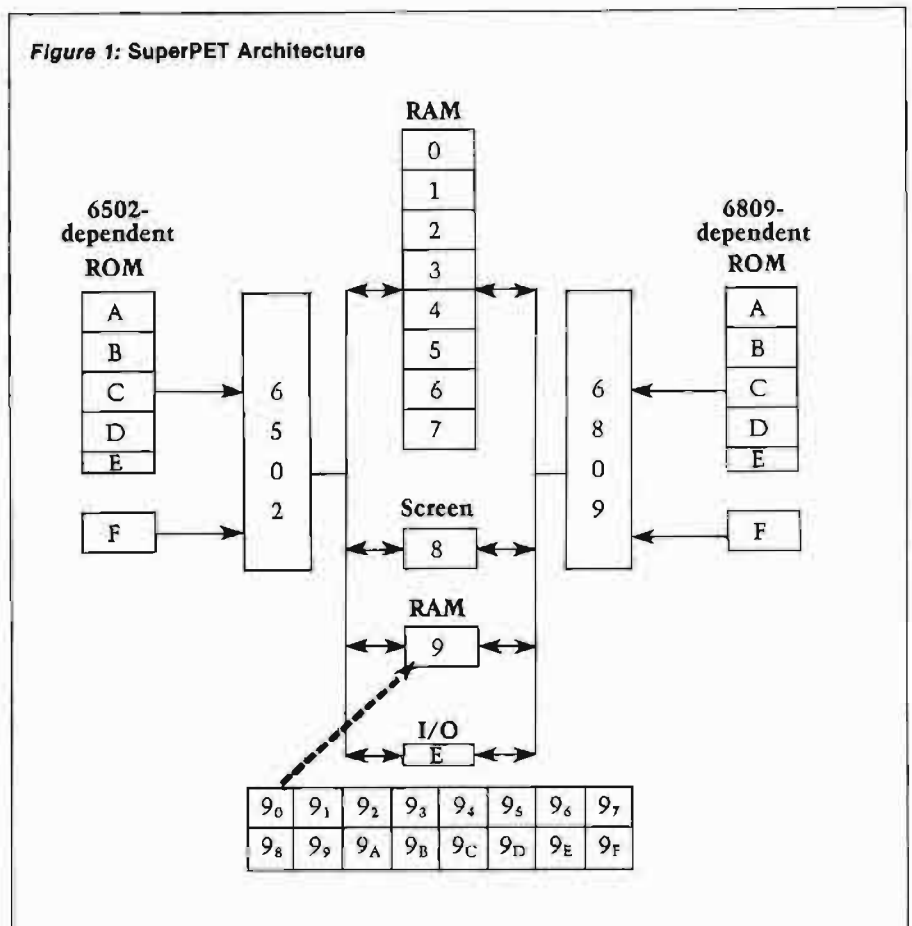
### The Waterloo Assembler/Linker

When the SuperPET is powered up in the 6809 mode, one of the choices offered from the menu is "development." When this option is selected, another menu is presented with the options: asm, edit, linker, monitor, and quit. Quit returns you to the main menu.

### Editor

The first step is to create a source file in the editor. This is the same editor used by Pascal, FORTRAN, and BASIC. It is basically a powerful line editor, but PET-type screen editing and a number of window commands are offered. Tab stops can be set to help provide a suitably indented, structured listing.

Figure 1: SuperPET Architecture



## PET Vet (Continued)

### Assembler

The assembler creates two files: a list file, with the object code appearing adjacent to the source, and the object file. Because the 6809 code is generally relocatable, the assembler does not require an ORG statement. The locations of the resulting object files are determined in the linking process.

There are several "structured" constructs available with the assembler: IF...ELSE...ENDIF, GUESS...ADMIT...ENDGUESS, LOOP...ENDLOOP, LOOP...UNTIL, and QUIT (which may be used within the other constructs). The condition tested by IF or QUIT may be any of the conditions tested by the 6809's branch or long-branch instructions.

The assembler also offers conditional assembly, macro capabilities, and a variety of pseudo-ops. Operands may include Boolean expressions, as well as addition, subtraction, multiplication, and division.

### Linker

The linker receives instructions from a command file created with the editor. The command file includes the

program origin, the names of the object modules, the names of any library files, and the name to be applied to the executable module. Bank switching, bank sizing, and names of global variables are also specified in the command file.

### Monitor

To run your program, you must enter the monitor and load the module created by the linker. In addition to the usual dump, save, go, load, and register commands, there are bank, fill, passthrough, and translate (=dis-assembler). Additional commands set and clear breakpoints for debugging.

### Documentation

Like the other elements of the Waterloo "micro-" software, the assembler/linker is supported with a reference manual. The first part consists of a series of exercises that serve more to familiarize you with the features of the package than to teach 6809 assembly language. The remainder of the manual is a good reference on the various components of the package and the programs included in the system library.

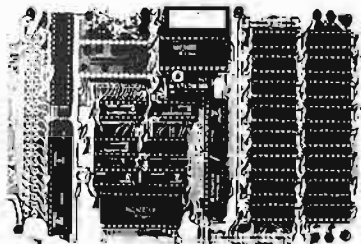
Donald Cowan of Waterloo University has written a text on 6809

assembly language programming. This text is available from WATFAC Publications Ltd., P.O. Box 803, Waterloo, Ontario, Canada N2J 4C2 for \$10 (prepaid only). Some dealers may also have this book available. The next edition will be a bound book, while the first two editions are intended to be put into a three-ring binder. It is an excellent text for learning 6809 assembly language on the SuperPET.

### New 8096 Software

Most business software packages available for the 8032 have now been rewritten for the 8096. In addition, new products are being produced, like the "Silicon Office" from the creators of OZZ. The package includes a versatile data base manager that allows transfer of data from one data base to another or to the built-in word processor. There is also a communications module, which allows communication between "Silicon Office" installations. My brief encounter with this software left me truly impressed. However, a package of this magnitude obviously requires a much more thorough evaluation. If "Silicon Office" (or at least its concept) is any indication of the future support we can expect for the 8096, then we will be seeing some truly fantastic software.

**MICRO**



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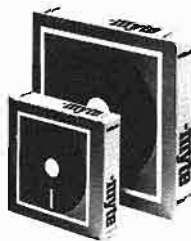
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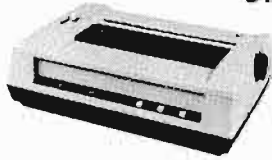




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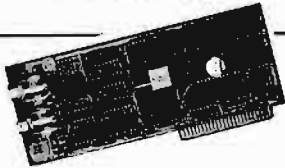
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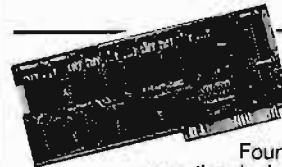
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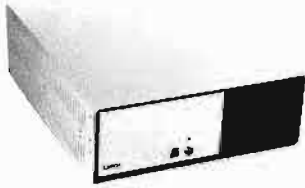
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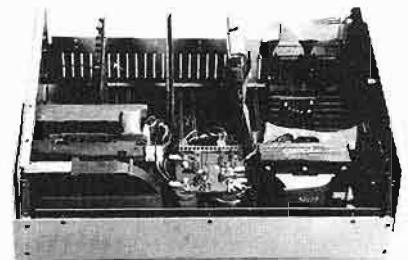
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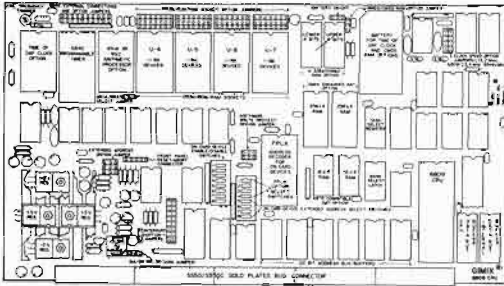
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- Separate buffers for the 6809 and the on card devices

- 4 PROM/ROM/RAM sockets for monitors and user software (up to 32K)
- PROM/ROM/RAM sockets individually jumper selectable for single or multiple supply voltage and 1, 2, 4 or 8K byte devices (Some FPLAs do not support 8K devices)
- 1K bytes of scratchpad RAM
- 6840 programmable timer with provisions for external clock, gate and output connections
- Time of Day Clock (58167) w/Battery backup
- 9511A or 9512 Arithmetic Processor w/Jumper selectable 2, 3, or 4 MHz clock speeds (optional)
- FPLA address decoding for the 8 on card devices 4 PROM/ROM/RAM sockets, 58167, 9511A/9512, 6840, 1K scratchpad RAM
- Software switching of address configurations for the 8 on card devices (allows software switching between on board PROM/ROM/RAM resident system monitors)
- All FPLA decoded devices can be individually enabled/disabled
- FPLA decoded devices are available for DMA access
- Extended addressing for the FPLA decoded devices (can be disabled)
- Software switching between on and off board system monitors using extended addressing
- Jumper selectable interrupts for the 6840, 58167, and 9511A/9512
- NMI input can be jumpered to the bus or to an external connector
- BA & BS jumper selectable for independent or gated operation
- User defined latch output
- Gold MOLEX connectors for trouble free contact
- SS-50 and SS-50C compatible
- Full DMA compatibilities (works with any of the 6809 DMA methods)
- Full Slow memory capabilities
- Fully assembled, tested and burned in

**NOTE:** GIMIX 6809 CPU BOARDS do not include a baud rate generator. In systems that require a baud rate generator, it must be provided elsewhere. The GIMIX 6800/6809 mainframe includes a baud rate generator on the master board.

## 2 MHz 6809 PLUS CPU #05 ..... \$578.05

The GIMIX 6809 PLUS CPU board has a variety of other options that may be ordered at the time of purchase or added later. It is fully socketed to allow adding the following options at any time.

- GIMIX ENHANCED Dynamic Address Translation ..... **\$35.00**      SWTPC Compatible DAT (required for SBUG-E) ..... **\$15.00**  
 1K CMOS Scratchpad RAM (1.5 MHz) Substitution ..... **\$ 8.00**

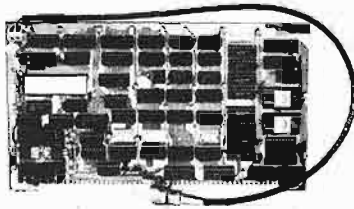
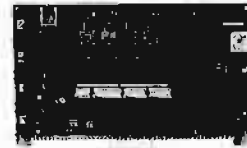
### ARITHMETIC PROCESSORS

- 9511A (32 bit math w/transcendentals) 4 MHz ..... **\$312.00**      9512 (64 bit math only) 3 MHz ..... **\$265.00**

## GIMIX 6800 CPU BOARD

- 6800 MPU
- 4K EPROM (2708)
- 128 byte RAM
- 6840 Programmable timer (optional)
- DIP-switch EPROM addressing, compatible with most standard 6800 monitors.

- ..... **\$224.03**
- With 6840 ..... **\$288.06**
- Baud Rate Option Add .. **\$ 30.00**



## THE UNIQUE GIMIX 80 x 24 VIDEO BOARD

Upper and Lower Case with Descenders • Hardware Scrolling

Contiguous 8 x 10 Character Cells • X-Y Addressable Hardware Cursor

**IT IS THE ONLY VIDEO BOARD THAT GIVES YOU:** A user programmable RAM character generator. Custom character sets, up to 128 characters each, can be stored and loaded into the board **under software control**, from disk, tape, etc. The ability to choose, **under software control**, 256 displayable characters from 384 available in the 3 on board 12 EPROM and 1 RAM character generators.

The ability to divide the 256 displayable characters into 8 groups, according to **both** ASCII Code and bit 8, lets your program determine how each group is displayed. (Which character generator to use, and whether it will be normal or inverse video, full or reduced intensity or a combination of these.)

**GHOSTability:** to place multiple boards at the same address and access them individually without affecting the display of the other boards.

The ability to control all these features, on the fly, through software.

- ★ Fully decoded, occupies only 2K of address space
- ★ Fully socketed — Gold bus connectors.
- ★ Assembled, Burned in, and Tested at 2MHz

Deluxe Version with RAM Character Generator . . . **\$458.76**      Without RAM Character Generator . . . **\$398.74**

★ 50 Hz Versions Available ★

Versions of GMXBUG-90/FLEX and OS-9 that use the GIMIX 80 x 24 VIDEO BOARD in place of a serial terminal are available. These versions require a user supplied video monitor and parallel ASCII keyboard. Contact GIMIX for more information.

**Also Available:** For Use with Master Antenna Systems,  
 Our 64 or 32 x 16 Fully Interlaced, Uppercase Only, Video Board . . . . . **\$198.71**

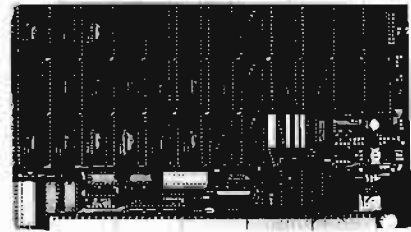
**GIMIX** inc.   
 1337 WEST 37th PLACE  
 CHICAGO, ILLINOIS 60609  
 (312) 927-5510 • TWX 910-221-4055

# 2MHz 64K BYTE STATIC RAM BOARD \$638.67

for 6800 and 6809 systems using the SS-50/SS-50C bus

Also available...

56K .....	\$578.57
48K .....	\$518.47
32K .....	\$398.37
24K .....	\$348.27



All versions have gold bus connectors and are fully socketed, assembled, burned in, and tested. Versions with less than 64K can be expanded at any time by adding additional RAM chips.

## FEATURES:

★ ADDRESSABLE in two 32K sections with separate regular and extended address decoding for each section. Each section can be addressed to any 32K boundary in the address range (1M Byte with extended addressing). Each 32K section is divided into four 8K blocks that can be individually enabled or disabled. Disabled sections do not occupy address space.

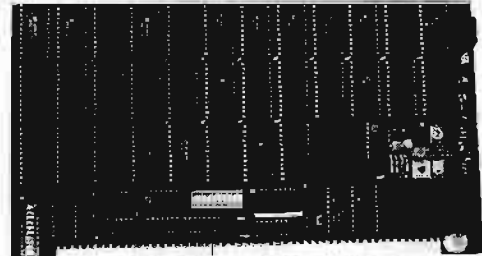
- ★ FULLY STATIC MEMORY does not require complicated refresh timing or clocks for data retention. Compatible with any of the 6800/6809 DMA techniques.
- ★ GUARANTEED 2MHz. OPERATION uses high speed (200 ns.) memory with no wait states or clock stretching required.
- ★ LOW POWER NMOS RAM requires less than 3/4 AMP (750 ma) typical at 8V, for a fully populated 64K board.

Also available...

## NON-VOLATILE 64K BYTE CMOS STATIC RAM BOARDS with BATTERY BACK-UP

With all the versatility of the above boards... PLUS!

- ★ NON-VOLATILE MEMORY with built in battery back-up. Retains data even with system power removed. With the battery fully charged, data remains intact for a minimum of 21 days.
- ★ ULTRA-LOW POWER CMOS RAM requires less than 1/4 AMP (250 ma.) typical at 8V for a fully populated 64K board.
- ★ LOW BUS VOLTAGE DETECTION inhibits memory access during power up and power down to prevent false writes to the memory.
- ★ WRITE PROTECT SWITCH permits the entire board to be write protected for PROM/ROM emulation and software debugging.



64K.. \$798.64 — 56K.. \$728.56 — 32K.. \$518.36

All above RAM Boards are guaranteed for 2MHz operation.

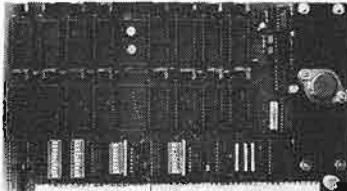
## 16 SOCKET EPROM / ROM / RAM BOARD

WITH EXTENDED ADDRESS DECODING

For Use With: Existing SS50 Systems and SS50C Extended Address Systems

FEATURES: Up to 128K on a single board (using 8K devices)

Can be used with 2, 4, and 8K 24 pin, 2716/2516 pinout, single supply voltage EPROMs and most pin-compatible ROMs and static RAMS.



- Device sizes and types can be mixed on the same board
- 2 separate 8 socket sections
  - DIP-switch selection of base address for each section
  - Individual address decoders for each section, including extended address decoding
  - Bi-polar PROMs for address decoding allow mixing of device sizes within a section
  - Separate slow memory generation for each section. (6809 only)
- Each socket is jumper programmable for device size and type (2, 4 or 8K PROM/ROM/RAM)
- Fully Buffered      • Fully Socketed      • Gold Bus Connectors

ASSEMBLED, BURNED-IN, AND TESTED .....

**\$238.32**



### 8K PROM BOARD .....

**\$98.34**

- Holds eight 2708 or 2708-compatible ROMS.
- Gold Bus Connectors
- DIP-switch addressable to any 8K boundary.

## HIGH RESOLUTION BIT MAP GRAPHICS BOARD SET

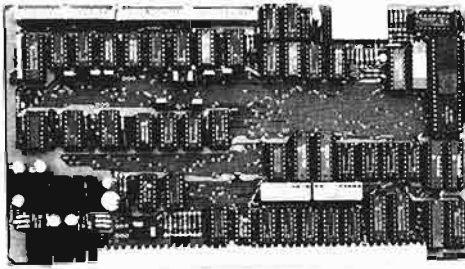
FEATURES: — 512 x 512 Dot resolution — A board set consisting of the Graphics Controller Board and the Screen Memory Board (32K of memory) — Does not tie-up the processor or system bus for screen refresh — Occupies 8K of address space plus 8 bytes for control ports — Separate DIP-switch selection for screen memory and control port addressing — GHOSTability allows multiple boards to be placed at the same address and be enabled/disabled under software control — Extended address decoding for SS50C extended address lines

ASSEMBLED BURNED IN AND TESTED .....

**\$996.77**

NOTE: This Graphic Board Set requires a high resolution video monitor such as the MOROTOLA M4408 with a 30KHz horizontal scan rate.

**GIMIX** inc. 1337 WEST 37th PLACE • CHICAGO, ILLINOIS 60609 • (312) 927-5510 • TWX 910-221-4055



## GIMIX DMA DOUBLE DENSITY DISK CONTROLLER #68

The GIMIX DMA (Direct Memory Access) DISK CONTROLLER has the capabilities needed to realize the full potential of today's sophisticated multi-user/multi-tasking operating systems such as OS-9™ and UniFLEX™.

**HIGH SPEED** using bi-polar logic DMA circuitry for guaranteed operation at 2MHz. DMA transfers take place at full bus speed using 6809 cycle steal DMA. Once the required parameters are passed to the controller and DMA transfer is initiated the processor is free for other tasks. Interrupts can be generated to indicate the completion of the transfer.

**SINGLE AND DOUBLE DENSITY** data storage on any combination of 5 1/4" and 8" floppy disk drives; single and double headed, single and double track density, up to 4 drives total.

**LOW ERROR RATES** are insured by a data recovery circuit (data separator) and adjustable write precompensation circuitry for drives that require precomp. Separate precomp adjustments are provided for 5 1/4" and 8" drives.

**ADDRESSABLE** to any 8 byte boundary in the address space (1M byte when extended address decoding is used). The board occupies only 8 bytes of address space.

**EXTENDED ADDRESSING** control using the SS-50C extended address lines. Control of the extended address lines allows the board to perform DMA transfers to and from any address in the 1M byte address space.

**FULLY BUFFERED** with separate 5 1/4" and 8" output buffers and schmidt trigger input buffers for the disk drive signals.

The DMA controller leaves the processor free to perform other tasks once the transfer is initiated, unlike programmed I/O disk controllers which require full time use of the processor during data transfers to and from disk.

This is extremely important in a multi-user/multi-tasking environment as the processor can perform other tasks such as console I/O while a disk transfer is in progress.

#68 fully assembled, burned in, and tested ..... \$588.68

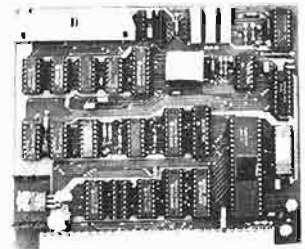
## GIMIX DOUBLE DENSITY PIO DISK CONTROLLER #28

The GIMIX DOUBLE DENSITY PIO (PROGRAMMED I/O) DISK CONTROLLER is a versatile floppy disk interface for use in 6809 systems on the SS-50 or SS-50C bus. The board physically occupies one slot of the 30 pin I/O bus.

- Double the unformatted storage capacity of single density controllers
- Single and double density operation
- Phase lock data recovery circuit (data separator)
- Adjustable write precompensation (precomp)
- Controls up to four 5 1/4" drives
- Controls single and double headed drives
- Designed to meet the data hold-time requirements of the Western Digital 1797 floppy disk controller I.C.

The GIMIX DOUBLE DENSITY PIO DISK CONTROLLER is ideal for systems that require greater data storage than that provided by single density controllers, without increasing the number or type of drives. In most cases existing 6809 systems can be upgraded by adding only the controller and the appropriate operating system software.

#28 fully assembled, burned in and tested ..... \$298.28



## GIMIX 5/8 DISK CONTROLLER BOARD #58

The GIMIX 5/8 DISK CONTROLLER is a versatile floppy disk interface for use with both 6800 and 6809 systems on the SS-50 or SS-50C bus. The board physically occupies one slot of the 30 pin I/O bus.

- Hardware and software compatible with existing disk controllers (SWTPc DC-1, DC-2 and DC-3)
- Controls up to four 5 1/4" drives in 6800 systems
- Controls any mix of 5 1/4" and 8" drives, up to four drives total, in 6809 systems
- Provides for double headed drives
- Synchronous data separator for data reliability
- Designed to meet the data hold-time requirements of the 1771 floppy disk controller I.C.

The GIMIX 5/8 DISK CONTROLLER is ideal for a variety of applications including the replacement of controllers in existing systems. As a replacement it can provide the added advantages of a data separator, double headed drive capability, and in 6809 systems the ability to use 8" drives. Double headed drives and 8" operation may require appropriate operating system software.

