SOFTWARE REFERENCE MANUAL

H88/WH89 COMPUTER

MONITOR

MTR-88

HEATH COMPANY
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INTRODUCTION

This manual describes the functions and operation of the H88 Monitor Program MTR-88 that is contained in a read-only memory (ROM) that is in your H88/H89. Some of the major features of MTR-88 are:

Memory contents display and alteration.
Program execution control.
Cassette load and dump routines.
Floppy diskette boot-strap routine.

In addition, MTR-88 can be instructed (by means of a flag byte maintained in read/write memory) to bypass some or all of its normal functions. In this manner, a sophisticated user can augment or replace these functions.

Since the H89 is an expansion of the H88, all the features of MTR-88 are available on an H89 also.

THEORY OF OPERATION

This section supplements the information in the "Operations" and "Circuit Description" sections of your H88 Operations Manual. In order to use all of the features of MTR-88, it is necessary to understand the Z80 operation codes and the circuit of your H88. This section gives you details of the operation of MTR-88. The listing of MTR-88 is given in Appendix A and a sophisticated example is given in Appendix B.

Power Up and Reset

MTR-88 initializes the H88 whenever you power-up or RESET. To power-up, use the switch on the back of the H88. To RESET, simultaneously press the RESET key and the right-hand SHIFT key on the keyboard. Both power-up and RESET cause a level zero interrupt (highest priority). MTR-88 sounds the audio alert and resets to its normal state. During the initialization procedure, MTR-88 determines the high limit of continuous RAM in your H88. Once this high limit has been determined, the Z80's stack pointer is set to this value. Then MTR-88 enters a loop waiting for you to enter a command.

Clock Interrupts

The Clock Interrupt is a crucial element in the operation of the H88. It is a level one interrupt and is generated on the H88 CPU board every 2 ms (millisecond). MTR-88 maintains "TICCNT" which counts up one every 2 ms. See the listing in Appendix A for the location of TICCNT.

Note that MTR-88 uses interrupts, so you should not disable interrupts for a long period of time. MTR-88 also requires a stack pointer at the top of memory with at least 80 bytes.

General Operations

When you RESET or power-up your H88 or H89, MTR-88 responds by clearing the screen and displaying "H:". This tells you that it is ready to respond to your typed commands. When you type in something, MTR-88 will either accept it or give a beep, indicating an error.

If the letter you enter is the first letter of one of MTR-88's commands, it will display the remaining letters of the word and start the appropriate program in MTR-88. If the letter is not the start of a command, MTR-88 will sound the horn and re-display the "H:".

The DELETE key will kill a partially entered line and cause MTR-88 to return to the "H:" prompt. You can use this to correct typing errors.

NOTE: In this manual, the symbol "△" means a space and "㊡" means a RETURN.

The following is a list of the acceptable MTR-88 commands. You type the first letter of the command, and MTR-88 will supply the remainder of the word. You have to press the (carriage) RETURN key before MTR-88 will respond.

TABLE OF MTR-88 COMMANDS

Boot	— Boot HDOS from a diskette
Dump	— Dump a program to cassette
Go	— Start a program
Load	— Load a program from cassette
Program Counter	— Set an address in the PC
Substitute	— Inspect or change memory

These commands are described more in the remainder of this manual.

DISPLAYING AND ALTERING MEMORY

One of the major features of MTR-88 is its ability to examine the contents of any H88 memory location and to modify the contents of that location if it is in RAM. This feature is described now.

The Substitute command is used to display memory locations. After a memory location has been displayed, its value can be changed before you proceed to something else. There is an example showing the Substitute procedure at the end of the description. You may jump ahead to it at any time.

To start the substitution process, first type "S". MTR-88 will respond by completing the word "Substitute". You should then enter the address of the memory location you want to inspect, followed by a RETURN. This address **must** be given in split-octal. Refer to Appendix C for the definitions of octal and split-octal.

MTR-88 will respond by re-displaying the address. Following the address, MTR-88 will display the contents of that memory location in octal.

Once the value of the memory location has been displayed, you may change it. To change it, simply type in the new value (in octal). The new value will be inserted after you complete the next step.

NOTE: MTR-88 will use the last three digits that you enter. That is, the entry "12345" will be entered as "345". You may use this to correct errors as entries are made.

After you have inspected or changed the value of a memory location, you have three options. First, you can cause MTR-88 to advance to the next memory location and display it by pressing the Space Bar. Second, you can cause MTR-88 to retreat to the previous memory location and display it by pressing the minus key, "−". Finally, you can cause MTR-88 return to its initial "H:" by pressing the RETURN key.

The following example shows these features. To help you follow what you enter and what the computer responds, your entries and the computer's responses are shown on different lines. If a new line is really used, the new line will start at the left of the page. Otherwise, the output is shown just down a line.

EXAMPLE

```
  H:                                  computer
     S                                you
      ubstitute                       computer
                2146 (CR)             you
002146 041                           computer
          Δ                           you
002147 011                           computer
          Δ                           you
002150 040                           computer
          -                           you
002147 011                           computer
           (CR)                       you
  H:                                  computer
     S                                you
      ubstitute                       computer
                40100 (CR)            you
040100 xxx                           computer
          123 Δ                       you
040101 xxx                           computer
          -                           you
040100 123                           computer
           (CR)                       you
  H:                                  computer
```

PROGRAM EXECUTION CONTROL

MTR-88 allows you to start a program that you have loaded into memory. It also offers a form of breakpointing.

The standard way of starting a program is to use the Go command. After you type in "G", MTR-88 responds "o". You should then type in the address (in split octal) where you want execution of your program to start. For example, if you have loaded a program at 040.100, you can start it with:

```
H:  Go 40100 ↵
```

MTR-88 allows another method of starting programs. MTR-88 maintains in its working memory a value for the Program Counter. If you enter "G" and then a RETURN after MTR-88 prints "o", MTR-88 will use the value in the PC as the starting address of your program.

To set the value in the Program Counter, you use the "P" command. After you enter "P", MTR-88 will respond "rogram Counter" and you can then enter the value you want. For example:

```
H: Program Counter 40100↵
H: Go↵
```

Your program will now be started at 40100.

If you do not enter a number after "P", but simply press RETURN, then MTR-88 will display the current value of the PC on the next line. You can change the PC by typing in a new value or you can leave it un-altered by pressing RETURN. For example:

```
  H: Program Counter↵
277377 40100↵
```

(You type the second number.)

When you are debugging an assembly language program, you can use MTR-88 to set breakpoints at various places in the program. To set a breakpoint, use the Substitute command and put an HLT (166 octal) instruction where you want your program to stop.

When your program reaches the breakpoint HLT instruction, it will return to MTR-88, display an "H", and then advance to a new line and display "H:". You can now inspect or change memory using the "Substitute" command.

To continue your program, you will first have to restore the byte in the location where you placed the breakpoint HLT. Since the computer had to execute the HLT instruction, the PC will point one beyond where you placed the HLT. To continue, you will have to decrease the PC value by one.

Do this by entering the "P" command and a RETURN. When the current value of the PC is shown, subtract one from it, and enter this value as the new value for the PC. Remember that you have to subtract in octal, so ten minus one is seven!

Alternatively, you can use the "Go" command to start the program from whatever address you want, including from the place where you put the HLT.