#58 fully assembled, burned in, and tested ..... \$226.58

**ALSO** As above, but for 5 1/4" drives only ..... \$198.48

**AVAILABLE:** As above, but without 1771, tested, not burned in ..... \$158.38

NOTE: When ordering disk controllers please specify the make and model of the drives being used.

## 5 1/4" DRIVES INSTALLED IN GIMIX SYSTEMS with all necessary cables

	SINGLE DENSITY		DOUBLE DENSITY		
	Formatted	Unformatted	Formatted	Unformatted	
40 track (48TPI) single sided	199,680	250,000	341,424	500,000	2 for \$700.00
40 track (48TPI) double sided	399,360	500,000	718,848	1,000,000	2 for 900.00
80 track (96TPI) single sided	404,480	500,000	728,064	1,000,000	2 for 900.00
80 track (96TPI) double sided	808,960	1,000,000	1,456,128	2,000,000	2 for 1300.00

CHART SHOWS TOTAL CAPACITY IN BYTES FOR 2 DRIVES.



# SOFTWARE AVAILABLE FOR GIMIX DISK SYSTEMS

**GIMIX VERSIONS OF TSC's 6809 FLEX** operating systems are available for all three GIMIX disk controllers. They fully support all the features of each controller and are software compatible with other versions of FLEX. GIMIX FLEX includes a disk FORMAT program that allows the user to pick the number of tracks to format, single or double sided disks, and where appropriate single or double density. It also supports both single (48 TPI) and double (96 TPI) track 5 1/4" drives and allows 80 track (96 TPI) drives to read, write, and format 40 track (48 TPI) disks. FLEX is single user and limited to 56KB systems.

Specify controller and type of drive: 8"; or 5 1/4" 40 or 80 track ..... **\$90.00**  
**NOTE: FLEX requires a system monitor (e.g. GMXBUG or S-BUG E). When used with a SWTP CPU and S-BUG E and the GIMIX #68 DMA CONTROLLER, the GIMIX BOOTSTRAP PROM is also required.**

**GMXBUG 09** includes advanced debugging capabilities as well as utility and memory manipulation routines. The standard terminal based version can be upgraded to video based for use with the GIMIX 80 x 24 Video board by changing the bootstrap PROM to the video/bootstrap Prom. It can be used with either GIMIX DAT or SWTP DAT, but they are not required.

Price includes PROMs, Manual, and Source listing (Specify DAT) ..... **\$98.65**  
 Video/bootstrap or Bootstrap PROM only (included w/GMXBUG) ..... **\$30.00**

GIMIX' versions of **MICROWARE's OS-9 Level 1** are available for all GIMIX disk controllers. OS-9 includes PROMS and Disk. Microware's OS-9 Debugger is also included. Level 1 is multi-user, but limits user to 56KB Specify controller and type of drive: 8"; or 5 1/4" 40 or 80 track ..... **\$195.00**

★ **SYSTEM SPECIAL** ★ GIMIX offers you GMXBUG/FLEX/OS-9 selectable under software control. See System prices elsewhere in this brochure.

**UNIFLEX** is available for GIMIX Systems using the GIMIX 6809 CPU board and the #68 DMA Controller with 8" drives. It requires a minimum of 128KB of RAM. A signed license agreement with TSC is required before shipping. The SWTP DAT parts must be installed on the GIMIX CPU.

UNIFLEX ..... **\$550.00** GIMIX boot PROM for UNIFLEX ..... **\$50.00**

**MICROWARE's OS-9 Level 2** requires a minimum of 128KB of RAM. The GIMIX DAT parts must be installed on the GIMIX CPU. GIMIX versions of Level 2 also include the Debugger (To be available soon) ..... **\$495.00**

## A WIDE VARIETY OF LANGUAGES AND OTHER SOFTWARE IS AVAILABLE FOR THESE 6809 DISK OPERATING SYSTEMS

**FOR MICROWARE's OS-9 LEVEL 1 & 2:**

Macro Text Editor .....	\$125.00	CIS COBOL .....	\$895.00	OS-9 PASCAL .....	\$400.00
OS-9 Assembler .....	125.00	Forms 2 Option .....	200.00	OS-9 C Compiler (Available Soon) .....	400.00
BASIC09 .....	195.00				

**FOR TSC's FLEX**

6809 Native-Code Pascal Compiler .....	\$200.00	Sort/Merge .....	\$ 75.00	Standard Basic Precompiler .....	\$ 50.00
Basic .....	75.00	6809 Debug Package .....	75.00	Extended Basic Precompiler .....	50.00
Extended Basic .....	100.00	6809 Diagnostics Package .....	75.00	6809 FLEX Utilities .....	75.00
Text Processing System .....	75.00	6809 Assembler .....	50.00	68000 Cross Assembler .....	250.00
Text Editing System .....	50.00				

**FOR UNIFLEX**

UniFLEX Operating System (6809) .....	\$550.00	UniFLEX Sort/Merge .....	\$150.00	Fortran 77 (requires relocating assembler) .....	\$350.00
UniFLEX Basic .....	200.00	UniFLEX Pascal .....	300.00	6809 Relocating Assembler & Linking Loader .....	175.00
UniFLEX Basic Precompiler .....	150.00	UniFLEX 68000 Cross Assembler .....	300.00	Fortran & Relocating Assembler (pkg. deal) .....	450.00
UniFLEX Text Processor .....	150.00	Enhanced Printer Spooler .....	150.00		
C Compiler (Requires relocating assembler, available soon) .....	400.00	C Compiler & Relocating Assembler .....	500.00		

1 Year Maintenance Included on all Uniflex Prices.

The above software is from **MICROWARE** and **TSC**. Numerous offerings of languages (e.g. C, PASCAL, FORTH), utilities (e.g. spelling dictionaries, cross assemblers, disassemblers) and application packages (e.g. word processing, data base management, accounting), are available from many other software houses.

**8" DISK CABINET and POWER SUPPLY.** The cabinet features the same quality, styling, and finish as the GIMIX MAINFRAME and mounts two standard size 8" floppy and/or winchester disk drives. It will also hold 4 thinline 8" floppys or a combination of 2 thinline floppys and an 8" winchester.

To provide an easy means of controlling the power to an entire system from one switch, three accessory outlets, one for the computer and two for peripherals (terminals, printer, etc.), are provided. The back panel mounted power switch selects either OFF, ON, or the AUTO mode. In the AUTO mode, the power supply and two of the accessory outlets are controlled by the computer (or other device), connected to the third accessory outlet. When the computer is turned on or off, the cabinet senses the presence or absence of current flow to the computer and turns itself and the other accessory outlets on or off. Circuitry is also provided to turn AC drive motors ON and OFF under computer control. A built in fan with a washable air filter provides cooling for the power supply and drives. The back panel is punched for 4 connectors (two 50 and two 20 pin) for connections between the cabinet and the computer.

The power supply uses a constant voltage Ferro-resonant transformer for reliability and protection against brownouts and power line noise. It provides +5 Volts at 6 Amps, +24 Volts at 6 Amps, and -5 Volts at 750 Ma. continuously; with ample surge capacity for drives that require higher starting currents. The supply has two separate 24 V. outputs that can be sequenced to delay starting of the second drive until the first is up to speed.

All units are fully assembled, burned in, and tested.

**8" DUAL DRIVE DISK SYSTEM:** includes two double sided 8" disk drives, cabinet, power supply, and all necessary cables to connect to a GIMIX MAINFRAME or controller (see shipping notes on page 8) ..... **\$2698.88**

**8" DISK CABINET ONLY:** includes power supply and AC & DC power cables **Note:** Because different drive models require different AC & DC connectors, be sure to specify the quantity and model number of the drives being used when ordering. .... **\$848.18**  
 For 50 Hz Export power supply, add ..... **\$ 30.00**

**DRIVE CABLE:** for 8" floppy drives includes connectors for the disk drives and a back panel connector for the 8" disk cabinet.  
 with 2 drive connectors ..... **\$44.82**  
 with 4 drive connectors ..... **\$67.84**

**MAINFRAME CABLE:** for use with the above cable; to connect the disk cabinet to GIMIX MAINFRAMES and disk controllers ... **\$45.81**

**8" FILLER PLATE:** used when only one drive is installed ..... **\$14.83**



# GIMIX 2MHz INPUT / OUTPUT BOARDS

## SERIAL INTERFACE BOARDS

All GIMIX serial interface cards use the versatile 68B50 programmable ACIA that provides software control over: number of data bits, parity, stop bits, and interrupts; plus a full set of error and status flags. They all feature RS-232 compatible input/output with RTS, CTS, and DCD handshake signals. The GIMIX SINGLE PORT serial interface also has 20 Ma. current loop output for use with GIMIX RELAY DRIVER BOARDS, teletypes, etc.

All serial boards have gold plated, header type connectors for corrosion resistance and reliable operation.

## PARALLEL INTERFACE BOARDS

All GIMIX parallel boards use the 6821 PIA for compatibility and versatility. Each 6821 provides two 8 bit ports with a variety of handshake and interrupt generation modes.

Optional cable sets are available to provide 25 pin "D" type data connectors for back-panel mounting.

## SINGLE PORT SERIAL INTERFACE

(For the 30 pin I/O bus) ..... **\$88.41**

DIP-switches provide full control over I/O and handshaking configuration — easily accessible, no soldering necessary for:

- RS-232 or Current Loop select
- One of five baud rates or an external clock
- Optional connection to the Interrupt Request line
- Override of the DCD and CTS modem control signals



On-card regulators for +5, +12, and -12 volts provide power at the connector for modems, cassette interfaces, etc.

RS-232 and current loop drivers and receivers keep output from the GIMIX Serial Interface powerful and clean.

### OTHER FEATURES INCLUDE:

- Modem Control Signals — has data carrier detect and clear to send inputs.
- Cassette Interface Control — has a diode-protected external clock input and a separate clock output.
- Current loop input and output
- Secondary RS-232 input and output channels
- Reader Control output
- Request to send output

## 2 PORT SERIAL INTERFACE (For the 30 pin I/O bus) ..... **\$128.43**

Solderless jumpers provide easy selection and changing of options.

### FEATURES:

- 2 separate RS-232 ports (with handshake) on a single board
- Jumper programmable connector pinouts for easier connection to external devices. (Connector can be programmed as DCE or DTE)
- Provides direct plug-in of standard RS-232 connectors when used with optional GIMIX cable sets.
- Individual baud rate and interrupt select jumpers for each port.
- Selectable for use with 4, 8, or 16 addresses per slot.

## 8 PORT SERIAL BOARD

(For the 50 pin bus) ..... **\$318.46**

The GIMIX 8 PORT SERIAL INTERFACE has 3 header type connectors for external connections. The center connector provides Transmit Data, Receive Data, and signal ground for all 8 ports. The outer 2 connectors each provide TX, RX, and signal ground as well as the 3 handshake lines RTS, DCD, and CTS for 4 ports.

### FEATURES:

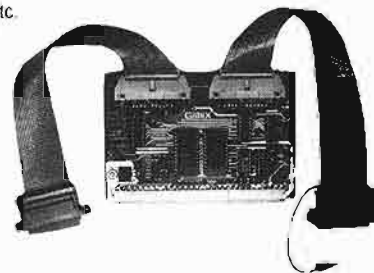
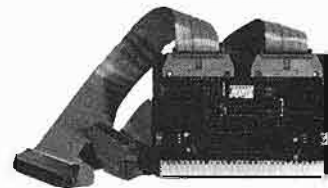
- 8 separate RS-232 ports (with handshake) on a single 50 pin board
- Extended address decoding for the 5550C bus
- Occupies only 16 bytes of address space
- DIP-switch addressable to any 16 byte boundary
- Individual DIP-switch selectable baud rates and interrupts for each port
- On board baud rate generator for baud rates from 75 to 38.4K baud

## TWO PORT PARALLEL INTERFACE CARD

(For the 30 pin bus): ..... **\$88.42**

### EACH PORT HAS:

- ✓ Eight data I/O lines — fully buffered, with Schmidt-trigger inputs for high noise immunity
- ✓ DIP-switch selection of either input or output
- ✓ Its own buffered input handshaking line
- ✓ Its own buffered output handshaking line that is strappable for input.
- ✓ DIP-switches for connecting to the interrupt Request or the Non-Maskable Interrupt lines.
- ✓ Its own professional-quality gold-plated header connector
- ✓ Gold Bus Connectors
- ✓ Its own DIP-socket for connecting to boards that need an external 8-bit or output port such as the GIMIX Opto board.
- ✓ On-card regulators for +5 and -12 volts provide power at the connectors for keyboards, tape readers, etc.



## 8 PORT PARALLEL INTERFACE BOARD

(For the 50 pin bus) ..... **\$198.45**

- Eight 8 bit parallel ports on a single board
- Four 6821 PIAs
- 3 ports buffered for output
- 5 ports bi-directional (not buffered)
- Built in interrupt generator outputs 1 second or 1 minute interrupts
- Occupies 16 bytes of address space
- DIP-switch addressable to any 16 byte boundary



## CABLE SETS FOR ALL ABOVE BOARDS . . . ea. **\$22.95**

Cable sets include: Ribbon cable with a matching connector for the I/O board, a 25 pin "D" type data connector for back panel mounting, and mounting hardware.

(Please specify which board when ordering cable sets)

## GIMIX UNIVERSAL SYNCHRONOUS & ASYNCHRONOUS SERIAL I/O BOARDS.

This 30 pin board is available in three versions: with a 68B50 ACIA, a 68B52 SSSA (Synchronous Serial Data Adapter) or a 68B54 ADLC (Advanced Data-Link Controller). Control logic is provided for loop mode operation of the 68B54 ADLC. All three feature jumper selectable RS-232C or RS-423 (single-ended), or RS-422 (Differential) line drivers and receivers for the Receive data, transmit data, external clock, and handshake signals. External connections can be made through the 26 pin header at the top of the board or, when used with an optional GIMIX cable set, a 25 pin "D" type data connector. The jumper programmable I/O connector pinouts can be arranged to suit a variety of interface configurations.

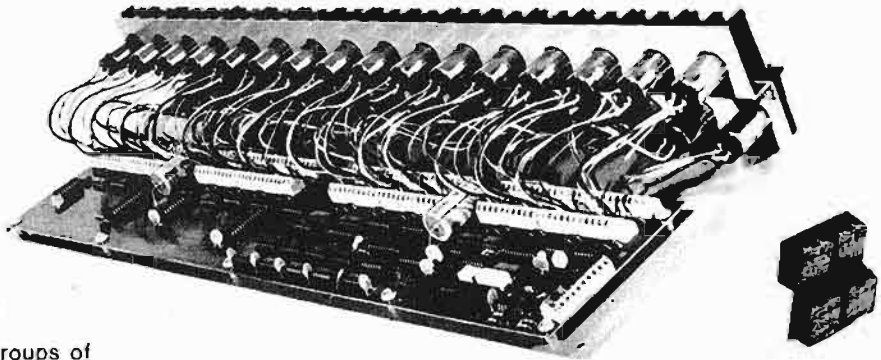
with 68B50 ACIA (\$244.50) with 68B52 SSSA (\$254.52) with 68B54 ADLC (\$268.54)



**GIMIX** inc.

1337 WEST 37th PLACE  
CHICAGO, ILLINOIS 60609  
(312) 927-5510 • TWX 910-221-4055

**Control 31 Separate  
AC Circuits (20 amps max. ea.)  
RELAY  
DRIVER BOARDS  
FOR A.C.  
POWER CONTROL**



4 Boards (124 relays) can be connected to one 20 ma. current loop. Each board controls 31 G.E. RR8 relays.

Use multiple serial ports for additional groups of 124 relays.

**SIMPLE TO CONNECT** Only two pairs of wires coming from your computer are needed for each set of four Relay Driver Boards, these wires may be the standard telephone type.

**REMOTELY LOCATABLE.** Relay Driver Boards can be conveniently located for A.C. power distribution — away from the computer and other Relay Driver Boards. The board operates in either the active or the report mode, as specified by the computer. In the active mode, the board interprets the 8-bit data received as a command to turn on or off a particular relay. Following a brief interval to allow the selected relay to operate, the board senses that relay's status (on or off). If the status is other than expected, the computer takes appropriate action, as determined by the program. A command received in the report mode has the same results, except for relay activation. This allows the mode to check relay status at any time.

If the on-board UART detects a transmission error, such as in framing, parity, or overrun, no relays are activated and no status scan occurs.

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**COMPACT** — Only 24" x 5"

Distances and operation of boards and relays are dependent upon wire length and gauge, and type of transformer.

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COGNIVOX recognizes words (such as "one," "enter," etc.) or short phrases (like "total amount," "net weight," etc.) from a vocabulary of 32 entries. The vocabulary entries are chosen by the user to suit his application. Then COGNIVOX is "trained" to the vocabulary by repeating each entry three times into the microphone under the prompting of the system.

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Vocabularies larger than 32 words are possible by swapping reference patterns in memory using a key word, for example, "change vocabulary." Or the swap can be performed under program control.

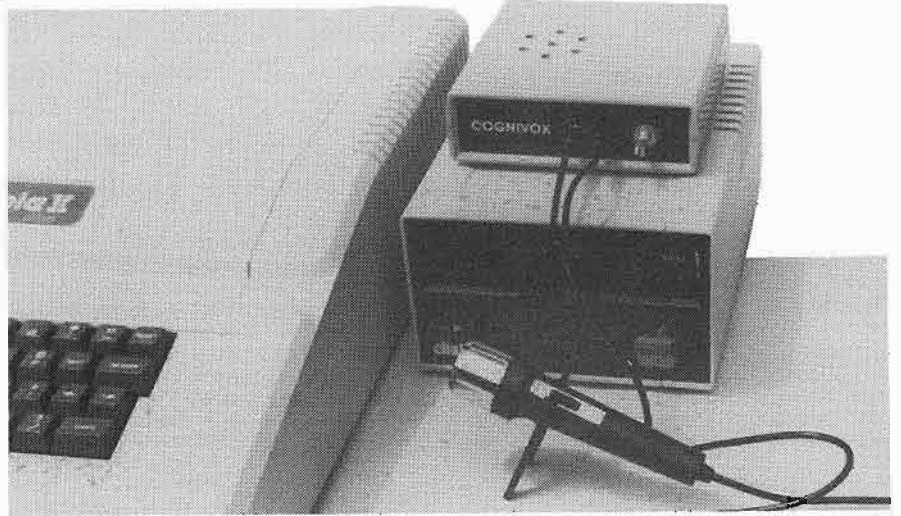
**VOICE OUTPUT**

COGNIVOX can talk with a vocabulary of 32 words or short phrases. No restrictions are placed on the vocabulary which can be programmed simply by saying the words into the microphone. The speech waveform is then digitized using a data compression method and stored in memory.

When voice output is desired, the selected word or phrase is reconstructed and played back using a built-in speaker/amplifier. A jack is also provided that allows connection to external amplifiers or speaker.

This method of voice output offers two very important advantages: First, the user has full control over the selection of the vocabulary and the type and tone of voice. Second, the voice output is naturally sounding human speech which is pleasant and easy to understand. These features are not available in most other voice output devices in the market.

The voice output and speech recognition vocabularies are independent of each other and can be different. Thus it is possible to establish a dialog with the computer.



**USING COGNIVOX**

COGNIVOX is designed for extreme ease of use. It is a complete system, fully assembled and tested, including hardware in an instrument case, microphone, power supply, cassette with software and user manual. It plugs into the game I/O port in the APPLE and does not use up the valuable peripheral slots.

Software provided with COGNIVOX include demonstration programs and two voice operated, talking video games. All programs are unprotected so that the user can examine and modify them.

An optional diskette for DOS 3.3 includes all cassette software plus disk facilities to store and retrieve vocabularies on disk.

Adding voice I/O to your own programs is very simple. A statement in BASIC is all that is needed to either recognize or say a word. Complete instructions on how to add voice to your programs are given in the manual.

**APPLICATIONS**

COGNIVOX adds a whole new dimension to man-computer interaction. It can be used for data and command entry when hands and/or eyes are busy. As an educational tool. As an aid to handicapped. As sound effects generator. As a telephone answering machine. As a talking calculator, or talking clock.

The list is endless. With a BSR home controller interface it can be used to control by voice appliances and lights around the house. With an IEEE 488 interface card it can be used to control by voice instruments, plotters, test systems. And all these devices could talk back, saying their readings, alarm conditions, even their name. Finally, COGNIVOX is a super toy, a fascinating device to play with. Imagine an adventure game that talks to warn you of danger and listens to your commands!

**SPECIFICATIONS**

- Recognizer type:** Isolated word, speaker dependent.
- Vocabulary size:** 32 words or short phrases for both recognition and voice response.
- Dialog capability:** Recognition and response vocabularies can be different.
- Word Duration:** Greater than 150 ms and less than 3 seconds.
- Silence gap between words:** 150 ms minimum.
- Training required:** Must pronounce vocabulary 3 times to train recognizer. Allows words to be individually retrained.
- Recognition accuracy:** Up to 98%. Recognition accuracy depends on speaker experience and choice of vocabulary.
- Type of voice output:** Digital recording of user voice.
- Audio output:** 130 mW
- Frequency response:** 100 to 3200 Hz.
- Power consumption:** 120 mW during recognition, 350 mW maximum during speech output.
- Power supply:** 9V DC, 300 mA, unregulated.
- Dimensions:** 5" x 6" x 1.25"
- Memory requirements:** Approx. 4K bytes for program and tables. 1.5K bytes per sec. of speech for storage of voice response vocabulary (Approx. 700 bytes per word).

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To order COGNIVOX by phone, call us at (805) 685-1854, 9AM to 4PM PST. Monday through Friday, and charge it to your MASTERCARD or VISA. Or you can order by mail. Send us a check or money order for \$249 plus \$5 shipping and handling (CA residents add 6% tax). Software on diskette (DOS-3.3) order part # DSK-3.3, \$19. Foreign orders welcome, add 10% for air mail shipping and handling. COGNIVOX is backed by a 120 day warranty against manufacturing defects.

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# 7SEG: PET Giant Character Set

by John Girard

Use this routine to display alpha-numeric characters in a large, seven-segment display on the screen.

## 7SEG

requires:

40-column PET/CBM

With slight modifications for screen size, it will run on an 80-column CBM or a 22-column VIC.

Changing the size of PET characters is impossible without major modification to your PET. But, with the print utility 7SEG, you can construct giant, seven-segment style characters on CBM/PET screens. 7SEG characters are visible up to 40 feet away and are ideal for any application where visibility is critical.

This article presents an all-BASIC core program which can be adapted to your specific needs. Some of the potential applications include clocks, counters, device status, and instrument readouts, such as digital multi-meter displays.

7SEG constructs numbers by sequentially drawing the contents of seven strings, A1\$ through A7\$ [see figure 1]. Each string prints one segment, composed of a series of spaces and cursor controls. The segments are turned on or off by adding reverse field controls to the print statements. To print an 8, for example, you would call the subroutine (program line 315):

```
PRINT " "A1$A2$A3$A4$A5$A6$A7$;
:RETURN
```

In this example all seven strings print in reverse field. To print a 0, you would call another routine (line 235):

```
PRINT " "A1$A2$A3$A4$A5$A6$ " "
A7$; :RETURN
```

Figure 1: Illustration of the seven numeric segment print strings.

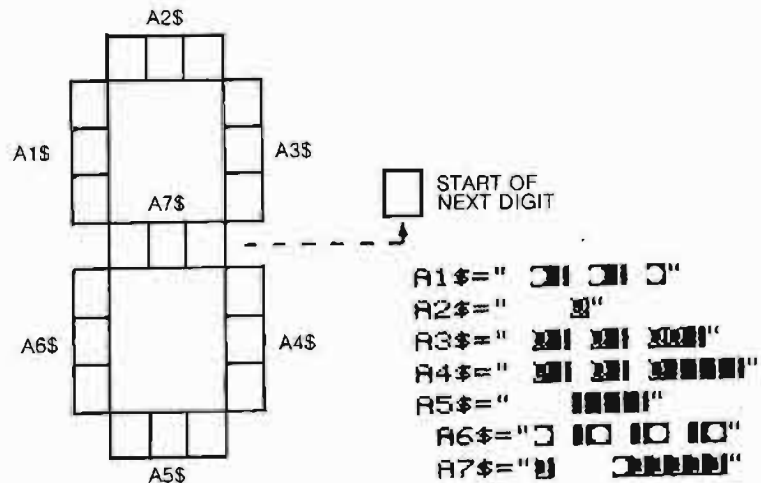
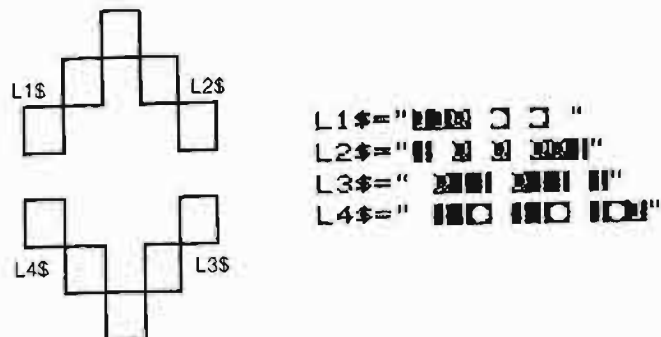


Figure 2: Display of a floating point number.



Figure 3: Illustration of the four diagonal segment print strings.



In the latter example, the final string (A7\$) is printed off. Referring again to figure 1, note that the printing of A7\$ positions the cursor at the starting point for the next character. Therefore, to print a series of numbers, you just move the cursor to the desired starting position, then simply print A1\$ through A7\$ over and over with the appropriate reverse field controls. This relative positioning technique allows for fast operation. A four-digit real number with floating decimal will appear in less than 1/3 second (see figure 2). To produce alphabetic displays, you will need just four more strings to handle the diagonals, L1\$ through L4\$, illustrated in figure 3.

Load the driver core and enter several numbers less than 10,000. Note the editing features. Leading and trailing zeroes are blanked for numbers with less than four significant digits. Enter the word "MAD" and watch the diagonals come into play. Enter the word "ERROR" and see the largest

word I have squeezed into a 40-column screen. Think of the possibilities on an 80-column screen!

To illustrate the flexibility of 7SEG, I have included a short overlay program to reduce the character size and allow display of five significant digits. Simply type the overlay onto the original program.

John Girard (along with Loren Wright, MICRO's PET Vet) developed more than two dozen college-level physics programs for the University of California at Berkeley. Girard is now working as an accounting applications programmer at Pacific Telephone. His address is 676 Alma # 202, Oakland, CA 94610.

**Listing 1: Four-digit "core" program.**

```

100 REM*** 7SEG DRIVER CORE WITH 4 GIANT SIZE DIGITS & LETTERS ***
105 REM WRITTEN BY JOHN GIRARD 11/1/80
110 REM DO NOT RENUMBER THIS PROGRAM!!
115 GOSUB 465:REM INITIALIZE STRINGS-
120 PRINT" "
125 PRINT" " " : INPUT" " ; A$ : FL = 0
130 N = ABS(VAL(A$)) : SN = SGN(VAL(A$))
135 N$ = STR$(N)
140 REM MAIN DISPLAY LOOP-----
145 IF A$ = "MAD" THEN 415
150 IF A$ = "ERROR" THEN 395
155 PRINT" "DN$ : L = LEN(N$) : IF L > 6 THEN L = 6
160 REM CLEAR DISPLAY ON ZERO RESULT
165 IF VAL(A$) = 0 THEN FOR I=1TO4:GOSUB 330:NEXT I:DLN$="" : DS = 0:GOTO 125
170 REM FLOATING DECIMAL-----
175 FOR I=1TO5:POKE DC+I*9,32
180 IF MID$(N$,I+1,1) = "." THEN FL = 1:POKE DC+I*9,160
185 ON VAL(MID$(N$,I+1,1)) GOSUB 240,250,260,270,280,290,300,310,320
190 IF MID$(N$,I+1,1) = "0" THEN GOSUB 230

```

(Continued)

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Centronics Standard Parallel printer interface for OSI computers. The card comes complete with 10 ft. of flat ribbon cable. Compatible with OS-65D and OS-65U software.		
<b>IO-CA9D DIABLO PARALLEL PORT</b>	<b>\$175</b>	
Diablo 12 BIT WORD Parallel port for use with word processor type printers. Complete with 10 ft. cable. Compatible with OS-65U software.		
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<b>24MEM-CM9... \$360</b>	<b>16MEM-CM9... \$300</b>	<b>8 MEM-CM9... \$210</b>
24K memory card is available at 3 different populated levels. All cards are fully socketed for 24K of memory. The card uses 2114-300ns chips. DIP SWITCH addressing is provided in the form of one 16K block and one 8K block. Also supports DIP SWITCH memory partition addressing for use in multi-user systems.		
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OSI-Type floppy disk controller and real time clock. Will Support 5 1/4" or 8". Single or double-sided drives. Requires drives with separated data and clock outputs.		
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## EXCITING NEWS FOR COLOR COMPUTER USERS

### FLEX, OS-9 and the Radio Shack Disk System ALL on the SAME Color Computer

Would you believe that you can run FLEX, OS-9 and Radio Shack disk software on the same Color Computer, and all you have to do is change the disk? That's right, just change the disk. If you have a 32K Color Computer with the Radio Shack disk system, all you need to do is make a trivial modification to access the hidden 32K, as described in the Feb. issue of COLOR COMPUTER NEWS and the March issue of '86 Micro. You can get FLEX from us right now. OS-9 will be ready by summer. Please note that this will only work with the Radio Shack disk system and 32K/64K memory chips that RS calls 32K. Maybe they put 64K's in yours, too. If you don't have a copy of the article, send a SASE and we'll send it to you.

Using this system to run FLEX and OS-9 has many advantages. First, it gives you 48K from zero right up to FLEX. This means that ALL FLEX compatible software will run with NO MODIFICATIONS and NO PATCHES! There are no memory conflicts because we moved the screen up above FLEX which leaves the lower 48K free for user programs.

What you end up with is 48K for user programs, 8K for FLEX and another 8K above FLEX for the screens and stuff! We are working on a multi-screen format so you can page backward to see what scrolled by and a Hi-Res screen that will enable us to have 24 lines by 42 character display. That's better than an Apple!

We also implemented a full function keyboard, with a control key and escape key. All ASCII codes can now be generated from the Color Computer keyboard!

We also added some bells and whistles to Radio Shack's Disk system when you're running FLEX or OS-9. We are supporting single or double sided, single or double density, 35, 40 and 80 track drives. If you use double sided drives, the maximum is three drives because we use the drive 3 select for side select. When you are running the Radio Shack disk, it will work with the double sided drives but it will only use one side and only 35 tracks. Using 80 track drives is okay, but will not be compatible with standard Radio Shack software. You can also set each drive's stepping rate and drive type. (SS or DS - SD or DD)

In case you don't understand how this works, I'll give you a brief explanation. The Color Computer was designed so that the roms in the system could be turned off under software control. In a normal Color Computer this would only make it go away. However, if you put a program in memory to do something first (like boot in FLEX or OS-9), when you turn off the roms, you will have a full 64K RAM System with which to run your program (FLEX or OS-9). When the roms are turned off, it is as if you had removed them from the computer. They are gone!

Now, we need the other half of the 64K ram chips to work, and this seems to be the case most of the time, as the article states. Of course, you could also put 64K chips in.

We decided that this was the best way to run FLEX and OS-9 on the Color Computer because it does remove the roms from the memory map and leaves the full 48K for user programs. If you just put in memory for FLEX and use the Basic hooks for I/O, all you have is a little over 30K for user programs. In addition, very few FLEX programs will run without being modified and some work very well, if at all (our DATAMAN + for example). Let me state it again. ALL FLEX COMPATIBLE PROGRAMS WILL RUN WITHOUT MODIFICATION!!! and the same goes for OS-9!

It is also the ONLY way OS-9 will run because 30K is just not enough.

Some neat utilities are included.

MOVOROM moves Color Basic from ROM to RAM. Because it's moved to RAM you can not only access it from FLEX, you can run it and even change it!! You can load Color Computer cassette software and save it to FLEX disk. Single Drive Copy, Format and Setup commands are also included.

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#### SYSTEM

REQUIREMENTS: 48K Apple II or II+, ROM or RAM Card, DOS 3.3 (or DOS 3.2.1 for UBI) and one or more disk drives.

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# Applesoft Variable Dump

by Philippe Francois

This handy debugging utility presents a "dump" of current variable array values for Applesoft in ROM.

## Applesoft Array Dump requires:

Apple with Applesoft in ROM

This program follows and completes the "VARIABLE DUMP" program by Scott D. Schram from the May 1981 MICRO. The original program printed all non-subscripted variables.

My version retains the Schram skeleton program but is a little more complex since array storage is more complicated than simple variable storage.

To load "ARRAY DUMP" enter monitor mode and type machine code into memory beginning at \$4000. Then save the routine to disk with "BSAVE ARRAY DUMP, A\$4000, L\$1A3."

To use the program load ARRAY DUMP into memory with a "BLOAD ARRAY DUMP" followed by "CALL 16384." (You may instead BRUN ARRAY DUMP.) As in the "VARIABLE DUMP" program, hit any key to stop or start the listing.

Please direct correspondence to the author at CNRS/Laboratoire D'Informatique pour les Sciences de l'Homme, 31 Chemin Joseph Aiguier, B.P. 71, 13277 Marseille Cedex 9, France.

## Sample Run

```
10 DIM AA%(1,2),BB$(2),CC(3)
20 AA%(0,0) = 1:AA%(1,2) = 19999
30 CC(1) = 999.99
40 BB$(0) = "THIS":BB$(1) = "IS A":BB$(2) = "TEST"
```

```
JRUN
```

```
JBRUN ARRAY DUMP
```

```
AA%(0,0)=1
  (1,0)=0
  (0,1)=0
  (1,1)=0
  (0,2)=0
  (1,2)=19999
```

```
BB$(0)=THIS
  (1)=IS A
  (2)=TEST
```

```
CC (0)=0
  (1)=999.99
  (2)=0
  (3)=0
```

```
ID$(1)="THAT'S ALL"
```

```
JCALL 16384
```

```
AA%(0,0)=1
  (1,0)=0
  (0,1)=0
  (1,1)=0
  (0,2)=0
  (1,2)=19999
```

```
BB$(0)=THIS
  (1)=IS A
  (2)=TEST
```

```
CC (0)=0
  (1)=999.99
  (2)=0
  (3)=0
```

```
D $(0)=
  (1)=THAT'S ALL
  (2)=
  (3)=
  (4)=
  (5)=
  (6)=
  (7)=
  (8)=
  (9)=
  (10)=
```



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**MICRO**

```

; *****
; ***          ARRAY DUMP          ***
; ***          ***
; *** ROUTINE TO DUMP ALL ARRAY ***
; *** VARIABLES TO CURRENT ***
; *** OUTPUT DEVICE ***
; ***          ***
; *** BY PHILIPPE FRANCOIS ***
; ***          ***
; *****
;
;
; EQUATES...
;
VARL EPZ $6B      ; APSOFT'S POINTER
VARH EPZ $6C      ; TO ARRAY VARIABLE STORAGE
ENDSTL EPZ $6D     ; APSOFT'S POINTER
ENDSTH EPZ $6E     ; TO END OF STORAGE
CH EPZ $24
XSAU EPZ $46      ; SAVE AREA FOR X REG.
;
POINTL EPZ $00    ; POINTER TO
POINTH EPZ POINTL+1 ; CURRENT VARIABLE
SPL EPZ POINTH+1 ; STRING PRINT POINTER
SPH EPZ SPL+1
LEN EPZ SPH+1     ; LENGTH OF STRING TO PRINT
ADDL EPZ LEN+1    ; OFFSET POINTER TO
ADDH EPZ ADDL+1   ; NEXT VARIABLE
TYPE EPZ $D0      ; TYPE OF VARIABLE
TYPQUT EPZ TYPE-1 ; SYMBOL TABLE OF VARIABLES
ENDUAR EPZ TYPQUT+6 ; END OF CURRENT ARRAY VARIABLE
SHIFT EPZ ENDUAR+2
INDX EPZ SHIFT+1 ; MAX. VALUE FOR X REG.
INDY EPZ INDX+1  ; MAX VALUE FOR Y REG.
NBDIM EPZ INDY+1 ; NUMBER OF DIMENSION
DIM EPZ NBDIM+1  ; SIZE DIMENSION TABLE
;
STROBE EQU $C010 ; KEYBOARD STROBE
KBOARD EQU $C000 ; KEYBOARD
;
; APPLEQUATES...
; (SEE APPLE PEELED VOL2)
;
GIVAVF EQU $E2F2 ; APSOFT'S INTERNAL NUMBER
PTRFAC EQU $ED2E ; HANDLING ROUTINES
MOUEFM EQU $EAF9
OUTDO EQU $DB3C ; PRINT CHAR IN A REG.
CRDO EQU $DAFB ; PRINT A CARRIAGE RETURN
OUTSPC EQU $DB57 ; PRINT A SPACE
PRELK EQU $F948 ; PRINT THREE SPACES
APSOFT EQU $D43C ; APSOFT'S WARM START
;
;
; ORG $4000
;
;
; DETERMINE TYPQUT'S TABLE
;
; START:
4000 A9A5 LDA #%" ; INTEGER ARRAY (SYMBOL %)
4002 A202 LDX #*02 ; USE TWO BYTES FOR EACH ELEMENT
4004 95CF STA TYPQUT,X
4006 A9A4 LDA #"$" ; STRING ARRAY (SYMBOL $)
4008 A203 LDX #*03 ; USE THREE BYTES FOR EACH ELEMENT
400A 95CF STA TYPQUT,X
400C A9A0 LDA #" " ; REAL ARRAY (SYMBOL " ")
400E A205 LDX #*05 ; USE FIVE BYTES FOR EACH ELEMENT
4010 95CF STA TYPQUT,X
4012 ;
4012 20FBDA JSR CRDO ; PRINT A C.R.
4015 A568 LDA VARL ; MOVE BYTES
4017 0500 STA POINTL ; FROM APSOFT'S
4019 A56C LDA VARH ; POINTERS TO
401B 0501 STA POINTH ; PROGRAM'S POINTERS
401D ;
401D A500 LOOP LDA POINTL ; SEE IF WE
401F C56D CMP ENDSTL ; ARE AT END
4021 D009 BNE PRINT1 ; NO
4023 A501 LDA POINTH ; CHECK HIGH BYTE
4025 C56E CMP ENDSTH ; IF BOTH ARE EQUAL NO MORE
4027 D003 BNE PRINT1 ; ARRAY VARIABLE LEFT
4029 4C3CD4 JMP APSOFT ; RETURN TO BASIC
402C ;
402C ; DETERMINE THE TYPE OF THE NEXT ARRAY VARIABLE AND
402C ; NOTE IT IN THE VARIABLE "TYPE"

```

(Continued on next page)

### Array Dump (continued)

```

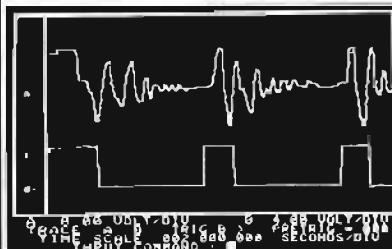
402C      ;
402C      PRINT1:
402C A000      LDY #000      ; NEXT CHAR WILL BE PRINT
402E 8424      STY CH      ; AT THE LEFT MARGIN OF THE WINDOW
4030 20FBD4     JSR CRD0      ; PRINT A C.R.
4033 B100      LDA (POINTL),Y ; THE HIGH ORDER BIT OF THE
4035 3013      EMI TYP1     ; DETERMINE THE TYPE'S VARIABLE
4037 C8        INV
4038 E100      LDA (POINTL),Y
403A 1007      BPL TYP2
403C A903      LDA #03      ; IT'S A STRING
403E 8508      STA TYPE
4040 4C4E40     JMP LABEL5
4043      TYP2:
4043 A905      LDA #05      ; IT'S A REAL
4045 8508      STA TYPE
4047 4C4E40     JMP LABEL5
404A      TYP1:
404A A902      LDA #02      ; IT'S AN INTEGER
404C 8508      STA TYPE
404E      ;
404E      ; PRINT THE ARRAY VARIABLE'S NAME
404E      ; FOLLOWED BY ITS SYMBOL AND
404E      ; COMPUTE THE ADDRESS OF THE NEXT VARIABLE
404E      ;
404E      LABEL5:
404E 203341     JSR PRINTN     ; PRINT VARIABLE'S NAME
4051 A600      LDX TYPE     ; CHOOSE IN TYP2OUT TABLE THE SYMBOL
4053 B5CF      LDA TYP2OUT.X ; CORRESPONDING TO THE TYPE
4055 205CDB     JSR OUTDQ     ; AND PRINT IT
4058 C8        INV
4059 B100      LDA (POINTL),Y
405B 8505      STA ADDL
405D C8        INV
405E B100      LDA (POINTL),Y
4060 8506      STA ADDH
4062 18        CLC
4063 A505      LDA ADDL
4065 6508      ADC POINTL
4067 8505      STA ENDVAR
4069 A506      LDA ADDH
406B 6508      ADC POINTH
406D 8506      STA ENDVAR+1
406F C8        INV      ; DETERMINE THE NUMBER
4070 B100      LDA (POINTL),Y ; OF DIMENSION
4072 850A      STA NBDIM
4074 0A        ASL      ; INDY IS THE MAX. VALUE OF Y
4075 8509      STA INDY
4077 0A        ASL      ; INDX IS THE MAX. VALUE OF X
4078 8508      STA INDX
407A 18        CLC      ; SHIFT IS THE VALUE TO BE
407E A509      LDA INDY     ; ADDED TO THE POINTL POINTER TO
407D 6905      ADC #05      ; ATTEMPT THE FIRST ARRAY VALUE
407F 85D7      STA SHIFT
4081      ;
4081      ; MOVE BYTES FROM SIZES DIMENSIONS OF ARRAY INTO
4081      ; DIM TABLE
4081      ;
4081      ;
4081 A200      LDX #000
4083      LABEL8:
4083 C8        INV
4084 B100      LDA (POINTL),Y
4086 95DB     STA DIM.X
4088 C8        INV
4089 E8        INX
408A B100      LDA (POINTL),Y
408C 95DB     STA DIM.X
408E E8        INX
408F E4D9     CPX INDY
4091 D0F0     BNE LABEL8
4093      ;
4093      ; INITIALISE INDEXES I,J,K... TO ZERO
4093      ;
4093      ;
4093 A6D8      LDX INDX
4095 A900      LDA #000
4097 95DA     LABEL9 STA DIM-1,X
4099 CA        DEX
409A E4D9     CPX INDY
409C D0F9     BNE LABEL9
409E      ;
409E      ; COMPUTE ADDRESS OF THE CURRENT ARRAY'S FIRST VALUE
409E      ;
409E      ;
409E 18        CLC
409F A500      LDA POINTL
40A1 65D7     ADC SHIFT
40A3 8580     STA POINTL

```

(Continued on next page)

## APPLESCOPE

DIGITAL STORAGE OSCILLOSCOPE  
Interface for the Apple II Computer



The APPLESCOPE system combines two high speed analog to digital converters and a digital control board with the high resolution graphics capabilities of the Apple II computer to create a digital storage oscilloscope. Signal trace parameters are entered through the keyboard to operational software provided in PROM on the DI control board.

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M/C

# MICRO

## Microbes and Updates

R.L. Morris from Lynchburg, VA, offers this update to "Recursive Use of GOSUB in Microsoft BASIC" (43:68):

I enjoyed reading the above article and decided to experiment with my AIM 65 for the program calculating N-factorial. I had some problems due to the differences in BASIC between these two computers. Below is a listing that does run on the AIM 65. You can see from the "RUN" printout that the AIM quits at N=22 with an "OM" error. The only changes made from the original are in line 100 and the addition of line 170.