Note that if the program that you are debugging uses keyboard interrupts, MTR-88 and your program will "fight" for keyboard input! Your program will always see every character because it gets them by an interrupt. MTR-88 is continually testing if a character is available, and it will never see some of the characters that you enter. This can become very confusing, particularly in the debug program.

LOAD/DUMP ROUTINES

MTR-88 contains routines that let you load and dump memory contents from or to a cassette tape. These "boot strap" routines allow you to quickly and easily use your computer without entering a complex program by hand. These routines contain sophisticated error checking techniques that let you know if a problem has occurred.

Loading From Tape

To load from a cassette tape, ready the tape reader with the tape to be loaded. Then RESET MTR-88 and type "L". MTR-88 will respond "oad". When you enter a RETURN, MTR-88 will load the tape.

No change will be seen on the screen until MTR-88 finds the first file on the tape. The load routine places the entry point address into the H88's Program Counter and then continues loading. As data is loaded into memory, the address at which it is placed is shown on the screen. You can watch it change and see when the load is complete.

If the load is successful, MTR-88 will sound the alarm once to alert you. If a loading error occurs, MTR-88 will sound the alarm repeatedly. RESET the H88 and try loading the tape again.

You may RESET during loading, but the load will be invalid. To get a good load, you will have to start the procedure over.

Dumping a Tape

Before MTR-88 can dump a tape, it needs to have the first and last address of the section of memory that you want to have dumped. It also needs to have the starting address (which need not be the first address) so that when the program is loaded, the PC can be set, and "Go" can be used to start the program.

First, place the address of the program's starting address in the PC as described earlier. Later, when you load the tape, this value will be placed back in the PC so you can enter "Go" and start the program.

Next, give a "Dump" command by typing "D". MTR-88 will respond with "ump". You should then type in the first address you want saved on the tape, followed by the minus or dash character (-), and finally the last address you want saved. When you press the RETURN, MTR-88 will start recording the data on the tape.

The detail steps to DUMP to a tape are:

1. Ready a tape in the recorder and press the record button.
2. Enter the starting address of the program in the PC.
3. Enter the dump first and last addresses as:

   Dump 40100-43264

4. Press RETURN.

If you give a starting address, you must give an ending address separated by a dash. However, if you do not give a starting address, MTR-88 will use the starting and finishing address that were last used for a Load or a Dump. This is described next in Copying a Tape.

Copying a Tape

To copy a tape, simply load the tape as described in "Loading From Tape". Then ready the dump tape to receive the copy. Finally, type "D". When MTR-88 responds "ump", simply press RETURN. MTR-88 will remember the first, last, and starting addresses from the load.

You can modify the program before you dump it, but if the first or last addresses are different, your will have to enter them when you dump. The same is true for the PC.

Tape Errors

MTR-88 detects two types of tape errors: record errors and checksum errors. In either case, when an error is detected, the tape transport stops and an error number is printed on the screen. The error numbers are 001 for a checksum error and 002 for a record error. The alarm is repeatedly sounded when an error is detected. RESET the H88 to stop the alarm and return to MTR-88's command mode.

Record Errors

The following are typical causes of record errors.

- Attempting to load a file which is not a memory image. For example, loading an editor text file or a BASIC program file.
- Attempting to start a load in the middle of a file.
- A read error that causes a portion of the data to be lost, and records are not read in the proper sequence.

Checksum Errors

A checksum error occurs when the Cyclical Redundancy Check (CRC) checksum that follows a record does not match the CRC calculated by MTR-88. This error means that the record is either recorded incorrectly or the load was faulty. In either case, the load should be tried again. If repeated loads result in repeated failures, the tape is probably defective.

ADVANCED CONTROL

One of the advanced features of MTR-88 is its provisions allowing sophisticated users to augment or replace MTR-88's functions. This is usually done in conjunction with assembly language programs, although it is sometimes possible to use these features in BASIC using the PEEK and POKE commands. The sample program in Appendix B shows how to use several of MTR-88's advanced features.

The following discussion refers to symbols and locations in MTR-88. In order to make the most of this information, you should refer to the listing of MTR-88 that is in Appendix A. Note that at the end of the listing the definitions of RAM locations from 40.000 to 40.077 are given. Following these is a symbol reference table that will help you find where symbols are used in the program.

The Tick Counter (TICCNT)

MTR-88 maintains in memory a 16-bit (2 byte) tick counter named TICCNT. This counter is incremented when the clock interrupts occur. As long as interrupts are enabled, this will occur every 2 ms. You may set TICCNT to any value and change it as often as you like. The low-order byte of TICCNT is in location 40.033 (8219 decimal) and the high-order byte is in 40.034.

Using Interrupts

All H88 interrupts cause control to be transferred into the lowest 64 bytes of memory. Since MTR-88 occupies this area, it processes all interrupts first. Except for level zero interrupts (RESET function), you can supply a routine to process interrupts yourself.

Control is passed out of MTR-88 through the UIVECs that are located at 40.037 and following. Each vector is three bytes long, and contains a JMP instruction to an interrupt processing routine. MTR-88 calls or jumps to the appropriate UIVEC, and control is passed to the processing routine. The exit from an interrupt processing routine should be the return instruction, RET.

I/O Interrupts

Interrupts numbered 3 through 7 are I/O interrupts of devices that you connect to your H88. MTR-88 does not process these interrupts, but simply passes them on to a program in RAM by jumping to the appropriate UIVEC.

All Heath software (except MTR-88) uses interrupt 3 for input and output to and from the keyboard and screen. These programs set UIVEC themselves. If you want to use interrupts, your program has to place the appropriate jump in the appropriate UIVEC. See the sample program in Appendix B.

Clock Interrupts

The level one interrupt is generated by hardware in your H88 every 2 ms. MTR-88 always processes these interrupts, but you can force it to pass control to your routine once it is done.

To do this, set the appropriate jump in the first UIVEC locations. Then set the UO.CLK bit (001) in .MFLAG (40.010). MTR-88 will then pass each clock interrupt to your routine when it finishes its own processing. This is done in the example in Appendix B.

Single Instructions and Breakpoint Interrupts

Level two interrupts are generated by the single-instruction hardware contained in the H88. When a single-instruction interrupt occurs, MTR-88 processes it, and jumps to the location specified by the second UIVEC. This interrupt has no effect on MTR-88.

If you have set up UIVEC for level two interrupts, you can use RST-2 as a breakpoint instruction. Control will be returned to the location specified by the second UIVEC. These features are used by the DBUG programs supplied by Heath.

FLOPPY BOOT

MTR-88 contains the code necessary to boot-up HDOS from a floppy disk. If you enter "B" after the "H:" prompt, then MTR-88 will respond "oot". When you then press RETURN, MTR-88 will jump to location 30.000 which is the entry point for the HDOS boot-up routine.

Unless you have the floppy disk controller board installed in your H88, there will be no ROM at 30.000, and the results of the "B" command are unpredictable. If you perform a "B" command, and do not have a floppy interface card, you should RESET your H88 to put it back in a known state.

APPENDIX A

MTR-88 LISTING

This appendix contains a listing of MTR-88. MTR-88 resides in the low 2K (2048) bytes of the H88 or H89 computer's memory. It contains all the control for primitive keyboard input and screen output as well as cassette tape load and dump facilities. MTR-88 needs RAM locations available in locations 40.000 through 40.077, and it also needs 80 bytes of stack area in high memory.