### LIST

```
10 INPUT "ENTER N";N
20 IF N< 0 or INT(N) < N THEN 60
30 GOSUB 100
40 PRINT N; "FACTOR=";F
50 GOTO 10
60 PRINT N; "FACTOR UNDEFINED"
70 GOTO 10
100 IF N=1 OR N=0 THEN 170
110 N=N-1
120 GOSUB 100
130 N=N+1
140 F=F*N
150 RETURN
170 F=1 :RETURN
```

### RUN

```
ENTER N? 0
 0 FACTOR= 1
ENTER N? 1
 1 FACTOR= 1
ENTER N? 2
 2 FACTOR= 2
ENTER N? 3
 3 FACTOR= 6
ENTER N? 4
 4 FACTOR= 24
ENTER N? 21
 21 FACTOR= 5.10909422E + 19
ENTER N? 22
?OM ERROR IN 100
```

### RUN

```
ENTER N? - 1
- 1 FACTOR UNDEFINED
ENTER N? 5
 5 FACTOR UNDEFINED
```

(Continued on next page)

### Array Dump (continued)

```
40A5 A501 LDA POINTH
40A7 6900 ADC #*00
40A9 8501 STA POINTH
40AB ;
40AD ; PRINT CURRENT INDICES (I,J,K...)
40AF ;
40B1 LABEL2:
40B3 A9A2 LDA #("<"
40B5 205CDB JSR OUTDO
40B7 A6D8 LDY INDY
40B9 LABEL1:
40BB B5DA LDA DIM-1,X
40BD 08 TAY
40BF CA DEX
40C1 8646 STX XSAU ; SAVE X REG.
40C3 B5DA LDA DIM-1,X
40C5 20F2E2 JSR GIUAYF
40C7 205EED JSR PTRFAC
40C9 F646 LDY XSAU ; RECOVER X REG.
40CB CA DEX
40CD E4D9 CPX INDY
40CF F088 BEQ LABEL3
40D1 09AC LDA #", "
40D3 205CDB JSR OUTDO
40D5 40B240 JMP LABEL1
40D7 LABEL3:
40D9 A929 LDA #") "
40DB 205CDB JSR OUTDO
40DD A93D LDA #"? "
40DF ;
40E1 ; NOW PRINT THE NUMERIC OR CHAR VALUE
40E3 ;
40E5 205CDB JSR OUTDO
40E7 A508 LDA TYPE
40E9 C903 CMP #*03
40EB F088 BEQ LABEL10 ; TYPE=3,PRINT STRING
40ED 308C BMI LABEL11 ; TYPE=2,PRINT INTEGER VALUE
40EF ;
40F1 ; TYPE=5,PRINT REAL VALUE
40F3 ;
40F5 209941 JSR REALOU
40F7 40F040 JMP NXTSIM
40F9 LABEL10:
40FB 207741 JSR STROUT
40FD 40F040 JMP NXTSIM
40FF LABEL11:
4101 206741 JSR INTOUT
4103 ;
4105 ; NXTSIM SETS THE ARRAY POINTERS TO THE NEXT ARRAY
4107 ;
4109 NXTSIM:
410B 20F6DA JSR CRDO
410D 2048F9 JSR PRBLK
410F 18 CLC
4111 A5D0 LDA TYPE
4113 6500 ADC POINTL
4115 8500 STA POINTL
4117 9002 BCC CONT2
4119 E601 INC POINTH
411B CONT2:
411D 204641 JSR END ; IS IT THE END
411F ; OF THE CURRENT ARRAY ?
4121 ;
4123 ; SETS CURRENT ARRAY INDEXES
4125 ;
4127 06D8 LDY INDY
4129 A4D9 LDY INDY
412B LABEL4:
412D B5DA LDA DIM-1,X
412F 18 CLC
4131 6901 ADC #*01
4133 95DA STA DIM-1,X
4135 CA DEX
4137 B5DA LDA DIM-1,X
4139 6900 ADC #*00
413B 95DA STA DIM-1,X
413D B5DA LDA DIM-1,X
413F D5D8 CMP DIM,X
4141 D08B BNE LABEL2
4143 88 DEY
4145 B5DA LDA DIM-1,X
4147 D5D8 CMP DIM-1,X
4149 D083 BNE LABEL2
414B A900 LDA #*00
```

(Continued on next page)



```

412A 950A          STA DIM-1,X
412C 95DB          STA DIM,X
412E 0A           DEX
412F 88           DEY
4130 4C0B41       JMP LABEL4
4133              ;
4133              ; PRINT THE NAME OF THE CURRENT ARRAY
4133              ;
4133 PRINTN:
4133 A000          LDY #A00
4135 B100          LDA (POINTL),Y
4137 205C0B       JSR OUTDO
413A C8           INY
413B B100          LDA (POINTL),Y
413D 297F        AND #7F
413F D002        BNE CONT3
4141 A9A0          LDA #""
4143 4C5C0B       CONT3 JMP OUTDO
4146              ;
4146              ; CHECK IF ALL ELEMENTS OF CURRENT ARRAY ARE PRINTED
4146              ;
4146 ENDN:
4146 A500          LDA POINTL
4148 C505          CMP ENDUAR
414A D009        BNE RTS1
414C A501          LDA POINTH
414E C506          CMP ENDUAR+1
4150 D003        BNE RTS1
4152 4C1D40       JMP LOOP
4155 60           RTS1  RTS
4156              ;
4156              ; ROUTINE FOR START/STOP LISTING
4156              ;
4156 WAIT:
4156 AD00C0        LDA KBOARD
4159 10FA          BPL RTS1
415B AD10C0        LDA STROBE
415E AD00C0        LDA KBOARD
4161 10FB          BPL WAIT1
4163 AD10C0        LDA STROBE
4166 60           RTS1  RTS
4167              ;
4167              ; ROUTINE FOR PRINTING INTEGER VALUES
4167              ;
4167 INTOUT:
4167 A000          LDY #A00
4169 B100          LDA (POINTL),Y      ; GET LOW BYTE
416B AA           TAX
416C C8           INY
416D B100          LDA (POINTL),Y      ; GET HIGH BYTE
416F AS           TAX
4170 0A           TXA
4171 20F2E2       JSR GIUAYF
4174 4C2EED       JMP PTRFAC      ; CONVERT TO FLOATING POINT
4177              ;
4177              ; ROUTINE FOR PRINTING STRING
4177              ; POINTED BY SPL,SPH OF LENGTH "LEN"
4177              ;
4177 STROUT:
4177 A000          LDY #A00
4179 B100          LDA (POINTL),Y
417B F01B         BEQ RTS2
417D 0504         STA LEN
417F C8           INY
4180 B100          LDA (POINTL),Y
4182 0502         STA SPL
4184 C8           INY
4185 B100          LDA (POINTL),Y
4187 0503         STA SPH
4189 A000          LDY #A00
418B LOOP1:
418B C404         CPY LEN
418D F009         BEQ RTS2
418F B102         LDA (SPL),Y
4191 205C0B       JSR OUTDO
4194 C8           INY
4195 4C0B41       JMP LOOP1
4198 60           RTS2  RTS
4199              ;
4199              ; ROUTINE FOR PRINTING REAL VALUE
4199              ;
4199 REALO:
4199 A401          LDY POINTH
419B A500          LDA POINTL
419D 20F9EA       JSR MOVEFN
41A0 4C2EED       JMP PTRFAC

```

MICRO™

## Microbes (Continued)

Here is a note from Chuck Wardin, Colorado Springs, Colorado:

Thank you for the fine article and program "Apple Pascal Textfile Lister, (44:100). I bind my listings and this format helps me find the listing I want quickly.

I did come across one problem with the program as printed. It will work for the first textfile only and force one to start the program over to get a second file to list. Below is a simple solution.

PROGRAM READ:

```

End
end
Until Filename = ""
End. (* MAIN PROGRAM *)

```

SHOULD READ:

```

End
end;
close (textfile)
Until Filename = ""
End. (* MAIN PROGRAM *)

```

MICRO™

D.S.I. C4P      Trs-80 Model I & III

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This is a one player game where you fight the computer. The object is to destroy the ENEMY TANK and HOUSES before he destroys YOU and YOUR HOUSES. But WATCH-OUT for the hidden MINES!  
D.S.I. C4P Color Sound Joysticks 8K Cassette - \$6.95

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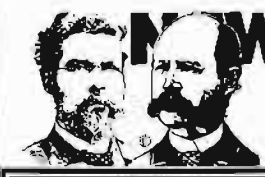
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# Integer Cross-Reference Utilities

by Lee Reynolds

A cross-reference table is an invaluable aid to development or debugging of a BASIC program. This article and the accompanying program confront the task of generating a complete cross-reference table for Apple Integer BASIC programs.

These Utilities require:

Apple II  
with Integer BASIC

Most Apple programmers probably realize that a computer program is a constantly changing and growing entity. You finish writing a program that does just what you want, and later you think of something else you would like it to do. Perhaps you think of a different technique that will better achieve your goal, or — horrors! — you find a bug in your masterpiece. Whatever the reason, most programs need to be modified in some way. Too often the changes must be made long after all the programming details have fled from memory.

This article presents two different cross-reference applications: one prints out a cross-reference of all the line numbers used in a program, and the other does the same for all variable and array names. It is usually much easier to modify a program when you know where every GOTO or GOSUB is going, or in what lines each of your variables and arrays is used.

Applesoft programmers have available a variety of cross-reference utilities that perform these valuable

## Line Number Cross Referencer

```
5 LOMEM:2500
10 DIM A$(255):SHLAM=300
20 CALL -936: PRINT "THIS PROGRAM GENERATES A BINARY FILE": PRINT "WHICH IS
THE MACHINE LANGUAGE"
30 PRINT "LINE NUMBER CROSS REFERENCE ROUTINE"
100 A$="0800:A5 CA B5 03 A5 CB B5 04 A9 00 B5 0C 20 5B FC A2 00 BD 1E 0B 20 E
D FD EB E0 12 D0 F5 F0 ": GOSUB SHLAM
110 A$="0810:12 CC C9 CE C5 A3 A0 A0 A0 D2 C5 C4 C5 D2 C5 CE C3 C5 D3 A0 00 B
1 03 B5 09 B4 00 CB B1 ": GOSUB SHLAM
120 A$="083A:03 B5 01 CB B1 03 B5 02 A5 CA B5 07 A5 CB B5 08 A0 00 B1 07 B5 0
A CB B1 07 B5 05 CB B1 ": GOSUB SHLAM
130 A$="0857:07 B5 06 A0 03 B1 07 C9 5F F0 4B C9 5C F0 47 C9 24 F0 43 C9 0B F
0 3F C9 09 F0 41 C9 74 ": GOSUB SHLAM
140 A$="0874:F0 43 CB C4 0A 90 E1 A5 07 18 65 0A B5 07 A5 0B 69 00 B5 0B A5 0
7 C5 4C A5 08 E5 4D 90 ": GOSUB SHLAM
150 A$="0891:BB A5 03 18 65 09 B5 03 A5 04 69 00 B5 04 A5 03 C5 4C A5 04 E5 4
D 90 B7 20 BE FD 60 A9 ": GOSUB SHLAM
160 A$="08AE:00 B5 0B F0 0A A9 0A B5 0B D0 04 A9 75 B5 0B CB B1 07 C9 B0 90 1
D C9 BA B0 19 CB B1 07 ": GOSUB SHLAM
170 A$="08CB:CB C5 01 D0 11 B1 07 C5 02 D0 0B CB B1 07 C9 04 90 1D C5 0B F0 1
9 A5 0B F0 91 CB B1 07 ": GOSUB SHLAM
180 A$="08EB:C5 0B F0 06 C9 04 90 B6 B0 F3 A9 00 B5 0B F0 C5 F0 AF A5 00 D0 1
4 E6 00 20 BE FD A9 00 ": GOSUB SHLAM
190 A$="0905:B5 0C A5 01 B5 F2 A5 02 B5 F3 20 1F E5 A5 0C 18 69 06 C9 24 D0 0
5 20 BE FD A9 06 B5 0C ": GOSUB SHLAM
200 A$="0922:85 24 A5 05 B5 F2 A5 06 B5 F3 20 1F E5 A9 00 20 AB FC 2C 00 C0 1
0 1B AD 00 C0 2C 10 C0 ": GOSUB SHLAM
210 A$="093F:C9 A0 F0 06 C9 BD F0 B1 D0 0B 2C 00 C0 10 FB BD 10 C0 4C 7B 0B "
: GOSUB SHLAM
220 PRINT : PRINT "ROUTINE HAS BEEN POKED INTO MEMORY"
222 PRINT "INSTRUCTIONS:": PRINT " 1. CALL 2048": PRINT " 2. PAUSE DISPLAY WI
TH SPACE BAR, OR"
224 PRINT " 3. ABORT DISPLAY WITH RETURN KEY"
230 NEW
240 END
300 A$( LEN(A$)+1)="N EBBAG": FOR I=1 TO LEN(A$): POKE 511+I, ASC(A$(I))
: NEXT I: POKE 72,0: CALL -144
310 RETURN
```

## Symbol Cross Referencer

```
10 DIM A$(255):SHLAM=300
20 CALL -936: PRINT "THIS PROGRAM GENERATES A BINARY FILE": PRINT "WHICH IS
THE MACHINE LANGUAGE"
30 PRINT "SINGLE VARIABLE CROSS REFERENCE ROUTINE"
100 A$="300:20 5B FC A0 00 B4 09 B1 4A F0 0C C9 40 D0 02 A9 A4 20 F0 FD CB D0
F0 B4 00 20 BE FD A5 CA ": GOSUB SHLAM
110 A$="031E:B5 03 A5 CB B5 04 A0 00 B1 03 B5 01 3B E5 00 B5 0E 90 7C A0 03 C
4 03 B0 76 B1 03 C9 B0 ": GOSUB SHLAM
120 A$="033B:B0 16 C9 5D F0 6C C9 2B D0 0B CB C4 05 B0 63 B1 03 C9 29 D0 F5 C
8 D0 E0 C9 C1 B0 04 C8 ": GOSUB SHLAM
130 A$="0358:CB 90 F5 B4 06 18 98 65 03 B5 07 A5 04 69 00 B5 0B A0 00 B1 07 D
1 4A D0 0B CB C4 00 D0 ": GOSUB SHLAM
140 A$="0375:F5 B1 07 C9 B0 90 12 98 18 65 06 AB B1 03 C9 B0 90 AC CB C4 05 9
0 F5 B0 1F A5 09 69 06 ": GOSUB SHLAM
150 A$="0392:C9 24 D0 05 20 BE FD A9 06 B5 09 B5 24 A0 01 B1 03 B5 F2 CB B1 0
3 B5 F3 20 1F E5 A5 01 ": GOSUB SHLAM
160 A$="03AF:1B 65 03 B5 03 AA A5 04 69 00 B5 04 E4 4C E5 4D B0 03 4E 24 03 2
0 BE FD 60 ": GOSUB SHLAM
170 PRINT : PRINT "MACHINE LANGUAGE ROUTINE HAS BEEN": PRINT "POKED INTO MEMO
RY"
172 PRINT "INSTRUCTIONS:": PRINT " 1. TYPE 'CLR': PRINT " 2. DECLARE SYMBOL
TO XREF": PRINT " 3. CALL 768"
180 NEW
190 END
300 A$( LEN(A$)+1)="N EBBAG": FOR I=1 TO LEN(A$): POKE 511+I, ASC(A$(I))
: NEXT I: POKE 72,0: CALL -144
310 RETURN
```



functions. For example, the Applesoft Tool Kit (which is part of Apple's DOS Tool Kit) has a symbol cross-referencing capability built into it. Roger Wagner's Apple-Doc package contains routines to perform both types of cross-referencing. Both of these utilities are for Applesoft. What about Integer BASIC?

When I bought my Apple II, most of my early programming was in Integer, so one of my first serious tasks was to write such utilities for Integer. This article contains listings of my results. Both were first written in assembly language; source listings from my assembler are included. Later, I wrote Integer programs that POKEd the machine language routines into memory, using S.H. Lam's method. Listings of these programs are also included.

The line cross-reference routine resides in memory locations \$800 to \$953, while the symbol cross-reference routine extends from \$300 to \$3C7. Consequently, it is possible to have your Integer program and both routines in memory with no addressing conflicts. If you choose to BLOAD the line cross-referencer (rather than RUNning the Integer program that POKEs it into memory), you will have to set LOMEM to some address higher than \$953. This will prevent the routine from getting wiped out by any immediate-mode statements you type in that contain a variable or array name. My Integer program automatically does this in line 5 by setting LOMEM to 2500 before POKeing the routine into that part of memory which is usually reserved for the Integer symbol table.

Both routines will display the cross-reference table on the screen; the line number cross-referencer can be stopped at any time by hitting the space bar. When you want to resume the display, merely press another key. If you want to permanently abort the display, press the return key.

You can, of course, get the tables printed out by doing a PR#1 (or whatever other slot you use) before CALLing the machine language routine.

RUNning the Integer programs will set up the machine language cross-referencers. You then LOAD the Integer program that you want to cross-reference. If you want to perform a line number cross-reference, you start the

### Integer BASIC Symbol XREF

```

;INTEGER BASIC SYMBOL XREF
;
;BY LEE REYNOLDS
;
;ZERO PAGE
;
0000 SYMLEN EPZ $00 ;SYMBOL NAME LENGTH
0001 LINLEN EPZ $01 ;LENGTH OF TEST LINE
0003 LINADR EPZ $03 ;CURR. PROGR. LINE ADDR.
0005 LAST EPZ $05 ;# BYTES TO TEST UP TO IN CURR
. LINE
0006 CURBYT EPZ $06 ;Y VALUE FOR CURRENT MATCH
0007 CURADR EPZ $07 ;ADDR. OF CURR. MATCH
0009 HPOS EPZ $09 ;LAST CURSOR HORIZ. POS.
0800 ;
0300 ; ORG $300
0300 ; OBJ $800
;
0300 20 58 FC JSR $FC58 ;HOME & CLEAR SCREEN
0303 A0 00 LDY #$00
0305 84 09 STY HPOS ;INIT. CURS. POS.
0307 B1 4A LOOP1 LDA ($A),Y ;SYMBOL PRINT LOOP
0309 F0 0C BEQ FNDREF ;DSP BYTE?
030B C9 40 CMP #$40 ;@ SIGN?
030D D0 02 BNE OUTCHR
030F A9 A4 LDA #A4 ;CHANGE TO $
0311 20 F0 FD OUTCHR JSR $FDFO ;CHAR. OUTPUT
0314 C8 INY ;INCR. # CHARS.
0315 D0 F0 BNE LOOP1 ;ALWAYS
0317 84 00 STY SYMLEN ;SAVE SYM. LENGTH
0319 20 8F FD FNDREF JSR $8FDE ;OUTPUT CARRIAGE RETURN
031C A5 CA LDA #CA ;LOMEM, LOW
031E 85 03 STA LINADR
0320 A5 CB LDA #CB ;LOMEM, HIGH
0322 85 04 STA LINADR+1
0324 A0 00 LDY #$00 ;LINE SEARCH LOOP
0326 B1 03 LDA (LINADR),Y ;LINE LENGTH
0328 85 01 STA LINLEN ;SAVE LINE LENGTH
032A 38 SEC
032B E5 00 SBC SYMLEN ;SUBTRACT SYM. LENGTH
032D 85 05 STA LAST ;SAVE PTR TO LAST BYTE TO TEST

032F 90 7C BCC NXTLIN
0331 A0 03 LDY #$03 ;GET PAST LINE #
0333 C4 05 CPY LAST ;FIND NON-TOKEN LOOP
0335 B0 76 BCS NXTLIN ;Y>=PTR TO LAST?
0337 B1 03 LDA (LINADR),Y
0339 C9 B0 CMP #$B0
033B B0 16 BCS TSTNUM ;>=$B0?
033D C9 5D CMP #$5D
033F F0 6C BEQ NXTLIN ;REM TOKEN?
0341 C9 28 CMP #$28 ;BEGIN QUOTE?
0343 D0 0B BNE NXTBYT
0345 C8 LOOP3 INY ;FIND QUOTE LOOP
0346 C4 05 CPY LAST
0348 B0 63 BCS NXTLIN ;DONT WITH LINE?
034A B1 03 LDA (LINADR),Y
034C C9 29 CMP #$29 ;END QUOTE?
034E D0 F5 BNE LOOP3
0350 C8 NXTBYT INY
0351 D0 E0 BNE TSTOKN ;ALWAYS
0353 C9 C1 CMP #$C1
0355 B0 04 BCS ALPHA
0357 C8 INY ;SKIP OVER 2ND BYTE
0358 C8 INY ;SKIP OVER 1ST BYTE OF INTEGER

0359 90 F5 BCC NXTBYT ;ALWAYS
035B 84 06 STY CURBYT ;SAVE PTR TO CURR. BYTE
035D 18 CLC
035E 98 TYA
035F 65 03 ACC LINADR
0361 85 07 STA CURADR
0363 A5 04 LDA LINADR+1
0365 69 00 ACC #$00
0367 85 08 STA CURADR+1
0369 A0 00 LDY #$00
036B B1 07 LOOP4 LDA (CURADR),Y ;TEST SYMBOL MATCH LOOP
036D D1 4A CMP ($A),Y
036F D0 0B BNE FNDTOK ;NO MATCH. GO FIND TOKEN
0371 C8 INY
0372 C4 0C CPY SYMLEN ;COMPARE TO SYMBOL LENGTH
0374 D0 F5 BNE LOOP4

```

(Continued)

### Integer BASIC Symbol XREF (continued)

```

0376 B1 07          LDA (CURADR),Y      ;NEXT BYTE TOKEN?
0378 C9 80          CMP #$80
037A 90 12          BCC FOUND
037C 98             FNDTOK          TYA
037D 18             CLC
037E 65 06          ADC CURBYT
0380 A8             TAY
0381 B1 03          LOCP5          LDA (LINADR),Y      ;FIND TOKEN LOOP
0383 C9 80          CMP #$80
0385 90 AC          BCC TSTOKN          ;<$BC?
0387 C8             INY
0388 C4 05          CPY LAST
038A 90 F5          BCC LOOP5          ;>=LAST VALUE TO TEST?
038C B0 1F          BCS NXTLIN          ;ALWAYS
038E A5 09          FOUND          LDA HPCS
0390 69 06          ADC #$06
0392 C9 24          CMP #$24          ;REACHED 36?
0394 D0 05          BNE PRT
0396 20 8E FD       JSR $FD8E          ;CARRIAGE RETURN
0399 A9 06          LDA #$06
039B 85 09          PRT           STA HPCS          ;SAVE CURSOR POSITION
039D 85 24          STA $24          ;MOVE CURSOR
039F A9 01          LDA #$01
03A1 B1 03          LDA (LINADR),Y      ;REFERENCING LINE #, LO
03A3 85 F2          STA $F2          ;PASS TO SUBR.
03A5 C8             INY
03A6 B1 03          LDA (LINADR),Y      ;HIGH BYTE
03A8 85 F3          STA $F3          ;PASS TO SUBR.
03AA 20 1F E5       JSR $E51F          ;PRINT LINE #
03AC A5 01          NXTLIN          LDA L/NLEN          ;LINE LENGTH
03AF 18             CLC
03B0 65 03          ADC LINADR
03B2 85 03          STA LINADR
03B4 AA             TAX
03B5 A5 04          LDA LINADR+1
03B7 69 00          ADC #$00
03B9 85 04          STA LINADR+1       ;NEXT LINE# ADDR.
03BB E4 4C          CPX $4C          ;REACHED HIMEM?
03BC E5 4D          SBC $4D
03BE B0 03          BCS EXIT
03C1 4C 24 03       JMP LOOP2
03C4 20 8E FD       EXIT          JSR $FD8E
03C7 60             RTS
03C8             END

```

display by means of "CALL 2048." If you want to perform the symbol cross-reference, it's a bit more complicated:

1. Type CLR to clear the symbol table. This is necessary because I chose to have my routine perform its cross-reference on only one symbol at a time, and it is always the first one declared.
2. Declare the symbol you want to cross-reference. Thus, if you wanted to find all references of a variable named PLAYER, you would type in a statement such as PLAYER=0. If you wanted to search for an array named BOARD, then a statement like DIM BOARD(64) would do. When cross-referencing a string array, you must also declare the symbol by means of a DIM statement.
3. Activate the display by means of "CALL 768." When you want to cross-reference another variable or array name, begin again from step 1.