The first few pages of the listing show definitions that are used. The last portion of the listing contains references to the symbols that are used in MTR-88. Just before this cross reference listing is the definition of RAM locations in 40.000 through 40.077.

Note that most of the PAM-8 entry points are preserved in MTR-88. (PAM-8 is the equivalent of MTR-88 on the H8 computer.) This was done to allow compatibility between H8 and H88 programs. Of course, H8 front panel routines will not operate, but they will return properly.

Because PAM-8 entry points have been preserved, the MTR-88 code has to jump around in a somewhat arbitrary manner. Also, the Memory Test and Floppy Disk Rotational Speed Test routines are scattered throughout memory. The listing of these two routines are not shown. The Memory Test entry point is 7.375 and the Floppy Speed Test entry point is 7.372.

```
                        4  ***     MTR88 - H88 MONITOR                    ISSUE 09.00.00
                        5  *
                        6  *       MTR88 IS AN ADAPTATION OF PAM/8 ORIGINALLY WRITTEN FOR THE
                        7  *       HEATH H8 COMPUTER BY J. G. LETWIN IN 1976 AND MODIFIED BY
                        8  *       R. N. BORCHARDT IN 1979 FOR USE IN THE HEATH H88/H89
                        9  *       COMPUTERS.
                       10  *
                       11  *       MTR88 PROVIDES COMPATABILITY WITH PAM/8 SUCH THAT ALL ROUTINES
                       12  *       HAVE RETAINED PREVIOUSLY DESCRIBED ENTRY POINTS AND ENTRY AND
                       13  *       EXIT CONDITIONS.  ROUTINES WHICH ARE NOT APPLICABLE SUCH AS
                       14  *       THOSE PERTAINING TO THE FRONT PANEL DISPLAY HAVE BEEN DELETED.
                       15  *
                       16  *
                       17  *       COPYRIGHT  05/1976, WINTEK CORPORATION,
                       18  *                           902 N. 9TH ST.
                       19  *                           LAFAYETTE, IND.
                       20  *
                       21  *       COPYRIGHT  01/1979, HEATH COMPANY
                       22  *                           BENTON HARBOR, MI.
                       23  *
                       24
                       25
030.000                26  ROMDD   EQU     30000A          HDOS BOOT ROM ADDRESS
                       27
                       28


                       30  ***     MTR88 - H88/H89 MONITOR.
                       31  *
                       32  *       THIS PROGRAM RESIDES (IN ROM) IN THE LOW 2048 BYTES OF THE HEATH
                       33  *       H88/H89 COMPUTERS.


                       35  ***     INTERRUPTS.
                       36  *
                       37  *       MTR88 IS THE PRIMARY PROCESSOR FOR ALL INTERRUPTS.
                       38  *       THEY ARE PROCESSED AS FOLLOWS:
                       39  *
                       40  *       RST     USE
                       41  *
                       42  *       0       MASTER CLEAR. (NEVER USED FOR I/O OR RST)
                       43  *
                       44  *       1       CLOCK INTERRUPT. NORMALLY TAKEN BY MTR88,
                       45  *               SETTING BIT *UO.CLK* IN BYTE *.MFLAG* ALLOWS
                       46  *               USER PROCESSING (VIA A JUMP THROUGH *UIVEC*).
                       47  *               UPON ENTRY OF THE USER ROUTINE, THE STACK
                       48  *               CONTAINS:
                       49  *               (STACK+0)  = RETURN ADDRESS (TO MTR88)
                       50  *               (STACK+2)  = (STACKPTR+14)
                       51  *               (STACK+4)  = (AF)
                       52  *               (STACK+6)  = (BC)
                       53  *               (STACK+8)  = (DE)
                       54  *               (STACK+10) = (HL)
```

```
                *               (STACK+12) = (PC)
                *               THE USER'S ROUTINE SHOULD RETURN TO MTR88 VIA
                *               A *RET* WITHOUT ENABLING INTERRUPTS.
                *
                *       2       SINGLE STEP INTERRUPTS RECEIVED WHEN IN
                *               USER MODE CAUSES A JUMP THROUGH *UIVEC*+3.
                *               STACK UPON USER ROUTINE ENTRY:
                *               (STACK+0)  = (STACKPTR+12)
                *               (STACK+2)  = (AF)
                *               (STACK+4)  = (BC)
                *               (STACK+6)  = (DE)
                *               (STACK+8)  = (HL)
                *               (STACK+10) = (PC)
                *               THE USER'S ROUTINE SHOULD HANDLE IT'S OWN RETURN
                *               FROM THE INTERRUPT.  THAT IS, *EI* FOLLOWED BY *RET*
                *
                *       THE FOLLOWING INTERRUPTS ARE VECTORED DIRECTLY THROUGH *UIVEC*.
                *       THE USER ROUTINE MUST HAVE SETUP A JUMP IN *UIVEC* BEFORE ANY
                *       OF THESE INTERRUPTS MAY OCCUR.  RETURN IS VIA *EI* AND THEN *RET*
                *
                *       3       I/O 3. CAUSES A DIRECT JUMP THROUGH *UIVEC*+6
                *
                *       4       I/O 4. CAUSES A DIRECT JUMP THROUGH *UIVEC*+9
                *
                *       5       I/O 5. CAUSES A DIRECT JUMP THROUGH *UIVEC*+12
                *
                *       6       I/O 6. CAUSES A DIRECT JUMP THROUGH *UIVEC*+15
                *
                *       7       I/O 7. CAUSES A DIRECT JUMP THROUGH *UIVEC*+18
```

```
                        87  **      ASSEMBLY CONSTANTS

                        89  **      IO PORTS
                        90
                        91  ***     ALL REFERENCES TO THE H8 FRONT PANEL PORTS ARE TRAPPED BY THE
                        92  *       Z80 NMI OF THE H88/H89.  OP.CTL WILL STILL PERFORM AS IN AN H8
                        93  *       IN RESPECT TO THE CLOCK AND SINGLE STEP CONTROL.  FOR MORE
                        94  *       INFORMATION SEE THE NMI ROUTINE.
                        95
000.360                 96  IP.PAD  EQU     360Q            PAD INPUT PORT
000.360                 97  OP.CTL  EQU     360Q            CONTROL OUTPUT PORT
000.360                 98  OP.DIG  EQU     360Q            DIGIT SELECT OUTPUT PORT
000.361                 99  OP.SEG  EQU     361Q            SEGMENT SELECT OUTPUT PORT
                       100
                       101  *       H88/H89 CONTROL PORT
000.362                102  H88.CTL EQU     362Q            H88/H89 PORT FOR CLOCK AND SINGLE STEP
000.002                103  H88B.CK EQU     00000010B       2MS CLOCK ENABLE/DISABLE
000.001                104  H88B.SS EQU     00000001B       SINGLE STEP ENABLE/DISABLE
                       105
000.362                106  H88.SW  EQU     362Q            8 POSITION DIP SWITCH
000.300                107  H88S.BR EQU     11000000B       BAUD RATE SWITCHES
000.040                108  H88S.M  EQU     00100000B       MEMORY TEST/NORMAL OPERATION SWITCH


                       110  **      CASSETTE PORTS
                       111
000.371                112  IP.TPC  EQU     371Q            TAPE CONTROL IN
000.371                113  OP.TPC  EQU     371Q            TAPE CONTROL OUT
000.370                114  IP.TPD  EQU     370Q            TAPE DATA IN
000.370                115  OP.TPD  EQU     370Q            TAPE DATA OUT


                       117  **      ASCII CHARACTERS.
                       118
000.026                119  A.SYN   EQU     026Q            SYNC CHARACTER
000.002                120  A.STX   EQU     002Q            STX CHARACTER
000.007                121  A.BEL   EQU     007Q            BELL CHARACTER
000.010                122  A.BKS   EQU     010Q            BACKSPACE CHARACTER
000.012                123  A.LF    EQU     012Q            LINE FEED CHARACTER
000.015                124  A.CR    EQU     015Q            CARRIAGE RETURN CHARACTER
000.033                125  A.ESC   EQU     033Q            ESCAPE CHARACTER
000.177                126  A.DEL   EQU     177Q            DELETE OR RUBOUT CHARACTER
```

```
                        128  **      FRONT PANEL HARDWARE CONTROL BITS.
                        129
                        130  CB.SSI  EQU     00010000B       SINGLE STEP INTERRUPT
000.020                 131  CB.MTL  EQU     00100000B       MONITOR LIGHT
000.040                 132  CB.CLI  EQU     01000000B       CLOCK INTERRUPT ENABLE
000.100                 133  CB.SPK  EQU     10000000B       SPEAKER ENABLE
000.200

                        135  **      DISPLAY MODE FLAGS (IN *DSPMOD*)
                        136
000.000                 137  DM.MR   EQU     0               MEMORY READ
000.001                 138  DM.MW   EQU     1               MEMORY WRITE
000.002                 139  DM.RR   EQU     2               REGISTER READ
000.003                 140  DM.RW   EQU     3               REGISTER WRITE
000.000                 141          XTEXT   TAPE            TAPE DEFINITIONS

                        163  **      MACHINE INSTRUCTIONS.
                        164
000.166                 165  MI.HLT  EQU     01110110B       HALT
000.311                 166  MI.RET  EQU     11001001B       RETURN
000.333                 167  MI.IN   EQU     11011011B       INPUT
000.323                 168  MI.OUT  EQU     11010011B       OUTPUT
000.072                 169  MI.LDA  EQU     00111010B       LDA
000.346                 170  MI.ANI  EQU     11100110B       ANI
000.021                 171  MI.LXID EQU     00010001B       LXI D
000.303                 172  MI.JMP  EQU     11000011B       JMP
000.335                 173  MI.LDXA EQU     11011101B       LD IX,  (BYTE A)
000.041                 174  MI.LDXB EQU     00100001B       LD IX,  (BYTE B)
000.375                 175  MI.LDYA EQU     11111101B       LD IY,  (BYTE A)
000.041                 176  MI.LDYB EQU     00100001B       LD IY,  (BYTE B)
000.010                 177  MI.EXAF EQU     00001000B       EX AF,AF'
000.335                 178  MI.JIXA EQU     11011101B       JP (IX)  (BYTE A)
000.351                 179  MI.JIXB EQU     11101001B       JP (IX)  (BYTE B)
000.375                 180  MI.JIYA EQU     11111101B       JP (IY)  (BYTE A)
000.351                 181  MI.JIYB EQU     11101001B       JP (IY)  (BYTE B)

                        183  **      USER OPTION BITS.
                        184  *
                        185  *       THESE BITS ARE SET IN CELL .MFLAG.
                        186
000.200                 187  UO.HLT  EQU     10000000B       DISABLE HALT PROCESSING
000.100                 188  UO.NFR  EQU     CB.CLI          NO REFRESH OF FRONT PANEL
000.002                 189  UO.DDU  EQU     00000010B       DISABLE DISPLAY UPDATE
000.001                 190  UO.CLK  EQU     00000001B       ALLOW PRIVATE INTERRUPT PROCESSING
```

```
000.000                 192         XTEXT   U8251       DEFINE 8251 USART BITS

000.000                 239         XTEXT   U8250       DEFINE 8250 ACE BITS
```

```
                                303  ***     INTERRUPT VECTORS.
                                304  *
                                305
                                307  **      LEVEL 0 - RESET
                                308  *
                                309  *       THIS 'INTERRUPT' MAY NOT BE PROCESSED BY A USER PROGRAM.
                                310
                                311
000.000  303 000 004           312  INIT0   JMP     INIT0X          DO H88 EXTENSION OF INITIALIZATION
000.003  041 012 040           313  INIT0.0 LXI     H,PRSRAM+PRSL-1 (HL) = RAM DESTINATION FOR CODE
000.006  303 073 000           314          JMP     INIT            INITIALIZE
                                315
377.073                         316          ERRPL   INIT-1000A     BYTE IN WORD 10A MUST BE 0
                                317
                                319  **      LEVEL 1 - CLOCK
                                320
000.010                         321  INT1    EQU     10Q             INTERRUPT ENTRY POINT
                                322
000.000                         323          ERRNZ   *-11Q           INT0 TAKES UP ONE BYTE
                                324
000.011  315 132 000           325          CALL    SAVALL          SAVE USER REGISTERS
000.014  026 000               326          MVI     D,0
000.016  303 201 000           327          JMP     CLOCK           PROCESS CLOCK INTERRUPT
377.201                         328          ERRPL   CLOCK-1000A     EXTRA BYTE MUST BE 0
                                330  **      LEVEL 2 - SINGLE STEP
                                331  *
                                332  *       IF THIS INTERRUPT IS RECEIVED WHEN NOT IN MONITOR MODE,
                                333  *       THEN IT IS ASSUMED TO BE GENERATED BY A USER PROGRAM
                                334  *       (SINGLE STEPPING OR BREAKPOINTING). IN SUCH CASE, THE
                                335  *       USER PROGRAM IS ENTERED THROUGH (UIVEC)+3
                                336
000.020                         337  INT2    EQU     20A             LEVEL 2 ENTRY
                                338
000.000                         339          ERRNZ   *-21A           INT1 TAKES EXTRA BYTE
                                340
000.021  315 132 000           341          CALL    SAVALL          SAVE REGISTERS
000.024  032                   342          LDAX    D               (A) = (CTLFLG)
040.011                         343          SET     CTLFLG
000.025  303 244 001           344          JMP     STPRTN          STEP RETURN
```

```
                                346  ***     I/O INTERRUPT VECTORS.
                                347  *
                                348  *       INTERRUPTS 3 THROUGH 7 ARE AVAILABLE FOR GENERAL I/O USE.
                                349  *
                                350  *       THESE INTERRUPTS ARE NOT SUPPORTED BY MTR88, AND SHOULD
                                351  *       NEVER OCCUR UNLESS THE USER HAS SUPPLIED HANDLER ROUTINES
                                352  *       (THROUGH UIVEC)
                                353
 000.030                        354          ORG     30A
                                355
 000.030  303 045 040          356  INT3    JMP     UIVEC+6         JUMP TO USER ROUTINE
                                357
 000.033  064 064 064          358          DB      '44440'         HEATH PART NUMBER 444-40


                                360
 000.040                        361          ORG     40A
                                362
 000.040  303 050 040          363  INT4    JMP     UIVEC+9         JUMP TO USER ROUTINE
                                364
 000.043  044 122 116          365          DB      44Q,122Q,116Q,102Q,44Q  SUPPORT CODE


                                367
 000.050                        368          ORG     50A
                                369
 000.050  303 053 040          370  INT5    JMP     UIVEC+12        JUMP TO USER ROUTINE
                                371
                                372
                                373  **      DLY - DELAY TIME INTERVAL.
                                374  *
                                375  *       ENTRY   (A) = MILLISECOND DELAY COUNT/2
                                376  *       EXIT    NONE
                                377  *       USES    A,F
                                378
 000.000                        379          ERRNZ   *-53A
                                380
 000.053  365                   381  DLY     PUSH    PSW             SAVE COUNT
 000.054  257                   382          XRA     A               DONT SOUND HORN
 000.055  303 143 002          383          JMP     HRN0            PROCESS AS HORN


                                385
 000.060                        386          ORG     60A
                                387
 000.060  303 056 040          388  INT6    JMP     UIVEC+15        JUMP TO USER ROUTINE
                                389