Remember that if a non-array variable has the same name as an array, its value is stated in element 0 of the array. Thus, if you have a variable called GAME and also an array called GAME, the value of the variable is saved in GAME(0). This interesting quirk of that language means that my symbol cross-referencer will cross-reference both usages at once.

If you understand assembly language, you may find it interesting to delve into the source listings; the comments are fairly complete, so it shouldn't be difficult to understand, if you are aware of how Integer BASIC stores program lines in memory. (See the Nov./Dec. 1979 issue of *Call* —A.P.P.L.E.)

Both Integer programs NEW themselves out of memory after running, and — as mentioned before — the line number cross-referencer program must begin by setting LOMEM. Consequently, line 180 in the symbol cross-referencer is "illegal." The same goes for lines 5 and 230 in the line cross-referencer. In order to type these lines in, you will have to go to a bit of trouble. One method is to use Ray McVay's Integer BASIC Post-Editor program (see the March/April 1980 issue of *Call* —A.P.P.L.E.). If you don't have this program available, the changes can be implemented using the following procedures.

### Integer BASIC Line XREF

```

0800             ;INTEGER BASIC LINE XREF
0800             ;
0800             ;BY LEF REYNOLDS
0800             ;
0000             FLAG1          EPZ $00          ;FLAG:=1 WHEN 1ST REF.
0001             CURLIN         EPZ $01          ;CURRENT LINE #, WHOSE REF'S A
RE BEING SEARCHED
0003             CURADR          EPZ $03          ;ADDRESS OF CURLIN
0005             SRCHLN         EPZ $05          ;CURRENT LINE BEING SEARCHED F
OR REF'S
0007             SRCHAD          EPZ $07          ;ADDRESS OF SRCHLN
0009             LENREF         EPZ $09          ;LENGTH OF REFERENCED LINE
000A             LENSEA         EPZ $0A          ;LENGTH OF LINE BEING SEARCHED
000B             FLAG2          EPZ $0B          ;FLAG: 0=GOTO, $A=DEL, $75=LIST
000C             LSTPOS         EPZ $0C          ;LAST HORIZ. CURSOR POS.
0800             ;
0300             ORG $300
0800             ORG $800
0800             ;
0800 A5 CA          BEGIN          LDA $CA          ;PROG. START, LOW
0802 85 03          STA CURADR
0804 A5 CE          LDA $CB          ;PROG. START, HIGH
0806 85 04          STA CURADR+1
0808 A9 00          LDA #$00
080A 85 0C          STA $0C          ;INIT. LAST CH
080C 20 58 FC       JSR $FC58          ;HOME & CLEAR SCREEN
080F A2 00          LDX #$00
0811 BD 1E 08       LOOP          LDA TITLE,X

```

(Continued)

## Integer Symbol Xref Program Procedure

1. Type in this statement before any others:  
180 PRINT
2. Go into the monitor by means of  
CALL - 151
3. Type CA.CB

You will see something like this:

```
*00CA - FB 95
```

This is telling you that locations \$CA and \$CB contain the values \$FB and \$95. If you combine the two values into one 4-digit hex number, after switching their order, you will get the memory location \$95FB where line number 180 begins. The entire memory representation of this line will be the following sequence of hex values (which, in this case, you can display by means of the monitor command 95FB.95FF):

```
05 B4 00 63 01
```

That "63" is what BASIC stores in place of the word "PRINT", which you typed in on line 180. Change that value to the token for the key word "NEW." In this example, 95FE:0B accomplishes this.

When you have succeeded in getting BASIC to accept an illegal statement containing the word "NEW", you must go back to BASIC by means of Control-C (return), and type in the rest of the Integer program.

## Integer Line Xref Program Procedure

You will have to go through a very similar process to get lines 5 and 230 into the program.

1. Type in these lines first:  
5 PRINT 2500  
230 PRINT
2. Go into the monitor, by CALL - 151
3. Type CA.CB. My 48K system displays:  
\*00CA - F3 95

So line number 5 starts at location \$95F3. You can display both lines by means of:

```
95F3.95FF
```

You will see these hex values:

```
08 05 00 62 B2 C4 09 01 05 E6 00 63 01
```

## Integer BASIC Line XREF (continued)

0814 20 ED FD	JSR \$FD8D	;OUTPUT CHAR.
0817 E8	INX	
0818 E0 12	CPX #\$12	;END OF TITLE?
081A D0 F5	BNE LOOP	
081C F0 12	BEO INIT1	
081E 4C 49 4E	TITLE ASC 'LINE#	REFERENCES'
0821 45 23 20		
0824 20 20 52		
0827 45 46 45		
082A 52 45 4E		
082D 43 45 53		
0830 A0 00	INIT1 LDY #\$00	
0832 E1 03	LDA (CURADR),Y	;LENGTH OF LINE
0834 85 09	STA LENREF	
0836 84 00	STY FLAG1	;CLEAR FLAG: NO REF'S
0838 C8	INY	
0839 E1 03	LDA (CURADR),Y	;LINE TO FIND, LOW
083B 85 01	STA CURLIN	
083D C8	INY	
083E E1 03	LDA (CURADR),Y	;LINE TO FIND, HIGH
0840 85 02	STA CURLIN+1	
0842 A5 CA	LDA \$CA	;PROG. START, LOW
0844 85 07	STA SRCHAD	;SEARCH START, LOW
0846 A5 CB	LDA \$CB	;PROG. START, HIGH
0848 85 08	STA SRCHAD+1	;SEARCH START, HIGH
084A A0 00	LDY #\$00	;LINE LOOP
084C B1 07	LDA (SRCHAD),Y	;LENGTH OF LINE
084E 85 0A	STA LENSEA	
0850 C8	INY	
0851 E1 07	LDA (SRCHAD),Y	;LINE# SEARCHING, LO
0853 85 05	STA SRCHLN	
0855 C8	INY	
0856 B1 07	LDA (SRCHAD),Y	; " " , HIGH
0858 85 06	STA SRCHLN+1	
085A A0 03	LDY #\$03	;GET PAST LINE #
085C E1 07	SEARCH LDA (SRCHAD),Y	;GET CURR. BYTE
085E C9 5F	CMP #\$5F	;GOTO TOKEN?
0860 F0 4B	BEO GOTO	
0862 C9 5C	CMP #\$5C	;GOSUB TOKEN?
0864 F0 47	BEO GOTO	
0866 C9 24	CMP #\$24	;THEN TOKEN?
0868 F0 43	BEO GOTO	
086A C9 08	CMP #\$08	;RUN TOKEN?
086C F0 3F	BEO GOTO	
086E C9 09	CMP #\$09	;DELETE TOKEN?
0870 F0 41	BEO DEL	
0872 C9 74	CMP #\$74	;LIST TOKEN?
0874 F0 43	BEO LIST	
0876 C8	NXTBYT INY	
0877 C4 0A	CPY LENSEA	;DONE WITH LINE?
0879 90 E1	BCC SEARCH	
087B A5 07	NXTLI LDA SRCHAD	;ADDR. OF LINE SEARCHING
087D 18	CLC	
087E 65 0A	ADC LENSEA	;LENGTH
0880 85 07	STA SRCHAD	;NEXT LINE ADDR.
0882 A5 08	LDA SRCHAD+1	
0884 69 00	ADC #\$00	
0886 85 08	STA SRCHAD+1	
0888 A5 07	LDA SRCHAD	
088A C5 4C	CMP \$4C	;COMPARE TO HIMEM
088C A5 08	LDA SRCHAD+1	
088E E5 4D	SEC \$4D	
0890 90 BF	BCC INIT2	
0892 A5 03	LDA CURADR	;ADDR. OF TEST LINE
0894 18	CLC	
0895 65 09	ADC LENREF	;LENGTH
0897 85 03	STA CURADR	;NEXT TEST LINE ADDR.
0899 A5 04	LDA CURADR+1	
089B 69 00	ADC #\$00	
089D 85 04	STA CURADR+1	
089F A5 03	LDA CURADR	
08A1 C5 4C	CMP \$4C	;END OF PROGRAM?
08A3 A5 04	LDA CURADR+1	
08A5 E5 4D	SEC \$4D	
08A7 90 87	BCC INIT1	
08A9 20 8E FD	EXIT JSR \$FD8E	;PRINT CARR. RET.
08AC 60	RTS	;GO BACK TO BASIC
08AD A9 00	GOTO LDA #\$00	
08AF 85 0E	STA FLAG2	;FLAG TESTING GOTO
08B1 F0 0A	BEO TSTLIN	
08B3 A9 0A	DEL LDA #\$0A	
08B5 85 0E	STA FLAG2	;FLAG TESTING DELETE
08B7 D0 04	BNE TSTLIN	

(Continued)



**Integer BASIC Line XREF (continued)**

08B9 A9 75	105	LIST	LDA #\$75	
08BB 85 0B	106		STA FLAG2	;FLAG TESTING LIST
08BD C8	107	TSTLIN	INY	;BYTE AFTER GOTO, ETC.
08BE B1 07	108		LDA (SRCHAD),Y	
08C0 C9 80	109		CMP #\$80	
08C2 90 1A	110		BCC TESTB	;<\$B0?
08C4 C9 BA	111		CMP #\$8A	
08C6 80 19	112		BCS TESTB	;>\$B9?
08C8	113			
08C8	114			;BYTE VALUE BETWEEN \$B0 & \$B9 SAYS
08C8	115			;NEXT TWO BYTES ARE INTEGER #
08C8	116			
08C8 C8	117		INY	
08C9 B1 07	118		LDA (SRCHAD),Y	
08CB C8	119		INY	
08CC C5 01	120		CMP CURLIN	;LOW BYTE OF TEST LINE?
08CE D0 11	121		ENE TESTB	
08D0 B1 07	122		LDA (SRCHAD),Y	
08D2 C5 02	123		CMP CURLIN+1	;HIGH BYTE?
08D4 D0 0B	124		ENE TESTB	
08D6 C8	125		INY	;POINT TO BYTE AFTER INTEGER #
08D7 B1 07	126		LDA (SRCHAD),Y	
08D9 C9 04	127		CMP #\$04	
08DB 90 1D	128		BCC PRINT	;PRINT IT'S SEMICOLON OR END-O
F-LINE TOKEN				
08DD C5 0B	129		CMP FLAG2	;TYPE OF COMMA TOKEN
08DF F0 19	130		BEQ PRINT	
08E1 A5 0B	131	TESTB	LDA FLAG2	
08E3 F0 91	132		BEQ NXTBYT	;GOTO, ETC.
08E5 C8	133	FNDCCM	INY	;FIND COMMA OR STATEMENT SEPAR
ATOR				
08E6 B1 07	134		LDA (SRCHAD),Y	
08E8 C5 0B	135		CMP FLAG2	
08EA F0 06	136		BEQ FOUND	
08EC C9 04	137		CMP #\$04	
08EE 90 86	138		BCC NXTBYT	
08F0 B0 F3	139		BCS FNDCCM	
08F2 A9 00	140	FOUND	LDA #\$00	;FLAG FOR 1ST REF.
08F4 85 0B	141		STA FLAG2	
08F6 F0 C5	142		BEQ TSTLIN	;ALWAYS
08F8 F0 AF	143	OUT	BEQ EXIT	;ALWAYS
08FA A5 00	144	PRINT	LDA FLAG1	;FLAG FOR 1ST REF.
08FC D0 14	145		ENE PRTRF	;NOT FIRST REF?
08FE E6 00	146		INC FLAG1	;FLAG 1ST REF. FOUND
0900 20 8E FD	147		JSR \$FD8E	;PRINT CARR. RET.
0903 A9 00	148		LDA #\$00	;BEGIN NEW LINE
0905 85 0C	149		STA LSTPOS	
0907 A5 01	150		LDA CURLIN	;TEST LINE#, LOW
0909 85 F2	151		STA \$F2	;PASS TO ROUTINE
090B A5 02	152		LDA CURLIN+1	;TEST LINE#, HIGH
090D 85 F3	153		STA \$F3	;PASS
090F 20 1F E5	154		JSR \$E51F	;PRINT TEST LINE#
0912 A5 0C	155	PRTRF	LDA LSTPOS	;LAST CURSOR HORIZ.
0914 18	156		CLC	
0915 69 06	157		ADC #\$06	
0917 C9 24	158		CMP #\$24	;REACHED POS. 367
0919 D0 05	159		ENE PRT	
091B 20 8E FD	160		JSR \$FD8E	;CARR. RET.
091E A9 06	161		LDA #\$06	
0920 85 0C	162	PRT	STA LSTPOS	
0922 85 24	163		STA \$24	;MOVE CURSOR
0924 A5 05	164		LDA SRCHLN	;REFER. LINE #, LOW
0926 85 F2	165		STA \$F2	
0928 A5 06	166		LDA SRCHLN+1	;HIGH
092A 85 F3	167		STA \$F3	
092C 20 1F E5	168		JSR \$E51F	;PRINT REF. LINE #
092F A9 00	169		LDA #\$00	
0931 20 AB FC	170		JSR \$FCAB	;MAKE A LONG DELAY
0934 2C 00 C0	171		BIT \$C000	;TEST KBD. STROBE
0937 10 18	172		BPL ENDL1	;NOTHING TYPED?
0939 AD 00 C0	173		LDA \$C000	;GET KEY TYPED
093C 2C 10 C0	174		BIT \$C010	;CLR KBD. STROBE
093F C9 A0	175		CMP #\$A0	;IS IT A SPACE?
0941 F0 06	176		BEQ STOP	;GO STOP PRINTING
0943 C9 8D	177		CMP #\$8D	;CARR. RET.?
0945 F0 B1	178		BEQ OUT	;GO END PROGRAM
0947 D0 08	179		ENE ENDL1	
0949 2C 00 C0	180	STOP	BIT \$C000	;TEST STROBE
094C 10 FB	181		BPL STOP	;WAIT FOR KEYIN
094E 8D 10 C0	182		STA \$C010	;CLR STROBE
0951 4C 7B 08	183	ENDL1	JMP NXTL1	
0954	184	END	END	

You must change the "62" to an "11", and the "63" to a "0B". On my system, these monitor commands would do that:

95F6:11  
95FE:0B

4. Now go back to BASIC and enter the rest of the program.

If you don't know anything about the hexadecimal numbering system, or about the monitor commands, you should leave out line 230 of my Integer line cross-referencer, and NEW the program out of memory yourself in immediate mode, after RUNNING it. Also, leave out lines 5 and 180 in the other program, set LOMEM to 2500 before you RUN it, then NEW it out afterwards.

Lee Reynolds, a computer programmer for 15 years, owns an Apple II. He has published almost two dozen articles in magazines such as *MICRO*, *Call*, *A.P.P.L.E.*, and *Softalk*. Reynolds may be contacted at 5760 N.W. 60 Ave., Apt. B-101, Ft. Lauderdale, FL 33319.

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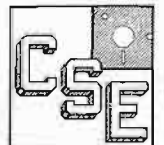
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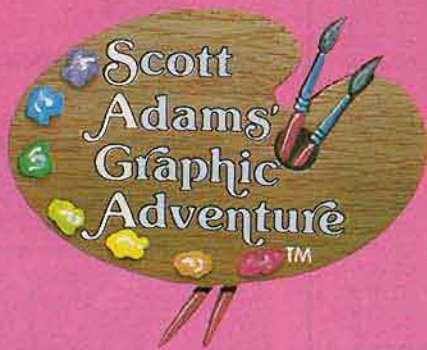


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### Time Marches On

*Dr. William Dial's 6502 Bibliography has played a major role in making bibliographical information available to 6502 users. But now that the 6502 is a mature processor, we at MICRO believe that most 6502 users need selectivity more than comprehensiveness. Therefore, the 6502 Bibliography in MICRO will in future selectively list a much smaller number of the better 6502 articles.*

*Users of the 6809 processor, however, do need the kind of comprehensive coverage that MICRO used to give the 6502. Therefore, MICRO will now start a comprehensive 6809 bibliography, to be published in installments as material accumulates. If any readers are aware of 6809 material we are missing, please contact Dr. Dial or the MICRO staff.*

*We feel that this combination—selective 6502 and comprehensive 6809 coverage—will serve our readers best.*

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# MICRO

## New Publications

Mike Rowe  
New Publications  
34 Chelmsford Street  
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**Intimate Instructions in Integer BASIC**, by Brian D. Blackwood and George H. Blackwood. Howard W. Sams and Co., Inc. (4300 West 62nd St., Indianapolis, IN 46268), 1981, 158 pages, 5¼ × 8½ inches, paperback.  
ISBN: 0-672-21812-7 \$7.95

Although written for Apple II users, this book can apply, with modifications, to other microcomputers using BASIC. In a lesson-type format, each chapter provides definitions, the basic fundamentals of programming techniques, and self-testing exercises.

**CONTENTS:** *Introduction; Clear the VDM Screen; Load and Save Program; Programming and Print Rules; Operators; Truncation and Integers; Simulated Reals; Catch-All; Flowcharting; Loops and Counting Variables; Rule of Default and Decision Statements; General Outline of Programs; Playing Computer; Subscripted Variables; MIN-MAX and SORT; Strings and GOSUB; Functions; Efficient Programming; Graphics; Menu and Flag; Games; Appendix; Index.*

**Pascal: A Problem Solving Approach**, by Elliot B. Koffman. Addison-Wesley (Reading, MA 01867), 1982, 6 × 9 inches, paperback.  
ISBN: 0-201-10341-9 \$14.95

This book emphasizes the structured, step-by-step design of computer programs. Both beginning programmers and those experienced in other languages will learn programming techniques, problem-solving skills, and UCSD Pascal.

**CONTENTS:** *Introduction to Computers and Programming—Introduction; Computer organization; Programs and programming languages; Introduction to Pascal;*

*Using the computer; Additional input and output features; Introduction to data types; Summary; Programming problems. Problem Solving with the Computer—Introduction; Problem analysis; Description of the problem solution; Algorithms involving decisions; Algorithms with loops; Implementing the algorithm; Summary; Programming problems. Fundamental Control Statements—Introduction to control statements; The IF statement; The WHILE statement; Application of control statements; The FOR statement; The widget inventory control problem; Debugging and testing programs; Common programming errors; Summary; Programming problems. Standard, Scalar, and Subrange Data Types—Introduction; Numeric data types—REAL and INTEGER; Functions in arithmetic expressions; Boolean variables, expressions and operations; String variables; Character variables and functions; More on input; Scalar and subrange data types; Numerical errors; Common programming errors; Summary; Programming problems. Intermediate Control Structures—Introduction; Multiple-alternative decisions; Top-down programming and functions; Procedures; Application of top-down design; Scope of an identifier; Common programming errors; Summary; Programming problems. Arrays and Strings—Introduction; Declaring arrays; Array subscripts; Manipulating array elements; Manipulating entire arrays; Partially filled arrays; Arrays of strings; Manipulating character strings; Common programming errors; Summary; Programming problems. Records and Sets—Introduction; Declaring a record; Manipulating a record—the WITH statement; Arrays of records; The set data type; Set operations; Searching an array of records; Common programming errors; Summary; Programming problems. REPEAT and GOTO Statements, Nested Structures and Recursion—Introduction; REPEAT-UNTIL loop; Nested loops; Sorting an array; The GOTO and EXIT statements; Solving a larger problem; Testing a program system; Recursion; Common programming errors; Summary; Programming problems. Hierarchical Records and Files—Introduction; Hierarchical records; Record variants; TEXT and INTERACTIVE files; User-defined file types; File update and merge; Common programming errors; Summary; Programming problems. Multidimensional Arrays—Introduction; Declaration of multidimensional arrays; Manipulation of multidimensional arrays; Room scheduling; Introduction to computer art: drawing block letters; Common programming errors; Summary; Programming problems. Pointer Variables and Dynamic Data Structures—Introduction; The NEW statement and pointers; Building linked data structures; Deleting a node; List insertion; Multiple-linked lists and trees; Common programming errors; Summary; Programming problems. Appendices—1. Differences Between UCSD Pascal and Standard Pascal; 2. Reserved Words: Standard Identifiers and Operators; 3. Using UCSD Pascal; 4. Pascal Syntax Diagrams. Index of Program Style Displays. Index of Programs, Procedures and Functions. Answers to Selected Exercises. Index.*

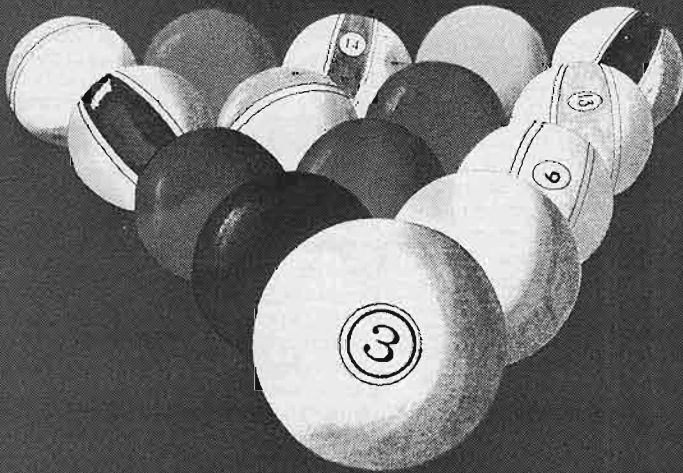
**Don't! (Or How to Care for Your Computer)** by Rodney Zaks. Sybex (Berkeley, CA), 1981, 224 pages, 6 × 9 inches, paperback.  
ISBN: 0-89588-065-2 \$11.95

An explanation of how to handle and maintain all components of a computer system: the CRT display, the diskettes, the printer, the magnetic tapes. Contains cartoons and photographs.

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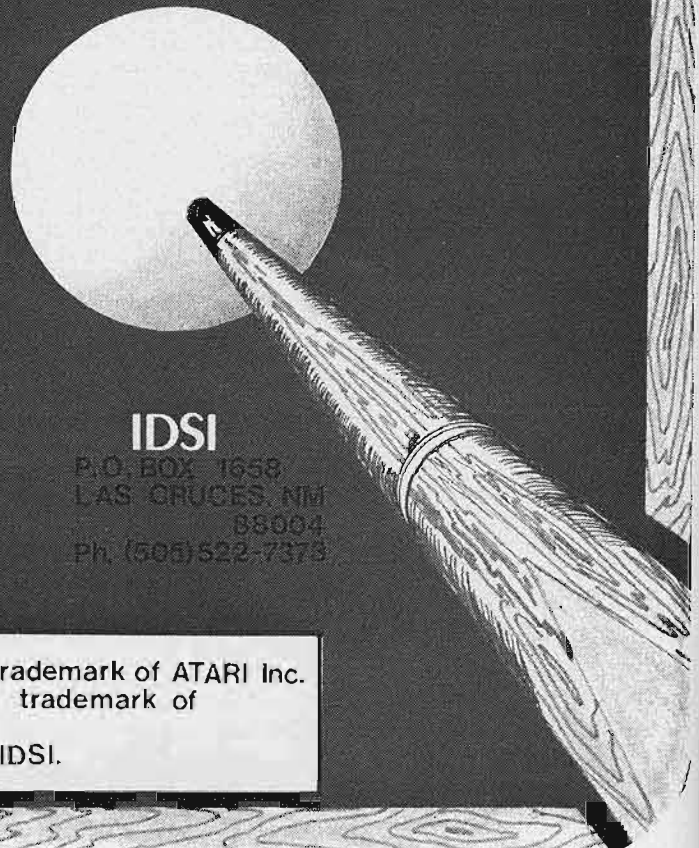
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# MICRO

## From Here to Atari

By James Capparell

Character sets, display codes, ATASCII codes, and keyboard codes are the subject of this month's column. This information will help you understand how a character appears on your T.V. screen. I will show you what the Atari character set is, where it resides in ROM, and how to access the character set. I'll also describe the three codes used to refer to the character set. Program 1 will print the keyboard code, ASCII character, and display code for any given key. Program 2 will show you how to place characters on a graphics 8 high-resolution screen. However, before we get that far we need to know what happens when a key is pressed on the keyboard.

When you press any key, an IRQ interrupt is generated. (For more on this, see my column in the January '82 MICRO.) The vector for IRQ is at memory location \$216, \$217 called VIMIRQ in the documentation. This vector points to \$E6F6, the entry point for the IRQ Interrupt Service Routine (ISR). This service routine performs the following functions:

1. Saves system registers.
2. Determines cause of interrupt by polling status register bits. IRQEN at \$D20E is interrogated for this purpose. See table 1 for IRQEN bit translations.
3. Jumps through the appropriate vector to the ISR. The ISR performs the necessary housekeeping associated with the interrupting source.

For the sake of our discussion, assume a key has been pressed. This causes an IRQ. Once it has been established that it was a keyboard-caused IRQ, a jump is made through locations \$208, \$209 called VKEYBD. This location contains \$FFBE, the start-of-keyboard service routine. This routine performs the following functions:

1. Processes debounce. Bounce is associated with the mechanical

vibration caused by key closure. This bounce can appear to the system as several keystrokes instead of just one. A software delay of 20 msec is sufficient to allow the vibration to dampen. A counter for this purpose is established at this point.

2. Starts/Stops(ctrl-1) processing. SSFLAG at location \$022F is set when the control and "1" keys are pressed simultaneously. This is the feature that allows you to start and stop listings or your favorite game.
3. Saves the keyboard code in locations \$2FC and \$2F2, called CH and CH1, respectively. This code is to be differentiated from ATASCII or the display codes.

Table 1

Address \$D20E, known as IRQEN (interrupt request enable), is interrogated whenever an IRQ interrupt occurs.

- Bit 7 = Break key interrupt
- Bit 6 = Other key interrupt
- Bit 5 = Serial input data ready interrupt
- Bit 4 = Serial output data needed
- Bit 3 = Serial output transmission finished
- Bit 2 = Timer 4 decremented to 0
- Bit 1 = Timer 2 decremented to 0
- Bit 0 = Timer 1 decremented to 0

### Listing 1

```
5 REM ** PROGRAM 1 **
6 REM PRESS ON ANY KEY WAIT FOR A COUPLE OF SECONDS
7 REM THE KEYBOARD CODE, CHARACTER, AND THE CHARACTER'S
8 REM DISPLAY CODE ARE PRINTED
10 OFFSET=6
20 DMEM=PEEK(88)+PEEK(89)*256:REM FIND DISPLAY MEMORY
30 A=PEEK(764):IF A>99 THEN OFFSET=7:IF A<10 THEN OFFSET=5
40 IF A<>255 THEN ? A;" ";CHR$(A);" ";PEEK(DMEM+OFFSET)
50 OFFSET=6
60 GOTO 20
```

### Listing 2

```
5 REM ** PROGRAM 2 **
6 REM PUT TEXT ON A GRAPHICS 8 SCREEN
7 REM CHANGE X, Y SEE WHAT HAPPENS
10 DIM OUT$(15),CNVRT$(1)
15 OUT$="ATARI 800"REM MESSAGE
20 CHBAS=57344:REM START OF CHARACTER SET
22 SPACE=2
25 X=12:Y=85:REM HORZ. VERT. OFFSETS
30 GRAPHICS 8+32
35 DMEM=PEEK(88)+PEEK(89)*256:REM START OF DISPLAY MEMORY
40 DMEM2=DMEM+X+(Y*40):REM OFFSET TO SCREEN CENTER
45 FOR I=1 TO LEN(OUT$):REM MOVE MESSAGE
50 CNVRT$(I)=OUT$(I):GOSUB 1000
55 CHAR=CHBAS+X*8:REM GET CHARACTER DATA
60 FOR BYTE=0 TO 7
65 POKE DMEM2+BYTE*40,PEEK(CHAR+BYTE)
70 NEXT BYTE
75 DMEM2=DMEM2+SPACE
80 NEXT I
85 STOP
900 REM SUBROUTINE CONVERTS ATASCII INTO DISPLAY CODES
910 REM DISPLAY CODE USED AS INDEX INTO CHARACTER SET IN ROM
1000 X=ASC(CNVRT$)
1010 IF X>127 THEN X=X-128:REM ELIMINATE REVERSED CHAR.
1020 IF X<31 AND X<96 THEN X=X-32:RETURN
1030 IF X<32 THEN X=X+64
1040 RETURN
```



## From Here to Atari

(Continued)

4. Sets attract mode flag at location \$4D. This prevents color rotation, which normally occurs after nine minutes of keyboard inactivity. If you choose to disable color rotation, be aware that prolonged operation without rotation could damage your picture tube's phosphor.
5. Sets location \$22B, called SRTIMR, to \$30. This is the auto-repeat timer and is used by Stage 2 Vblank routines to auto-repeat any key that is held down longer than 1/2 second. Stage 2 Vblank processing also decrements the debounce counter and updates the auto-repeat timer every 1/60 second.

After a key has been processed through the keyboard interrupt routines and Vblank, the resident keyboard handler takes over. This handler is part of the versatile Central Input/Output CIO facility. Most of what goes on here is very involved and the interested reader is advised to go to the operating system listing to follow the flow. These listings are available from

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Figure 1

. . . . .	= \$00
. . . x x . . .	= \$18
. . x x x x . .	= \$3C
. x x . . x x .	= \$66
. x x . . x x .	= \$66
. x x x x x x .	= \$7E
. x x . . x x .	= \$66
. . . . .	= \$00

The hex values are those found in ROM locations 57608 - 57615. These are the stored values representing the letter A.

Atari (ask for manual C016579). The one function that CIO performs that we need to understand is code translation.

If you read the manuals, you know there are many references to ATASCII code. Atari ASCII or ATASCII is Atari's version of the American Standard Code for Information Interchange. ASCII is an industry-standard description of how 26 letters of the alphabet, numbers, special punctuation, and some special characters can be represented in eight bits. Since there are 256 combinations available in eight bits, this leaves many combinations unused in the normal ASCII. The Atari, however, uses them all since it can display special graphics characters, inverted characters, and normal characters.

A universally accepted code — e.g. ASCII — is essential for devices to communicate properly with one another and with us. If the serial bit stream 01000001 is sent to any printer which recognizes ASCII, it will print the capital letter "A". Look at Appendix C-1 in your BASIC reference manual to see the entire ATASCII code and characters.

ATASCII is included in our machines to be compatible with peripheral devices. The Atari display code for each character is different from ATASCII. The display code is used to access the actual data that forms a character. It is all this data that is collectively referred to as a character set. The entire character set is stored in ROM starting at page address \$E0 (that's 57344 decimal). This character set is simply a string of bytes describing the shapes of individual characters.

Each character requires eight bytes, and is formed in an 8 x 8 grid. See figure 1. In order to access the appropriate eight bytes it is necessary to know the display codes of the character set. Program 1 is designed to tell you what a given code is for any key pressed on the keyboard, and will also work for shifted or controlled keys. Once we have found the data for the character we want, we can use that data. Look at program 2 to see how we moved letters, byte-by-byte, and stacked these bytes one on the top of the other to display characters in graphics mode 8.

The data stored at any location within a character set is arbitrary. Suppose when we go look for the string of bytes that normally is an "A" some other data is stored there. It would only be possible for different data to be there if the character set had been moved to RAM. Atari gave us another pointer called CHBAS \$D409. This location tells the O.S. where the first page of the character set data is. Normally residing in ROM, it can be moved to RAM. New data replaces old, and the pointer CHBASE can be changed to reflect the new location of the data. It is in this way that the letter "A" can be replaced by any pattern that will fit into the normal 8 x 8 grid. This process, known as redefining character sets, requires a few basic steps.

1. The new characters must be designed. Recall that each character must fit into an 8 x 8 grid. Then these byte values must be moved to an appropriate place reserved in memory just for this purpose.
2. ANTIC must be informed of where the redefined character set is in RAM. The character set must be on a 1K boundary, and CHBAS, location \$2P4, must be changed to point to the page address of the new character set.

Using some of these ideas, you could change the delay before a key repeats, redefine the keys on the console, use the keyboard vector to trap certain keys and give them special meaning. Well, you get the idea — it's completely flexible.

The author may be contacted at 297 Missouri St., San Francisco, CA 94107.

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# MICRO

## The Single Life

By Brad Rinehart

In the single board world, where virtually each machine can be slightly different, we need software that can adapt itself to several configurations. In contrast, other personal computer people do not need to be quite as careful: their machines are virtually the same. They do not have to worry about dealing with equipment produced by different manufacturers and configured together to build a system. But they also do not have the luxury of custom-tailoring their systems to the wide variety of equipment available.

As I'm sure you are aware, there are at least a hundred different terminals available. Some offer video, some hard copy only; others combine both. It is difficult to accommodate all the different possibilities, but the people at HDE have taken care of part of the job for you.

HDE Disk BASIC employs a feature called the personality module. The user has access to several locations contained in this module. These locations can be used to define backspace, backarrow, escape, edit inserts, cancel functions, and CLEAR SCREEN. There is a token (or command) in HDE Disk BASIC called CLS. CLS stands for Clear Screen. The personality module provides a function which is used to define the character sequence that is sent for the CLS command. Therefore, in your BASIC programs, when you want to clear the screen use a CLS command. For hardcopy terminal users, CLS transmits seven nulls if no characters are defined for it.

HDE Disk BASIC has a feature called LOADD, or load data. The full syntax for the load data command is:

```
LOADD "FILE NAME", DRIVE NO.
```

The drive number is optional; drive number two is the default. This command allows us to set up a common data file. In this file we can predefine any legal variables to any legal amount.

This includes strings, arrays, numeric variables, integers, etc. Once they are defined in this common data file, they can be loaded to memory from disk using the LOADD command. This accomplishes two things. First it loads our predefined variables, and second it ERASES all other variables. Instant free memory! But how is this used?

You enter HDE Disk BASIC the same way the old KIM BASIC was entered from FODS: enter the FODS command, BAS (RETURN). This loads BASIC from the disk and initializes it. Or you can enter BAS. (note the period) which loads and initializes BASIC. When BASIC "sees" the period following its name, it looks to the system disk (either drive #1 or drive #0) for a BASIC program called MENU. If BASIC finds MENU, it executes it. If you change the first three locations in FODS to NOPS (EA, EA, EA), FODS performs this from the boot strap. Instant auto start! Of course BASIC, its supporting routines, and your MENU program, must all be on your FODS system disk for this to happen.

The statement IF# (see figure 1) allows BASIC to "look" at the disk and determine if a program or file exists. In our example we are looking for a file named "COMMN". By adding the ,1 to the statement, we specify that we want HDE BASIC to look for the file on drive #1. We could have substituted a string variable for the file name, and a numeric variable for the drive number.

If the file exists, the IF# statement will be true. Therefore, the LOADD "COMMN",1 statement will be executed. If the file does not exist, the IF# statement will be false, and the ELSE statement will be executed, CHAINING the program SETUP from drive 1.

Let's assume that this is the first time this program has been run, our common data file does not yet exist, and control will be passed to our program SETUP. The next step is to determine what type of terminal is attached to the system. First I suggest you set up a menu which lists the types of terminals supported by the software. You may also want to add a menu selection which would allow the user to enter information for nonsupported terminals. For now, we'll assume the system is equipped with one of the terminals supported by the software.

Based on the user's entry to our menu, we would GOSUB to a routine similar to figure 2. From the REMarks you can see that this routine sets up

cursor controls for the Hazeltine 1400 and 1500 series of terminals. We would normally have similar routines for all other terminals supported by our software. Then, if we want to do a HOME CURSOR, we simply PRINT CU\$; from BASIC. Regardless of which terminal is attached to the system, PRINT CU\$ will position the cursor to HOME.

Once all of the proper variables have been defined, it is necessary to have the software "remember" them. The SAVED, or SAVE Data command, can be used to write all the current variables to disk. For example, the command SAVED"COMMN",1 will save the data to drive 1, under the name "COMMN". Then, whenever we need to load the data from disk, we use the LOADD"COMMN",1 command.

Addressing the cursor to an X, Y coordinate on the screen is a bit more complex. In figure 3, you will find an appropriate routine. Although no two terminals are alike, most require a LEAD IN character which tells the terminal that a command follows.

In figure 2 we defined a string called AD\$, which is our LEAD IN. It is normally followed by the row and column to which we address the cursor. To use the subroutine in figure 3, we first set up the variables R and C to the row and column we are addressing. Then we perform a GOSUB 1000.

The variable TT, or terminal type, was set up in our SETUP program when the user entered the terminal type for the system. TT, along with our cursor control characters, was "remembered" by the SAVED"COMMN",1 command. The variables '01, 02, and 03' were also defined in the SETUP routine. They are used to define any standard "offset" that may have to be added to the row and column for use with a particular terminal. Using a routine similar to this one eliminates the problem of rewriting the software for different terminals. It may take a little extra time to set this routine up in your program, but it will be well worth it in the long run.

Note that, if you address the cursor, print some information, and do a GOSUB 1010, the cursor will be repositioned to the beginning of the information just printed. This point is very useful when entering information into screen masks or forms. You can print a line of stars [\*\*\*\*] signifying the length of the information to be input, and then position the cursor to the beginning of the stars.

Common data files have other uses as well. HDE Disk BASIC currently supports from one to three five-inch or eight-inch disk drives. In addition, these drives may be either single- or double-sided. Using the common data file technique, we can assign variables which define these parameters.

Where HDE Disk BASIC is concerned, all single-sided drive disk systems operate with their system disk originally assigned as either drive number zero (0), or one (1). Therefore, if our BASIC programs are stored on the system disk, we may load them by specifying either LOAD "PGM NAME",0 or LOAD "PGM NAME",1. In the case of double-sided drives, the system disk is always drive zero (0). To load programs from the system disk, it is necessary to use the command LOAD "PGM NAME",0. From this example we see that it is best to specify the system drive in HDE Disk BASIC as drive zero (0) because this conforms to both the double- and single-sided drive standards.

You'll find it beneficial to predefine variables such as a system password, the maximum number of records allowed in a file, and the default system device drive name (as for a printer, modem, etc.). If the user wants to upgrade his

system he only needs to delete the common data file from the disk, rerun the MENU program, and redefine the proper variables.

Please address correspondence to: 1500 Stanton Street, York, PA 17404.