                                390
 000.063  076 320              391  GO.     MVI     A,CB.SSI+CB.CLI+CB.SPK  OFF MONITOR MODE LIGHT
 000.065  303 235 001          392          JMP     SST1            RETURN TO USER PROGRAM
```

```
                                394
                                395          ORG     70A
                                396
000.070 303 061 040             397  INT7    JMP     UIVEC+18        JUMP TO USER ROUTINE
```

```
                                400  **      INIT - INITIALIZE SYSTEM
                                401  *
                                402  *       INIT IS CALLED WHENEVER A HARDWARE MASTER-CLEAR IS INITIATED.
                                403  *
                                404  *       SETUP MTR88 CONTROL CELLS IN RAM.
                                405  *       DECODE HOW MUCH MEMORY EXISTS, SETUP STACKPOINTER, AND
                                406  *       ENTER THE MONITOR LOOP.
                                407  *
                                408  *       ENTRY   FROM MASTER CLEAR
                                409  *       EXIT    INTO MTR88 MAIN LOOP
                                410
 000.000                        411             ERRNZ   *-730
                                412
 000.073  032                   413  INIT       LDAX    D               COPY *PRSROM* INTO RAM
 000.074  167                   414             MOV     M,A             MOVE BYTE
 000.075  053                   415             DCX     H               DECREMENT DESTINATION
 000.076  034                   416             INR     E               INCREMENT SOURCE
 000.077  302 073 000           417             JNZ     INIT            IF NOT DONE
                                418
 004.000                        419  SINCR      EQU     4000A           SEARCH INCREMENT
                                420
 000.102  026 004               421             MVI     D,SINCR/256     (DE) = SEARCH INCREMENT
 000.104  041 000 034           422             LXI     H,START-SINCR   (HL) = FIRST RAM - SEARCH INCREMENT
                                423
                                424  *       DETERMINE MEMORY LIMIT.
                                425
 000.107  167                   426  INIT1      MOV     M,A             RESTORE VALUE READ
 000.110  031                   427             DAD     D               INCREMENT TRIAL ADDRESS
 000.111  176                   428             MOV     A,M             (A) = CURRENT MEMORY VALUE
 000.112  065                   429             DCR     M               TRY TO CHANGE IT
 000.113  276                   430             CMP     M
 000.114  302 107 000           431             JNE     INIT1           IF MEMORY CHANGED
                                432
 000.117  053                   433  INIT2      DCX     H
                                434
 000.120  371                   435             SPHL                    SET STACKPOINTER = MEMORY LIMIT -1
                                436
 000.121  345                   437             PUSH    H               SET *PC* VALUE ON STACK
 000.122  041 322 000           438             LXI     H,ERROR
 000.125  345                   439             PUSH    H               SET 'RETURN ADDRESS'
                                440
                                441  *       CONFIGURE LOAD/DUMP UART
                                442
 000.126  076 116               443             MVI     A,UMI.1B+UMI.L8+UMI.16X
 000.130  323 371               444             OUT     OP.TPC          SET 8 BIT, NO PARITY, 1 STOP, X16
```

```
                                447  **      SAVALL - SAVE ALL REGISTERS ON STACK.
                                448  *
                                449  *       SAVALL IS CALLED WHEN AN INTERRUPT IS ACCEPTED, IN ORDER TO
                                450  *       SAVE THE CONTENTS OF THE REGISTERS ON THE STACK.
                                451  *
                                452  *       ENTRY   CALLED DIRECTLY FROM INTERRUPT ROUTINE.
                                453  *       EXIT    ALL REGISTERS PUSHED ON STACK,
                                454  *               IF NOT YET IN MONITOR MODE, REGPTR = ADDRESS OF REGISTERS
                                455  *               ON STACK.
                                456  *               (DE) = ADDRESS OF CTLFLG
                                457
000.000                         458          ERRNZ   *-132A
                                459
000.132  343                    460  SAVALL  XTHL                    SET H,L ON STACK TOP
000.133  325                    461          PUSH    D
000.134  305                    462          PUSH    B
000.135  365                    463          PUSH    PSW
000.136  353                    464          XCHG                    (D,E) = RETURN ADDRESS
000.137  041 012 000            465          LXI     H,10
000.142  071                    466          DAD     SP              (H,L) = ADDRESS OF USERS SP
                                467
                                468  **      REPLACE THESE INSTRUCTIONS WITH A JUMP AROUND THE NMI VECTOR JUMP
                                469  *
                                470  *       PUSH    H               SET ON STACK AS 'REGISTER'
                                471  *       PUSH    D               SET RETURN ADDRESS
                                472  *       LXI     D,CTLFLG
                                473  *       LDAX    D               (A) = CTLFLG
                                474
000.143  303 105 004            475          JMP     SAVALLX         GO TO SAVALL EXTENSION
                                476
                                477  **      ENTRY POINT FOR THE Z80 NMI
                                478  *
                                479
                                480
000.000                         481          ERRNZ   *-66H           Z80 NMI ADDRESS
                                482
000.146  303 116 004            483  NMIENT  JMP     NMI
                                484
000.000                         485          ERRNZ   SAVALLR-151A    DO NOT CHANGE ORGANIZATION
                                486
000.151                         487  SAVALLR EQU     *               SAVALL EXTENSION RETURN ADDRESS
                                488
000.151  057                    489          CMA
000.152  346 060                490          ANI     CB.MTL+CB.SSI   SAVE REGISTER ADDR IF USER OR SINGLE-STEP
000.154  310                    491          RZ                      RETURN IF WAS INTERRUPT OF MONITOR LOOP
000.155  041 002 000            492          LXI     H,2
000.160  071                    493          DAD     SP              (H,L) = ADDRESS OF 'STACKPTR' ON STACK
000.161  042 035 040            494          SHLD    REGPTR
000.164  311                    495          RET
```

```
                                497  **      CUI - CHECK FOR USER INTERRUPT PROCESSING.
                                498  *
                                499  *       CUI IS CALLED TO SEE IF THE USER HAS SPECIFIED PROCESSING
                                500  *       FOR THE CLOCK INTERRUPT.
                                501
    000.000                     502          ERRNZ   *-165A
                                503
    040.010                     504          SET     .MFLAG          REFERENCE TO MFLAG
    000.165  012                505  CUI1    LDAX    B               (A) = .MFLAG
    000.000                     506          ERRNZ   UO.CLK-1        CODE ASSUMED = 01
    000.166  017                507          RRC
    000.167  334 037 040        508          CC      UIVEC           IF SPECIFIED, TRANSFER TO USER
                                509
                                510  *       RETURN TO PROGRAM FROM INTERRUPT.
                                511
    000.000                     512          ERRNZ   *-172A
                                513
    000.172  361                514  INTXIT  POP     PSW             REMOVE FAKE 'STACK REGISTER'