Figure 1

```
90 REM SEE IF COMMON DATA FILE ON DISK
100 IF#"COMMON",1 THEN LOAD#"COMMON",1 ELSE CHAIN "SETUP",1
110 REM
```

Figure 2

```
60000 REM CURSOR CONTROL SUBS FOR HAZELTINE 1400, 1500
60005 REM
60010 LE#=#128 REM LEAD IN
60020 CL#=#CHR$(LE#)+CHR$(28) REM CLEAR SCREEN
60025 CU#=#CHR$(LE#)+CHR$(18) REM HOME
60040 UP#=#CHR$(LE#)+CHR$(12) REM UP CURSOR
60045 DN#=#CHR$(LE#)+CHR$(11) REM DOWN CURSOR
60050 AD#=#CHR$(LE#)+CHR$(17) REM ADDRESS CURSOR
60055 DE#=#CHR$(LE#)+CHR$(15) REM CLEAR TO END OF LINE
60060 CE#=#CHR$(LE#)+CHR$(24) REM CLEAR TO END OF PAGE
60065 UL#=#CHR$(LE#)+CHR$(6) REM KEYBOARD UNLOCK
60070 LR#=#CHR$(LE#)+CHR$(21) REM LOCK KEYBOARD
60090 O1=#32, O2=#31, O3=#2, TT#="HAZ"+"L" GOT#60600
60095 REM
```

Figure 3

```
900 REM ADDRESS CURSOR SUBROUTINE
990 REM
1000 GOT#1000+TT
1001 R#R+O1,IF#O2 THEN L#=#O3 SWAP#R,O GOT#1010 ELSE SWAP#R,L GOT#1010
1002 R#R+O1,C#=#O1 GOT#1010 REM Left Single ARM 3/ADM 5
1003 R#R+O1,C#=#O1 GOT#1010 REM ADDR Regent
1004 R#R+WN,CE#=#WN GOT#1015 REM DEC VT100/VT103
1010 IF TT#F THEN PRINTAD#,CHR$(R),CHR$(C),FOR#22,2R RETURN
1012 REM This line to handle DEC VT100 and VT103
1015 PRINTAD#,RIGHT$(STR$(R),LEN(STR$(R))-1),",",
1020 PRINTRIGHT$(STR$(L),LEN(STR$(L))-1),"H",FOR#22,0 RETURN
1070 REM
```

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

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# MICRO

## Hardware Catalog

**Name:** TRS-80 Color Computer Learning Lab (26-3153)  
**System:** TRS-80 Color Computer  
**Memory:** 4K, 16K, 32K  
**Language:** Color BASIC  
**Hardware:** Cassette  
**Description:** A new self-instruction system that teaches user how to program in Color BASIC. Allows student to develop gradually through writing and editing longer, more complex programs. Example programs are practical and can be used for educational, family and personal purposes. The lab is divided into three sections: introduction to the computer; programming the computer; programming guides and tools to make programming easier, faster and more fun. The lessons take full advantage of color graphics and sound available from the TRS-80 Color Computer.  
**Price:** \$49.95 includes eight program cassettes and 30-lesson text  
**Author:** Radio Shack  
**Available:** Radio Shack

**Name:** Format ROM  
**System:** Apple II or Apple II Plus  
**Hardware:** M.C.'s ROMPLUS or Andromeda's ROMBoard  
**Description:** *Format ROM* will give you word processing and print using power for your Applesoft programs. Print Statement Formatting, a word processing system, looks at print statements in your program and makes sure they are properly formatted to your predefined requirements before Applesoft outputs them to your monitor or printer. The *Format ROM* will right and left justify, indent or outdent paragraphs, center text, pause, skip lines, redefine characters, and more. Print using commands will tabulate, right justify, line up decimal places, pad the right and left side of a number with any predefined character, insert commas every third digit from left of decimal

place, can be used within formulas and equations, has overflow capabilities, and more.  
**Price:** \$49.95  
**Available:** Soft CTRL Systems  
 P.O. Box 599  
 West Milford, NJ 07480  
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**Name:** Percom M65/50 Adapter  
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**Description:** Interface adapter board which allows AIM, KIM and SYM computer owners to expand their systems with standard System-50 (SS-50) modules. This gives the owner the advantage of being able to upgrade to disk storage, a CRT display and other devices using low-cost off-the-shelf SS-50 modules.  
**Price:** \$89.95 includes adapter, SS-50 motherboard  
**Available:** Percom Data Company, Inc.  
 11220 Pagemill Rd.  
 Dallas, TX 75243  
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**Name:** ETP  
**System:** Any  
**Memory:** 2K  
**Hardware:** Z80  
**Description:** The Mediamix *ETP* is an intelligent interface that connects the IBM Electronic Typewriter Models 50, 60, 75 or 175 to any computer. Available in Serial RS-232C or Centronics-compatible parallel versions, the Mediamix *ETP* adds RO printing capability to the typewriter as well as provides for total access to all of the special functions of the typewriter through the computer.  
**Price:** \$495 Parallel, \$595.00 Serial, includes cable and connector, power supply, and full documentation.  
**Available:** Mediamix  
 P.O. Box 67B57  
 Los Angeles, CA 90067  
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**Name:** Micromodule 16 (M68MM16-1; M68MM16-2; M68MM16-3)  
**Memory:** 16K to 64K bytes of dynamic RAM  
**Hardware:** Chassis and card cages (available from Motorola)

**Description:** *Micromodule 16* provides RAM, ROM, I/O and timer expansion for the Motorola Micromodule™ series of 8-bit monoboard microcomputers. It incorporates 2K bytes of static RAM which can be backed up with an external battery and power-fail detect circuit, and mounts an additional four 24-pin sockets in which the user may install his choice of 1K, 2K, 4K or 8K EPROMS, MOS or Bipolar PROMS, mask ROMs or pin-compatible RAMs for up to 32K of additional memory.  
**Price:** \$575 each  
**Available:** Motorola Systems distributors

**Name:** RAMPLUS+  
**Description:** Dual 16K RAM card for the Apple II. Two banks of 16K selectable RAM expand the Apple to 80K of available memory. The second bank of 16K RAM is controlled by user-supplied software. Hardware and/or software selection of each 16K bank of RAM is controlled by the user. The card also provides its own refresh circuitry. Just install it in any I/O slot; no bothersome cables to connect or IC's to remove from the Apple motherboard.  
**Price:** \$189.00 includes 16K of installed RAM  
**Available:** Mountain Computer Inc.  
 300 El Pueblo Road  
 Scotts Valley, CA 95066  
 (408) 438-6650

**Name:** Dual Thermometer  
**System:** Apple II  
**Memory:** 48K  
**Language:** Applesoft  
**Hardware:** One disk drive (13- or 16-sector) required; Printer and Clock Card optional  
**Description:** Use the *Dual Thermometer* to measure two temperatures almost anywhere. The software lets you display temperatures on the screen — maximum, minimum, the difference, and time. Store this

data on the disk or printer. Set the limit for an alarm to sound. Range: -55 to 125°C. Accuracy ±0.4°C from -20 to 50°C. [-4 to 122°F], ±1°C outside that range. Probes can be extended 500 feet.

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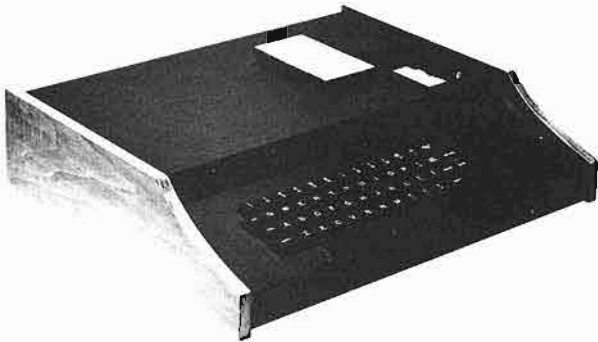
**Name:** MDM-1  
**System:** VIC-20  
**Hardware:** Commodore Vic  
**Description:** The *MDM-1* is a modem driver module that plugs directly into the user port of the Commodore VIC microcomputer. It has two additional serial ports for connecting a modem and a serial printer. It does not require any external power. A terminal program supplied with the unit permits telephone line connections to large timesharing computers, and to various computer networks, such as Source, Compu-Serve, Dow Jones, etc. There are two indicators on the *MDM-1* that illustrate the transmissions to and from the VIC. These transmissions are simultaneously recorded on the VIC TV screen and the serial printer.  
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 Dewitt, NY 13214

**Name:** Signalman  
**Hardware:** Modem Direct Connect  
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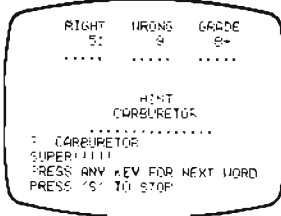
## CAI Programs Vol I

Cassette CS-4201 \$11.95

Requires 16K Apple II or Apple II Plus



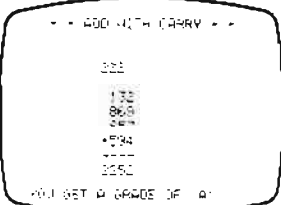
**U.S. Map** Identify states and their capitals



**Spelling** Study aid with your list of troublesome words.



**Math Drill** Arithmetic drill and practice with large or small display



**Add With Carry** Drill and practice on sums requiring numbers to be carried.

## Ecology Simulations - I

Disk CS-4706, \$24.95

Requires 48K Applesoft in ROM or Apple II Plus

### Steril

STERL allows you to investigate the effectiveness of two different methods of pest control—the use of pesticides and the release of sterile males into a screw-worm fly population. The concept of a more environmentally sound approach versus traditional chemical methods is introduced. In addition, STERL demonstrates the effectiveness of an integrated approach over either alternative by itself.

### Pop

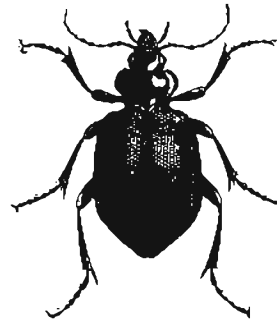
The POP series of models examines three different methods of population projection, including exponential, S-shaped or logistical, and logistical with low density effects. At the same time the programs introduce the concept of successive refinement of a model, since each POP model adds more details than the previous one.

### Tag

TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by tagging and recovery, TAG helps you to understand this process.

### Buffalo

BUFFALO simulates the yearly cycle of buffalo population growth and decline, and allows you to investigate the effects of different herd management policies. Simulations such as BUFFALO allow you to explore "what if" questions and experiment with approaches that might be disastrous in real life.



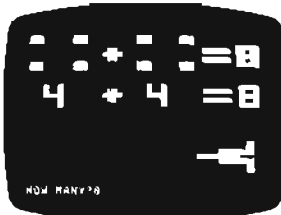
## CAI Programs Vol II

Cassette CS-4202 \$11.95

Requires 16K Apple II or Apple II Plus



**European Map** Identify countries and their capitals



**Meteor Math** Learn math skills by destroying menacing meteors

**Music Composing Aid** Make and play your own music on the Apple. No additional hardware required. Includes a sample from Bach's Toccata & Fugue in G minor.



## Ecology Simulations - II

Disk CS-4707 \$24.95

Requires 48K Applesoft in ROM or Apple II Plus

### Pollute

POLLUTE focuses on one part of the water pollution problem, the accumulation of certain waste materials in waterways and their effect on dissolved oxygen levels in the water. You can use the computer to investigate the effects of different variables such as the body of water, temperature, and the rate of dumping waste material. Various types of primary and secondary waste treatment, as well as the impact of scientific and economic decisions can be examined.

### Rats

In RATS, you play the role of a Health Department official devising an effective, practical plan to control rats. The plan may combine the use of sanitation and slow kill and quick kill poisons to eliminate a rat population. It is also possible to change the initial population size, growth rate, and whether the simulation will take place in an apartment building or an entire city.

### Malaria

With MALARIA, you are a Health Official trying to control a malaria epidemic while taking into account financial considerations in setting up a program. The budgeted use of field hospitals, drugs for the ill, three types of pesticides, and preventative medication, must be properly combined for an effective control program.

### Diet

DIET is designed to explore the effect of four basic substances: protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.



### CAI Programs I and II

Disk CS-4701 \$24.95  
Requires 32K Integer Basic

This disk contains all 7 programs from cassettes CS-4201 and CS-4202.

**Note:** The ecology simulations programs are not available on cassette.

### Stock & Options Analysis

Disk CS-4801, \$99.95  
Requires 32K Applesoft or Apple II Plus

This is a comprehensive set of four programs for the investment strategy of hedging listed options against common stocks. A complete description is in the TRS-80 section. Available August 1981.

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# MICRO

## Software Catalog

**Name:** Star Zap  
**System:** OSI  
**Memory:** 8K  
**Language:** BASIC  
**Hardware:** Cassette  
**Description:** *Star Zap* is a high speed re-creation of the popular arcade game. You must defend your starbase against the aliens who attack from all four quadrants at once! Only fast reflexes can save you! Includes machine code for sound on all C1Ps and Superboards, color and sound on C4Ps.  
**Price:** \$9.95  
**Author:** John Wilson  
**Available:**  
 Pretzelland Software  
 2005 Whittaker Rd.  
 Ypsilanti, MI 48197  
 (313) 483-7358

**Name:** Universe  
**System:** OSI C1, C2-4  
**Memory:** 8K tape  
 20K disk  
**Language:** Machine  
**Description:** Pilot your space ship across the surface of Arc-ton IV while engaging the enemy rockets and dodging meteorites. Can you maneuver through the mountains without being blown up into a thousand pieces? If you can, then be prepared for more action than you thought possible on your OSI computer. You can use your keyboard or a joystick to control your ship.  
**Price:** \$14.95 includes 5 1/4" disk or tape and instructions  
**Author:** Dave Pompea  
**Available:**  
 DMP Systems  
 319 Hampton Blvd.  
 Rochester, NY 14612

**Name:** The Vaults of Zurich  
**System:** PET, Atari  
**Memory:** 16K PET  
 24K Atari  
**Language:** BASIC  
**Hardware:** Cassette or diskette  
**Description:** Zurich is the banking capital of the world. The rich and powerful deposit their wealth in its famed im-pregnable vaults. But you, as a

master thief, have dared to undertake the boldest heist of the century. You will journey down a maze of corridors and vaults, eluding the most sophisticated security system in the world. Your goal is to reach the Chairman's Chamber to steal the most treasured possession of all: The OPEC Oil Deeds!  
**Price:** \$21.95 cassette  
 \$25.95 diskette  
**Author:** Felix and Greg Herlihy  
**Available:**  
 Artworx Software Company  
 150 N. Main Street  
 Fairport, NY 14450  
 800-828-6573 or  
 (716) 425-2833

**Name:** The Accountant Finance Data Base System  
**System:** Apple II, Apple II Plus with DOS 3.3 and Applesoft in ROM  
**Memory:** 48K  
**Language:** Applesoft BASIC  
**Hardware:** Single or dual drives  
**Description:** A double entry accounting system that prompts the user for the account(s) that are to be increased and/or decreased. The system permits the user to define his own account names and tax codes. Ad hoc queries and daily reports feature a natural dialogue. A VisiCalc interface is available.  
**Price:** \$99.95  
 Includes user manual, demo database and tutorial  
**Author:** Ernest H. Forman  
**Available:**  
 Decision Support Software  
 1438 Ironwood Drive  
 McLean, VA 22101  
 (703) 241-8316

**Name:** Business Planner  
**System:** Apple II  
**Memory:** 48K  
**Language:** Pascal  
**Description:** *Business Planner* is a modeling package for entrepreneurs planning to start or expand a new business. Designed to help develop viable business plans, the program groups labor, equipment and

other costs into income-related projects. Projects are combined into a model which generates graphical projections and estimated financial statements. "What If" scenarios help you plan for the future and respond appropriately to changing demands.  
**Price:** \$290.00  
 Includes three diskettes and manual  
**Available:**  
 Duosoft Corporation  
 Box 1827  
 Champaign, IL 61820  
 (217) 356-7542

**Name:** Investment Decisions  
**System:** Apple II, Apple II Plus, Apple III  
**Memory:** 48K (Apple II)  
 48K (Apple II Plus)  
 96K (Apple III)  
**Language:** Applesoft (Apple II and Apple II Plus); Business BASIC (Apple III)  
**Hardware:** Apple II with firmware card  
**Description:** Package components: loan schedules, savings schedules, annuity schedules, depreciation schedules, amortization schedules, APR schedules, payback method, net present value, internal rate of return, profitability index.  
**Price:** \$100.00  
 Includes disk, documentation and run instructions

**Author:** J.L. Campbell  
**Available:**  
 Mesa Research, Inc.  
 Rt. #1, Box 1456A  
 Waco, Texas 76710

**Name:** Capitalization  
**System:** Apple II Plus  
**Memory:** 48K  
**Language:** Applesoft  
**Description:** This 2-disk system provides for practice and testing on the application of the major rules of capitalization. The practice disk presents a rule followed by up to 20 randomly presented sentences which provide practice on the rule. The test disk measures the student's ability to correctly apply rules of capitalization. It may be used as a pre-test or post-test. The management system gives immediate feedback to the student and stores records of each student's test results for later review by the teacher. Results may be printed or viewed on the screen. The teacher has the

ability to modify or add new materials to either disk. The lessons using upper/lower case letters are appropriate for levels 3-8.  
**Price:** \$49.95  
 Includes 2 disks plus documentation  
**Author:** Hartley Staff  
**Available:**  
 Hartley Courseware, Inc.  
 Box 431  
 Dimondale, MI 48821  
 (616) 942-8987

**Name:** Cave Hunter  
**System:** TRS-80 Color Computer  
**Memory:** 16K  
**Language:** Machine  
**Hardware:** Joysticks  
**Description:** A fast-paced arcade game using Hi-Res graphics, sensational colors and a variety of unique sounds. Single or multiple players. Maneuver your way to the bottom of a spooky old cave to retrieve the treasures. It's not so easy! Passages lead in all directions and angry cave creatures pursue you relentlessly.  
**Price:** \$24.95  
 Includes cassette, directions and ppd shipping  
**Author:** Ron Krebs  
**Available:**  
 Mark Data Products  
 23802 Barquilla  
 Mission Viejo, CA 92691

**Name:** Moment of Inertia & Element of Triangle  
**System:** Apple II, Apple II Plus  
**Memory:** 32K with DOS 3.3 or 3.2 with FP installed  
**Language:** Applesoft BASIC  
**Hardware:** DOS 3.2 or 3.3 with controller card  
**Description:** The *Moment of Inertia* contains 56 physical formulas for 22 various bodies of mass. It calculates dimension, choice of mass or inertia on selected axis. This program is intended for engineers who never considered these important factors. The *Element of Triangle* program contains three major triangles (right, equilateral and general); 23 formulas; calculates sides, angles, altitude, area and radius of inscribed circle simultaneously to find force and directions. Both programs are packed in single diskette so they may be

## Software Catalog (continued)

used interactively. The menu program will display all formulas and the definition program will define all details. Both programs utilize touch-key selection input system, eliminating use of return key, but recognizes characters or initial (abbreviation) of known elements to find the formula and provide missing variables. Instructions include more than 100 commonly used industrial materials.

Price: \$40.00

Includes both programs on diskette

Available:

American Avicultural Art & Science, Inc.  
3268 Watson Rd.  
St. Louis, MO 63139  
(314) 645-4431

Name: **COLORFORTH**  
System: TRS-80 Color Computer  
Memory: 16K minimum  
Language: FORTH  
Hardware: Cassette or Radio Shack Color Disk System

Description: *COLORFORTH* is a special implementation of fig-FORTH for the TRS-80 Color Computer. This program requires a minimum of 16K, but does not require Extended BASIC. (Extended BASIC is required by the Radio Shack Color Disk operating system.) Includes an Editor and CSAVEM command normally not available without Extended BASIC, printer commands and much more! Write or call today. Visa and MasterCard accepted.

Price: \$49.95 ppd. Texas residents add 5% sales tax  
Includes cassette and disk versions and 31-page manual

Available:

Armadillo Int'l. Software  
P.O. Box 7661  
Austin, TX 78712  
(512) 459-7325

Name: **HSD Regress**  
System: Apple II or Apple II Plus, DOS 3.2 or 3.3  
Memory: 48K  
Language: Applesoft  
Hardware: Optional printer, serial or parallel interface, Silentype

Description: *HSD Regress* is a menu-driven multiple regression package which accepts up to 25 variables of 300 data points each. Data can be

entered from keyboard or disk. All data can be reviewed and edited, transformed numerically, and stored on disk. Multiple regression analysis can be performed on all variables input, or on any subset of variables, in any order. Output includes correlation matrix, predicted and residual scores, matrix inverse, semi-partial correlations, coefficient weights and p-values.

Price: \$99.95

Includes disk, complete documentation, imprinted 3-ring binder

Author: Stephen Madigan  
Virginia Lawrence

Available:

Human Systems Dynamics  
9249 Reseda Blvd. Suite 107  
Northridge, CA 91324  
(213) 993-8536  
or selected computer stores

Name: **Waterloo microAPL**  
Hardware: Commodore SuperPET, Volker-Craig 2900, 3900, 4900, Northern Digital microWAT

Description: *Waterloo microAPL* is intended to be a complete and faithful implementation of the IBM/ACM standard for APL with respect to the syntax and semantics of APL statements, operators and primitive functions, input and output forms, and defined functions. System commands, system variables and system functions are those consistent with a single user environment. There are no significant design limitations on the rank or shape of arrays or the length of names. The shared variable processor is omitted. Extensions include system functions supporting files of APL arrays. APL equivalents of the BASIC features PEEK, POKE and SYS are included.

Available:

Waterloo Computing Systems Limited  
158 University Ave. W.  
Waterloo, Ontario  
Canada N2L 3E9

Name: **OSI BASIC Enhancer**  
System: OSI C1P/Superboard/C4P  
Memory: 8K  
Language: Machine code w/BASIC-in-ROM  
Hardware: C1P, Superboard, C4P

Description: For the BASIC programmer who wants real power over his stock system. Get real delete action; replace cursor with one of your own choice (defaults to checkerboard square); commands to RENUMBER programs to make them easy to read; AUTOSEQUENCER saves typing in line numbers; screen control command has been added to running BASIC; LOAD and SAVE files w/filenames on a token I/O system reduce load/save times by 50%. Runs in approximately 1.5K of RAM. Send \$1.00 for complete catalog.

Price: \$19.95 ppd.

Includes autoloader, autorun cassette only. Users manual and bug-free guarantee.

Author: Timothy W. Jackson

Available:

Computer Science Engineering  
Box 50, 291 Huntington Ave.  
Boston, MA 02115

Name: **AIRSIM-1**  
System: Apple II or Apple II Plus  
Memory: 48K bytes  
Language: Machine  
Hardware: 1 disk drive, paddles or self-centering joystick, Applesoft in ROM or RAM

Description: *AIRSIM-1* is a realistic simulation of airplane flight. It has scenery from Boston, MA to New York City, with 6 distinct airfields for landings and takeoffs. A score is accumulated for successful landings at three of these fields. *AIRSIM-1* can do loops, rolls and even Immelmann turns. It is equipped for instrument flying, and can make landing approaches on instruments. Instrumentation includes radar, artificial horizon, and horizontal-situation indicator (HSI).

Price: \$40.00

Includes diskette and manual

Author: Ted Kurtz

Available:

Mind Systems Corporation  
Box 506  
Northampton, MA 01061  
(413) 586-6463

Name: **Pool 1.5**  
System: Apple, Atari  
Memory: 48K  
Language: Machine  
Hardware: Disk II, game paddles

Description: *Pool 1.5* is a real-time, Hi-Res color simulation of pool. This action-packed game allows you to play eight ball, rotation, nine ball, or straight pool.

Price: \$34.95

Available:

IDSi  
P.O. Box 1658  
Las Cruces, NM 88004  
(505) 522-7373

Name: **Management System for Stock Control**

System: Apple II  
Memory: 48K  
Language: Applesoft in ROM  
Hardware: Disk and 80- or 132-character per line printer

Description: This inventory management system is designed to offer a complete and current overview of stock with a minimal effort by the operator. Detailed information on any item can be gained instantly. The manual part of the package is written for the novice and comprised of four main sections: Introduction, Practice Run, Reference, and Appendices.

Price: \$175.00

Author: JACC, Inc.

Available:

The Hayden Book Company  
50 Essex Street  
Rochelle Park, NJ 07662

Name: **Color Assembler**  
System: TRS-80C Color Computer

Memory: 32K  
Language: Assembly  
Hardware: TRS-80C

Description: This is a complete 6809 machine code assembler that supports all 6809 mnemonics, addressing codes along with standard assembler options and directives. It operates as a two-pass assembler, so both forward and backward references are allowed. The Motorola Instruction Set Reference Card and documentation on many of the major subroutines in the Color Computer's BASIC are included with the manual.