    000.173  361                515          POP     PSW
    000.174  301                516          POP     B
    000.175  321                517          POP     D
    000.176  341                518          POP     H
    000.177  373                519          EI
    000.200  311                520          RET
```

```
                                523  ***   CLOCK - PROCESS CLOCK INTERRUPT
                                524  *
                                525  *     CLOCK IS ENTERED WHENEVER A 2-MILLISECOND CLOCK INTERRUPT IS
                                526  *     PROCESSED.
                                527  *
                                528  *     TICCNT IS INCREMENTED EVERY INTERRUPT.
                                529
 000.000                        530         ERRNZ   *-201A
                                531
 000.201  052 033 040           532  CLOCK  LHLD    TICCNT
 000.204  043                   533         INX     H
 000.205  042 033 040           534         SHLD    TICCNT          INCREMENT TICCOUNT
                                535
 000.210  072 011 040           536         LDA     CTLFLG          CLEAR CLOCK INTERRUPT FLIP-FLOP
 000.213  323 360               537         OUT     OP.CTL
                                538
                                539  *     EXIT CLOCK INTERRUPT.
                                540
 000.215  001 011 040           541         LXI     B,CTLFLG
 000.220  012                   542         LDAX    B               (A) = CTLFLG
 000.221  346 040               543         ANI     CB.MTL
 000.223  302 172 000           544         JNZ     INTXIT          IF IN MONITOR MODE
 000.226  013                   545         DCX     B
 000.000                        546         ERRNZ   CTLFLG-.MFLAG-1
 000.227  012                   547         LDAX    B               (A) = .MFLAG
 000.000                        548         ERRNZ   U0.HLT-200Q     ASSUME HIGH-ORDER
 000.230  027                   549         RAL
 000.231  332 270 000           550         JC      CLK4            SKIP IT
                                551
                                552  *     NOT IN MONITOR MODE. CHECK FOR HALT
                                553
 000.234  076 012               554         MVI     A,10            (A) = INDEX OF *P* REG
 000.236  315 052 003           555         CALL    LRA.            LOCATE REGISTER ADDRESS
 000.241  136                   556         MOV     E,M
 000.242  043                   557         INX     H
 000.243  126                   558         MOV     D,M             (D,E) = PC CONTENTS
 000.244  033                   559         DCX     D
 000.245  032                   560         LDAX    D
 000.246  376 166               561         CPI     MI.HLT          CHECK FOR HALT
 000.250  302 165 000           562         JNZ     CUI1
                                563
 000.253  076 007               564         MVI     A,A.BEL         DING BELL
 000.255  315 302 003           565         CALL    WCC
 000.260  076 110               566         MVI     A,'H'           'H' FOR HALT
 000.262  315 302 003           567         CALL    WCC
 000.265  303 322 000           568         JMP     ERROR
                                569
                                570  ***   JE      ERROR           IF HALT, BE IN MONITOR MODE
                                571
                                572  *     NONE OF THE ABOVE, SO ALLOW USER PROCESSING OF CLOCK INTERRUPT
                                573
 000.270                        574  CLK4   EQU     *
 000.270  303 165 000           575         JMP     CUI1            ALLOW USER PROCESSING OF CLOCK
                                600         LON     L
```

```
                                604  ***     ERROR - COMMAND ERROR.
                                605  *
                                606  *       ERROR IS CALLED AS A 'BAIL-OUT' ROUTINE.
                                607  *
                                608  *       IT RESETS THE OPERATIONAL MODE, AND RESTORES THE STACKPOINTER.
                                609  *
                                610  *       ENTRY   NONE
                                611  *       EXIT    TO MTR LOOP
                                612  *               CTLFLG SET
                                613  *               .MFLAG CLEARED
                                614  *       USES    ALL
                                615
000.000                         616             ERRNZ   *-322A
                                617
000.322                         618  ERROR      EQU     *
000.322  041 010 040            619             LXI     H,.MFLAG
000.325  176                    620             MOV     A,M             (A) = .MFLAG
000.326  346 275                621             ANI     377Q-UO.DDU-UO.NFR      RE-ENABLE DISPLAYS
000.330  167                    622             MOV     M,A             REPLACE
000.331  043                    623             INX     H
000.332  066 360                624             MVI     M,CB.SSI+CB.MTL+CB.CLI+CB.SPK   RESTORE *CTLFLG*
000.000                         625             ERRNZ   CTLFLG-.MFLAG-1
000.334  373                    626             EI
000.335  052 035 040            627             LHLD    REGPTR
000.340  371                    628             SPHL                    RESTORE STACK POINTER TO EMPTY STATE
000.341  315 136 002            629             CALL    ALARM           ALARM FOR 200 MS
```

```
                                631  **      MTR - MONITOR LOOP.
                                632  *
                                633
000.000                         634             ERRNZ   *-344A
                                635
000.344                         636  MTR        EQU     *
000.344  373                    637             EI
                                638
000.345                         639  MTR1       EQU     *
000.345  041 345 000            640             LXI     H,MTR1
000.350  345                    641             PUSH    H               SET 'MTR1' AS RETURN ADDRESS
000.351  041 112 006            642             LXI     H,MSG.PR        TYPE PROMPT MESSAGE
000.354  315 100 006            643             CALL    TYPMSG
                                644
000.357  315 262 003            645  MTR.2      CALL    RCC             READ A CONSOLE CHARACTER
000.362  346 137                646             ANI     01011111B       MAKE SURE ITS UPPER CASE TO MATCH TABLE
000.364  041 025 001            647             LXI     H,MTRA          LOOK UP CHARACTER IN *MTRA*
000.367  006 006                648             MVI     B,MTRAL         (B) = LENGTH OF TABLE
000.371  276                    649  MTR.3      CMP     M               SEE IF CHARACTER FROM CONSOLE = TABLE ENTRY
000.372  312 014 001            650             JZ      MTR.4           IF EQUAL
                                651
000.375  043                    652             INX     H               POINT TO NEXT TABLE ENTRY
000.376  043                    653             INX     H
000.377  043                    654             INX     H
001.000  005                    655             DCR     B               SEE IF PAST END OF TABLE
001.001  302 371 000            656             JNZ     MTR.3           IF NOT PAST
```

```
                                657
001.004  076 007               658          MVI     A,A.BEL         ELSE, DING ERROR
001.006  315 302 003           659          CALL    WCC
001.011  303 357 000           660          JMP     MTR.2           TRY AGAIN
                                661
001.014  315 302 003           662  MTR.4   CALL    WCC             WRITE CHARACTER BACK TO CONSOLE
001.017  043                   663          INX     H               GET ROUTINE ADDRESS LSB
001.020  176                   664          MOV     A,M
001.021  043                   665          INX     H               GET MSB
001.022  146                   666          MOV     H,M
001.023  157                   667          MOV     L,A             (H,L) = ROUTINE ADDRESS
001.024  351                   668          PCHL                    GO TO ROUTINE
                                669
                                670
                                671
001.025                         672  MTRA    EQU     *               JUMP TABLE
000.001                         673
001.025  107                   674          DB      'G'             GO TO USER ROUTINE
001.026  146 001                675          DW      GO88
                                676
001.030  114                   677          DB      'L'             CASSETTE LOAD
001.031  067 001                678          DW      SRMEM
                                679
001.033  104                   680          DB      'D'             SET UP CASSETTE DUMP
001.034  313 004                681          DW      SWMEM
                                682
001.036  123                   683          DB      'S'             SUBSTITUTE MEMORY MODE
001.037  370 004                684          DW      SUBM
                                685
001.041  120                   686          DB      'P'             PROGRAM COUNTER ALTER MODE
001.042  103 001                687          DW      PCA
                                688
001.044  102                   689          DB      'B'             BOOT HDOS
001.045  256 004                690          DW      BOOT
                                691
000.006                         692  MTRAL   EQU     *-MTRA/3        NUMBER OF TABLE ENTRYS          /JWT 790507/
                                703          LON     L
```

```
                                705  **      SAE - STORE ABUSS AND EXIT.
                                706  *
                                707  *       ENTRY   (HL) = ABUSS VALUE
                                708  *       EXIT    TO (RET)
                                709  *       USES    NONE
                                710
000.000                         711          ERRNZ   *-1063A
                                712
001.063  042 024 040            713  SAE     SHLD    ABUSS
001.066  311                   714          RET
```

```
                                717  **      SRMEM - H88/H89 ENTRY POINT FOR A CASSETTE LOAD
                                718  *
                                719
001.067  041 170 006            720  SRMEM   LXI     H,MSG.LD        COMPLETE MESSAGE
001.072  315 100 006            721          CALL    TYPMSG
001.075  315 003 006            722          CALL    WCR             WAIT FOR A CARRIAGE RETURN
001.100  303 261 001            723          JMP     RMEM            LOAD TAPE



                                725  **      PCA - PROGRAM COUNTER ALTER
                                726  *
                                727  *       PCA INPUTS AND/OR DISPLAYS THE CURRENT USER PROGRAM VALUE AND ALLOWS
                                728  *       A NEW VALUE TO BE ENTERED OR RETAINS THE CURRENT VALUE IF
                                729  *       A CR IS TYPED
                                730  *
                                731  *       ENTRY   NONE
                                732  *       EXIT    NONE
                                733  *       USES    A,D,E,H,L,F
                                734
                                735
001.103  041 214 006            736  PCA     LXI     H,MSG.PC        COMPLETE PC MESSAGE
001.106  315 100 006            737          CALL    TYPMSG
001.111  076 012                738          MVI     A,10            GET LOCATION OF USER PC
001.113  315 052 003            739          CALL    LRA.
001.116  136                    740          MOV     E,M             (D,E) = USER PC VALUE
001.117  043                    741          INX     H
001.120  126                    742          MOV     D,M
001.121  353                    743          XCHG                    (H,L) = USER PC VALUE
                                744
001.122  315 150 005            745          CALL    IROC            INPUT NEXT CHARACTER
001.125  332 137 001            746          JC      PCA1            IF FIRST CHARACTER WAS OCTAL, INPUT NEW PC
                                747
001.130  315 313 005            748          CALL    TOA             ELSE, OUTPUT CURRENT VALUE
001.133  315 150 005            749          CALL    IROC            SEE IF USER WANTS TO CHANGE IT NOW
001.136  320                    750          RNC                     IF NO CHANGE, EXIT
                                751
                                752  *       ENTER NEW USER PC VALUE
                                753
001.137  353                    754  PCA1    XCHG                    (H,L) = ADDRESS OF USER PC VALUE
001.140  026 015                755          MVI     D,A.CR          END BYTE WITH A RETURN
001.142  315 062 003            756          CALL    IOA             INPUT NEW ADDRESS
001.145  311                    757          RET                     EXIT



                                759  **      GO88 - GO TO USER ROUTINE FROM H88 MONITOR
                                760  *
                                761  *       GO88 WAITS FOR A CARRIAGE RETURN OR A NEW ADDRESS TERMINATED WITH
                                762  *       A CARRIAGE RETURN.  IF NO ADDRESS IS ENTERED, GO88 TRANSFERS
                                763  *       CONTROL TO THE ADDRESS SPECIFIED BY THE USER PC VALUE
                                764
                                765
001.146  041 165 006            766  GO88    LXI     H,MSG.GO        COMPLETE GO MESSAGE
```

```
001,151  315 100 006   767          CALL    TYPMSG
001.154  315 150 005   768          CALL    IROC        INPUT A RETURN OR AN OCTAL CHARACTER
001.157  322 177 001   769          JNC     G088.1      IF RETURN, GO TO CURRENT USER PC
                       770
001.162  365           771          PUSH    PSW         ELSE SAVE OCTAL CHARACTER AND FLAGS
001.163  076 012       772          MVI     A,10        GET ADDRESS OF USER PC
001.165  315 052 003   773          CALL    LRA.
001.170  043           774          INX     H           POINT TO MSB
001.171  361           775          POP     PSW         GET FIRST CHARACTER BACK
001.172  026 015       776          MVI     D,A.CR      END ADDRESS WITH A RETURN
001.174  315 062 003   777          CALL    IOA         INPUT NEW GO ADDRESS
001.177  315 302 003   778  G088.1  CALL    WCC         ECHO RETURN
001.202  076 012       779          MVI     A,A.LF      LINE FEED
001.204  315 302 003   780          CALL    WCC
001.207  303 222 001   781          JMP     GO          EXECUTE USER ROUTINE


001.212  110 103 101   783          DB      110Q,103Q,101Q,046Q,103Q,101Q,107Q,056Q DESIGN CODE


                       785  **      GO - RETURN TO USER MODE
                       786  *
                       787  *       ENTRY   NONE
                       788
000.000                789          ERRNZ   *-1222A
                       790
001,222  303 063 000   791  GO      JMP     GO.         ROUTINE IS IN WASTE SPACE


                       793  **      SSTEP - SINGLE STEP INSTRUCTION.
                       794  *
                       795  *       ENTRY   NONE
                       796
000.000                797          ERRNZ   *-1225A
                       798
001.225                799  SSTEP   EQU     *           SINGLE STEP
001.225  363           800          DI                  DISABLE INTERRUPTS UNTIL THE RIGHT TIME
001.226  072 011 040   801          LDA     CTLFLG
001.231  356 020       802          XRI     CB.SSI      CLEAR SINGLE STEP INHIBIT
001.233  323 360       803          OUT     OP.CTL      PRIME SINGLE STEP INTERRUPT
001.235  062 011 040   804  SST1    STA     CTLFLG      SET NEW FLAG VALUES
001.240  341           805          POP     H           CLEAN STACK
001.241  303 172 000   806          JMP     INTXIT      RETURN TO USER ROUTINE FOR STEP
```

```
                        808  **      STPRTN - SINGLE STEP RETURN
                        809