Price: \$29.95

Includes cassette, manual, Reference Card, and BASIC subroutine documentation

Available:

Computerware  
P.O. Box 668  
Encinitas, CA 92024  
(714) 436-3512

(Continued on page 118)



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**PRINT...USING** will tabulate, right justify, line up all decimal points, pad the right and left side of Alpha/Numerical data with any predefined character, insert commas, and can be used within formulas or equations which will then format the mathematical result! **\$49.95**

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- COMMAND ROM - Catalog Command Menu and Disk Map	<b>\$39.95</b>
- DISK COPY/SPACE ROM - Duplicates 13 or 16 Sector Disks	<b>\$39.95</b>
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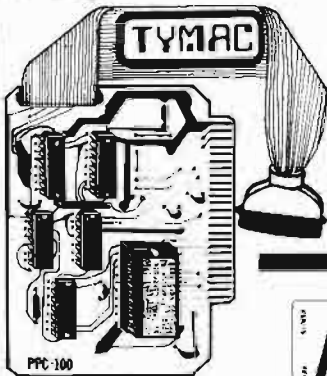
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**Software Catalog (continued)**



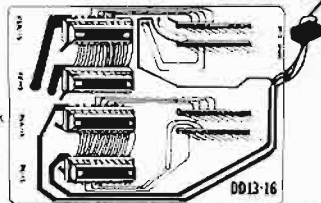
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**DOUBLE DOS Plus**



**DOUBLE DOS Plus** - a piggyback board that plugs into the disk controller card so that you can switch select between DOS 3.2 and DOS 3.3

Nothing needs to be soldered, just plug in and go. Since all four ROMs are used, all software will work, the ROMs fit on the back of the board allowing full use of slot #7. One set of ROMs is powered up at a time.

DOUBLE DOS Plus requires APPLE DOS ROMS

**\$39.00**

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Name: **Hi-Res/Multi-Color Graphics for BASIC**  
System: VIC-20  
Memory: 2 1/2K  
Language: Assembly  
Hardware: Standard VIC-20  
Description: These two utilities give the BASIC programmer the ability to use high-resolution and multi-color graphics on a standard VIC without the need to add additional hardware. Hi-Res yields a 104x152 position screen. In multi-color mode you get 52x76 size. You may plot and erase points, lines, boxes, and ASCII text in either Hi-Res or multi-color. All commands available from BASIC programs.

Price: \$20.00  
Includes manual and sample programs

Author: Roy Wainwright

Available: Abacus Software  
P.O. Box 7211  
Grand Rapids, MI 49510  
(616) 241-5510

Name: **Descriptive Statistics and Regression Analysis #26011**  
System: Apple II, Apple II Plus  
Memory: 32K RAM  
Language: Applesoft  
Hardware: 5 1/4" disk  
Description: This package contains three programs which perform statistical and regression analysis. Included are: Descriptive Statics (mean, standard deviation, variance, kurtosis, z-scores); Curvilinear Regression (linear, inverse, polynomial, exponential, logarithmic); Multivariable Linear Regression.  
Price: \$39.95  
Includes documentation

Available: Advanced Operating Systems  
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Name: **Hardisk Accounting Software**  
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Language: UCSD Pascal  
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Price: \$1495.00  
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113 Broadway  
Fargo, ND 58102

Name: **VisiFactory**  
System: Apple II, Apple II Plus  
Memory: 48K  
Language: Applesoft in ROM  
Hardware: Disk II  
Description: Allows a marriage between Data Factory and Visicalc™ files. You can move data in either direction, manipulate it within the chosen program, and then store it either way. It is an exciting tool for market research, information surveys, and analyses of any selected data.  
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**Answer to 6502 Puzzle**

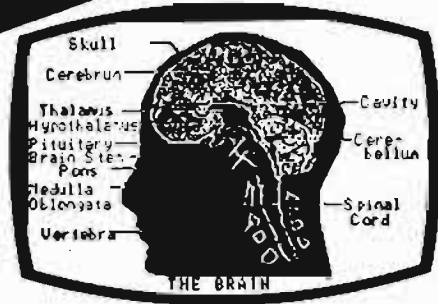
The obvious answer, that the program will execute the Jump Indirect through *Vector* and encounter the BRK at address 1000, is WRONG! The 6502 has a slight problem with page boundaries under some conditions. In this example it will perform the Jump Indirect by fetching the low byte of the target address from 6DFF and the high byte of the address from 6D00 — not 6E00 as one might expect. The effective address of the instruction will therefore be 6D00 — and the program will loop forever!

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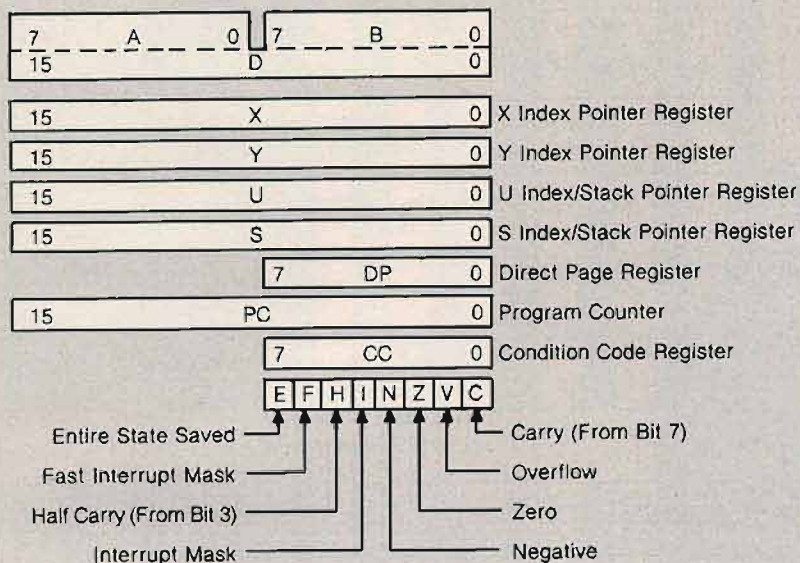
# 6809 Microprocessor

**MC6809/MC6809E**—an enhanced 8-bit microprocessor with some 16-bit functions and an 8-bit multiply. It is architecturally similar to both the 6502 and the 6800, and has removed many of their shortcomings. Designed primarily for ease of programming (rather than as a compromise for both programming and dedicated applications), it is particularly desirable for relocatable, reentrant, and modular programming. With its 16-bit capabilities, dual stacks, multiple index registers, and indexing modes, it is good for the stack-oriented implementations of Pascal, FORTH, and other high-level languages.

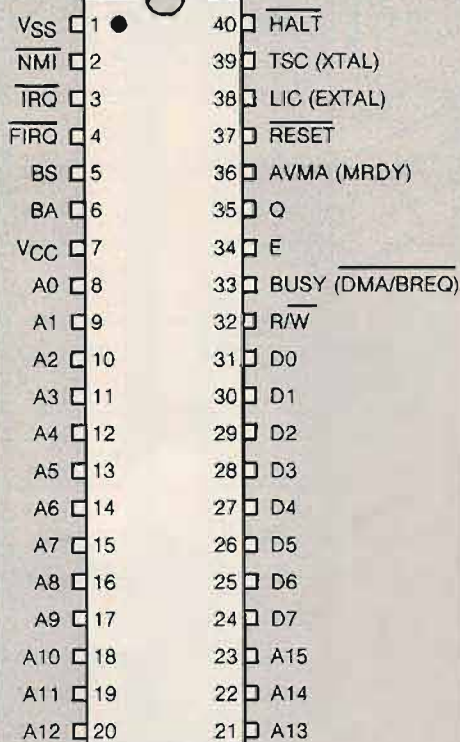
Manufactured by Motorola—The 'E' version requires an external clock and is especially well-suited to multiprocessing applications, such as in Stellation Two's "The Mill" board for the Apple and in Commodore's SuperPET.

Other computers with 6809's are the Radio Shack TRS-80 Color Computer and computers manufactured by Southwest Technical Products, Gimix, The Computerist, Canon, Smoke Signal Broadcasting, Percom Data, and others.

## PROGRAMMING MODEL



## MC6809E PIN-OUT



MC6809 pin-out in parentheses, where different

## INDEXED/INDIRECT CODES

Type	Forms	Non Indirect		Indirect	
		Assembler Form	Postbyte OP Code	Assembler Form	Postbyte OP Code
Constant Offset From R (2's Complement Offsets)	No Offset	,R	1RR00100	[,R]	1RR10100
	5-Bit Offset	n, R	0RRn0000	Defaults To 8-Bit	
	8-Bit Offset	n, R	1RR01000	[n, R]	1RR11000
	16-Bit Offset	n, R	1RR01001	[n, R]	1RR11001
Accumulator Offset From R (2's Complement Offsets)	A Register Offset	A, R	1RR00110	[A, R]	1RR10110
	B Register Offset	B, R	1RR00101	[B, R]	1RR10101
	D Register Offset	D, R	1RR01011	[D, R]	1RR11011
	Auto Increment/Decrement R	Increment By 1	,R+	1RR00000	Not Allowed
	Increment By 2	,R++	1RR00001	[,R++]	1RR10001
	Decrement By 1	,-R	1RR00010	Not Allowed	
	Decrement By 2	,--R	1RR00011	[,-R]	1RR10011
Constant Offset From PC (2's Complement Offsets)	8-Bit Offset	n, PCR	1xx01100	[n, PCR]	1xx11100
	16-Bit Offset	n, PCR	1xx01101	[n, PCR]	1xx11101
	16-Bit Address	—	—	[n]	10011111

R = X, Y, U or S  
x = Don't Care

RR:  
00 = X  
01 = Y  
10 = U  
11 = S



# 6809 Microprocessor

## MICRO™ Data Sheet #3

Instruction	Inherent	Immediate	Direct	Extended	Indexed / Indirect	Relative	Status
							EFHINZVC
MUL	3D	00	70	60			X X X X X X X X
NEG	40						X X X X X X X X
NEGB	50						X X X X X X X X
NOB	12						X X X X X X X X
ORA		9A	BA	AA			X X 0 X X X 0
ORB		DA	FA	EA			X X 0 X X X 0
ORCC							
FSHS		34					
FSHU		36					
PULS		35					
PULU		37					
ROL		09	79	69			X X X X X X X X
ROLB	49	06	76	66			X X X X X X X X
ROR	59						X X X X X X X X
RORB	46						X X X X X X X X
RORB	56						X X X X X X X X
RTR	3B						X X X X X X X X
RTS	39						X X X X X X X X
SBCA		82	B2	A2			X X X X X X X X
SBCB		C2	F2	E2			X X X X X X X X
SEX							
STA	1D						X X 0 X X X 0
STB		97	B7	A7			X X 0 X X X 0
STD		D7	F7	E7			X X 0 X X X 0
STD		DD	FD	ED			X X 0 X X X 0
STS		10 DF	10 FF	10 EF			X X 0 X X X 0
STU		DF	FF	EF			X X 0 X X X 0
STY		9F	BF	AF			X X 0 X X X 0
STY		10 9F	10 BF	10 AF			X X 0 X X X 0
SUBA		80	B0	A0			X X X X X X X X
SUBB		C0	F0	E0			X X X X X X X X
SUBD		83	B3	A3			X X X X X X X X
SWI							
SWI2	3F						
SWI3	10 3F						
SYNC	11 3F						
TFR	13						
TST							
TSTA	4D		7D	6D			X X 0 X X X 0
TSTB	5D						X X 0 X X X 0

### Branch Instruction Codes

BCC	24	10 24	BLT	2D	10 2D
BCS	25	10 25	LBMI	2B	10 2B
BEO	27	10 27	BNE	28	10 28
BGE	2C	10 2C	BPL	2A	10 2A
BGT	2E	10 2E	BRA	20	16
BHI	22	10 22	BRN	21	10 21
BHS	24	10 24	BRSR	8D	17
BLE	2F	10 2F	BVC	2B	10 2B
BLO	25	10 25	BVSC	29	10 29
BLS	23	10 23	BVS		
LBC	10 24				
LBCS	10 25				
LBEQ	10 27				
LBGE	10 2C				
LBGT	10 2E				
LBHI	10 22				
LBHS	10 24				
LBLE	10 2F				
LBLO	10 25				
LBSL	10 23				

Instruction	Inherent	Immediate	Direct	Extended	Indexed / Indirect	Relative	Status
							EFHINZVC
ABX	3A						X X X X X X X X
ADCA		89	99	A9			X X X X X X X X
ADCB		C9	D9	E9			X X X X X X X X
ADDA		8B	9B	AB			X X X X X X X X
ADDB		CB	DB	EB			X X X X X X X X
ADDD		C3	D3	F3			X X X X X X X X
ANDA		84	94	A4			X X 0 X X X 0
ANDB		C4	D4	F4			X X 0 X X X 0
ANDCC		1C					
ASL	48		08	78			X X X X X X X X
ASLB	58						X X X X X X X X
ASR	47		07	77			X X X X X X X X
ASRB	57						X X X X X X X X
BITA		85	95	A5			X X X X X X X X
BITB		C5	D5	F5			X X X X X X X X
CLR	4F		0F	7F			X X 0 X X X 0
CLRA							
CLRB							
CMPA		81	91	B1			X X X X X X X X
CMPB		C1	D1	F1			X X X X X X X X
CMPS		10 83	10 93	10 B3			X X X X X X X X
CMPS		11 8C	11 9C	11 B3			X X X X X X X X
CMPS		11 83	11 93	11 A3			X X X X X X X X
CMPS		8C	9C	BC			X X X X X X X X
CMPS		10 8C	10 9C	10 BC			X X X X X X X X
COM			03	73			X X 0 X X X 0
COMA	43						X X 0 X X X 0
COMB	53						X X 0 X X X 0
CWAI	19	3C					
DEC			0A	7A			X X X X X X X X
DECA	4A						X X X X X X X X
DECB	5A						X X X X X X X X
EORA		88	98	B8			X X X X X X X X
EORB		C8	D8	F8			X X X X X X X X
EXG		1E					X X 0 X X X 0
INC			0C	7C			X X X X X X X X
INCA	4C						X X X X X X X X
INCB	5C						X X X X X X X X
JMP							
JSR			0E	7E			X X X X X X X X
LDA		86	96	AD			X X 0 X X X 0
LDB		C6	D6	F6			X X 0 X X X 0
LDD		CC	DC	FC			X X 0 X X X 0
LDS		10 CE	10 DE	10 FE			X X 0 X X X 0
LDU		CE	DE	FE			X X 0 X X X 0
LDX		8E	9E	BE			X X 0 X X X 0
LDY		10 8E	10 9E	10 BE			X X 0 X X X 0
LEAS			32				
LEAU			33				
LEAX			30				
LEAY			31				
LSL			08	78			X X X X X X X X
LSLA	48						X X X X X X X X
LSLB	58						X X X X X X X X
LSR			04	74			X X X X X X X X
LSRA	44						X X X X X X X X
LSRB	54						X X X X X X X X



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- REPORT WRITING
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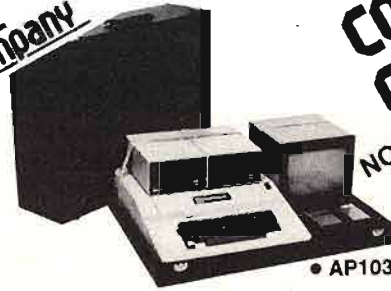
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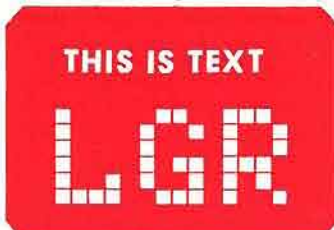
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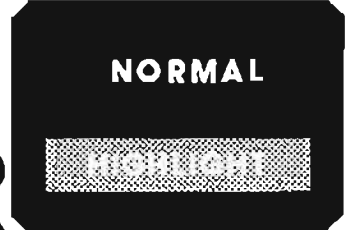
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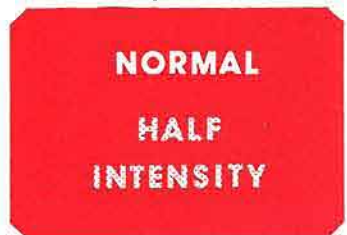
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Highlight

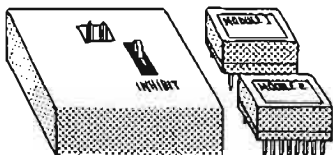


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# MICRO

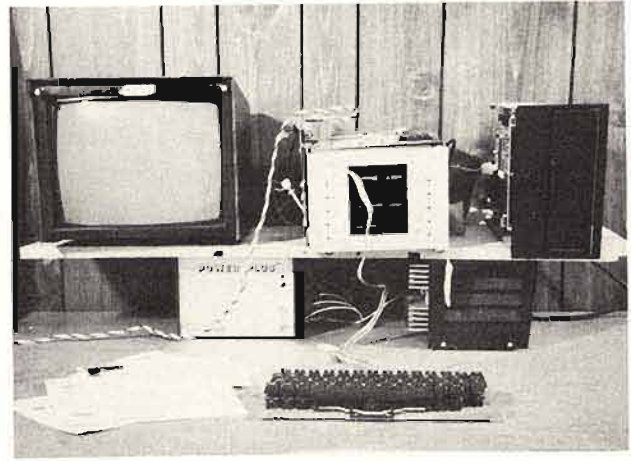
## It's All 1's and 0's

### No Connection

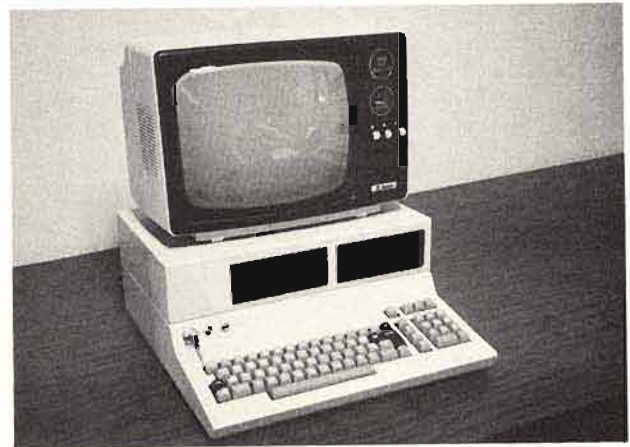
MICRO has maintained its subscription information for several years on a KIM-based computer system with a "homebrew" floppy disk controller. Last spring MICRO's sister company, The Computerist, decided to make a product that would include the floppy disk controller. A few minor design improvements were made and the board was sent out for PC layout. When the prototype board had been made and assembled, I prepared to test it. I expected to take an hour or two to test and verify the new version. It took several long days! Nothing seemed to work right. Even though each and every signal to the disk seemed to be okay, the system would not work. I set up a working system and compared it step-by-step with the new system and could find no difference on any of the control or data signals. I tried changing the various IC chips in the circuit and found that different floppy disk controller chips gave different results (this design used the popular Western Digital 1791). One chip would cause the drive to step in and step out on command but could not successfully perform a seek; another chip would restore and seek on track 00 but would not step at all; another would do nothing. Very strange and very frustrating. How could the identical design not work?

I had noticed, on one of my many examinations of the connections to the 1791, that there was a ground connection to a pin marked "No Connection." I had dismissed this as a possible cause of the problem, reasoning that this unused pin had no internal connection and was there simply to be pin 40 of the IC package. Having run out of sensible things to try, I finally cut the ground connection. Surprise — that cured the problem! What I had not known, at the time, was that "No Connection" did *not* mean that there was no connection to this pin on the IC itself, but that no connection should be made to this pin. Why? Because there *is* a connection to this pin within the 1791 chip. This pin is used in the manufacture and/or testing of the 1791 and must be left unconnected.

**Doctor Bob**



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### A 6502 Puzzle

Here is a little puzzle about the 6502. Since it is only two instructions and three lines of code, it can't be that tough, can it?

1000	00		BRK		
6D00	6D 6D FF	START	JMP	(VECTOR)	
6DFF	00 10	VECTOR	=	\$1000	

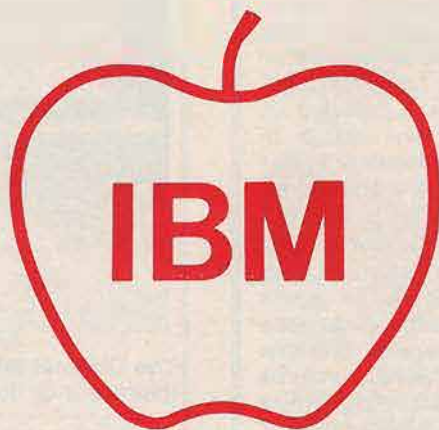
You can assume that the interrupts have been properly set up so that a BRK will go to a monitor. The simple question is, when this program is started at START, what will happen?

(Based on a note from Earl Morris of Midland, Michigan)

For answers to 6502 puzzle, see page 118.

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# Next Month in MICRO

## May PET Feature

- **PET Menu and Tape Timer** — This article describes a menu program that allows rapid access to any program on either side of a cassette tape. In addition, a tape timer is presented that supplies the fast forward timer for the menu program. These two programs feature advanced cassette control and use the WAIT command extensively.
- **Growing Knowledge Trees** — Knowledge often can be represented in tree diagrams. Microcomputers can store and analyze these diagrams. This PET program finds out what people know about a topic, analyzes answers, and shows users the organized results. A BASIC and an assembly language routine are presented for analyzing the diagrams.
- **PET Memory Protector** — Allows PETS with static RAM to protect 1K or more from resets, LOADs, and BASIC, by inserting a circuit between a RAM chip and its socket.

## Regular Columns

*From Here to Atari*  
*PET Vet*  
*The Single Life*

## Other May Features

*LISZT with Strings for the Apple*  
*AID Conversion Using a 555 Timer IC for the Atari*  
*Apple Graphics for Okadata Microline 80*  
*A General BASIC — Machine Language Interface for the AIM*  
*Memory Map Relocater for the Apple*

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 September — 68000  
 October — Education  
 November — Atari/Games  
 December — PET

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