000.000                 810          ERRNZ   *-1244A
                        811
001.244                 812  STPRTN  EQU     *
001.244  366 020        813          ORI     CB.SSI          DISABLE SINGLE STEP INTERRUPTION
001.246  323 360        814          OUT     OP.CTL          TURN OFF SINGLE STEP ENABLE
040.011                 815          SET     CTLFLG
001.250  022            816          STAX    D
001.251  346 040        817          ANI     CB.MTL          SEE IF IN MONITOR MODE
001.253  302 344 000    818          JNZ     MTR
001.256  303 042 040    819          JMP     UIVEC+3         TRANSFER TO USER'S ROUTINE


                        821  **      RMEM - LOAD MEMORY FROM TAPE.
                        822  *
                        823
000.000                 824          ERRNZ   *-1261A
                        825
001.261  041 244 002    826  RMEM    LXI     H,TPABT
001.264  042 031 040    827          SHLD    TPERRX          SETUP ERROR EXIT ADDRESS
                        828  *       JMP     LOAD


                        830  ***     LOAD - LOAD MEMORY FROM TAPE.
                        831  *
                        832  *       READ THE NEXT RECORD FROM THE CASSETTE TAPE.
                        833  *
                        834  *       USE THE LOAD ADDRESS IN THE TAPE RECORD.
                        835  *
                        836  *       ENTRY   (HL) = ERROR EXIT ADDRESS
                        837  *       EXIT    USER P-REG (IN STACK) SET TO ENTRY ADDRESS
                        838  *               TO CALLER IF ALL OK
                        839  *               TO ERROR EXIT IF TAPE ERRORS DETECTED.
                        840
                        841
000.000                 842          ERRNZ   *-1267A
                        843
001.267                 844  LOAD    EQU     *
001.267  001 000 376    845          LXI     B,1000A-RT.MI*256-256   (BC) = - REQUIRED TYPE AND #
001.272  315 265 002    846  LOA0    CALL    SRS                     SCAN FOR RECORD START
001.275  157            847          MOV     L,A             (HL) = COUNT
001.276  353            848          XCHG                    (DE) = COUNT, (HL) = TYPE AND #
001.277  015            849          DCR     C               (C) = - NEXT #
001.300  011            850          DAD     B
001.301  174            851          MOV     A,H
001.302  305            852          PUSH    B               SAVE TYPE AND #
001.303  365            853          PUSH    PSW             SAVE TYPE CODE
001.304  346 177        854          ANI     177Q            CLEAR END FLAG BIT
001.306  265            855          ORA     L
001.307  076 002        856          MVI     A,2             SEQUENCE ERROR
001.311  302 205 002    857          JNE     TPERR           IF NOT RIGHT TYPE OR SEQUENCE
```

```
001.314  315 325 002   858          CALL    RNP             READ ADDR
001.317  104           859          MOV     B,H
001.320  117           860          MOV     C,A             (BC) = P-REG ADDRESS
001.321  076 012       861          MVI     A,10
001.323  325           862          PUSH    D               SAVE (DE)
001.324  315 052 003   863          CALL    LRA.            LOCATE REG ADDRESS
001.327  321           864          POP     D               RESTORE (DE)
001.330  161           865          MOV     M,C             SET P-REG IN MEM
001.331  043           866          INX     H
001.332  160           867          MOV     M,B
001.333  315 325 002   868          CALL    RNP             READ ADDRESS
001.336  157           869          MOV     L,A             (HL) = ADDRESS, (DE) = COUNT
001.337  042 000 040   870          SHLD    START
                       871
001.342  315 331 002   872  LOA1    CALL    RNB             READ BYTE
001.345  167           873          MOV     M,A
                       874
                       875  *       SHOW H88 THAT SOMETHING IS HAPPENING
                       876
001.346  315 024 006   877          CALL    TPDSP           DISPLAY TO H88 USER THAT WE ARE LOADING
                       878
001.351  043           879          INX     H
001.352  033           880          DCX     D
001.353  172           881          MOV     A,D
001.354  263           882          ORA     E
001.355  302 342 001   883          JNZ     LOA1            IF MORE TO GO
                       884
001.360  315 172 002   885          CALL    CTC             CHECK  TAPE CHECKSUM
                       886
                       887  *       READ NEXT BLOCK
                       888
001.363  361           889          POP     PSW             (A) = FILE TYPE BYTE
001.364  301           890          POP     B               (BC) = -(LAST TYPE, LAST #)
001.365  007           891          RLC
001.366  332 133 002   892          JC      TFT             ALL DONE - TURN OFF TAPE
001.371  303 272 001   893          JMP     LOA0            READ ANOTHER RECORD
```

```
                                    896  ***   DUMP - DUMP MEMORY TO MAG TAPE.
                                    897  *
                                    898  *     DUMP SPECIFIED MEMORY RANGE TO MAG TAPE.
                                    899  *
                                    900  *     ENTRY   (START) = START ADDRESS
                                    901  *             (ABUSS) = END ADDRESS
                                    902  *             USER PC = ENTRY POINT ADDRESS
                                    903  *     EXIT    TO CALLER.
                                    904
     000.000                        905          ERRNZ   *-1374A
                                    906
     001.374                        907  WMEM    EQU     *
     001.374  041 244 002           908          LXI     H,TPABT
     001.377  042 031 040           909          SHLD    TPERRX          SETUP ERROR EXIT
                                    910
     000.000                        911          ERRNZ   *-2002A
                                    912
     002.002  076 001               913  DUMP    MVI     A,UCI.TE
     002.004  323 371               914          OUT     OP.TPC          SETUP TAPE CONTROL
     002.006  076 026               915          MVI     A,A.SYN
     002.010  046 040               916          MVI     H,32            (H) = # OF SYNC CHARACTERS
     002.012  315 024 003           917  WME1    CALL    WNB
     002.015  045                   918          DCR     H
     002.016  302 012 002           919          JNZ     WME1            WRITE SYN HEADER
     002.021  076 002               920          MVI     A,A.STX
     002.023  315 024 003           921          CALL    WNB             WRITE STX
     002.026  154                   922          MOV     L,H             (HL) = 00
     002.027  042 027 040           923          SHLD    CRCSUM          CLEAR CRC 16
     002.032  041 001 201           924          LXI     H,RT.MI+80H*256+1       FIRST AND LAST MI RECORD
     002.035  315 017 003           925          CALL    WNP             WRITE HEADER
     002.040  052 000 040           926          LHLD    START
     002.043  353                   927          XCHG                    (D,E) = START ADDRESS
     002.044  052 024 040           928          LHLD    ABUSS           (H,L) = STOP ADDR
     002.047  043                   929          INX     H               COMPUTE WITH STOP+1
     002.050  175                   930          MOV     A,L
     002.051  223                   931          SUB     E
     002.052  157                   932          MOV     L,A
     002.053  174                   933          MOV     A,H
     002.054  232                   934          SBB     D
     002.055  147                   935          MOV     H,A             (HL) = COUNT
     002.056  315 017 003           936          CALL    WNP             WRITE COUNT
     002.061  345                   937          PUSH    H
     002.062  076 012               938          MVI     A,10
     002.064  325                   939          PUSH    D               SAVE (DE)
     002.065  315 052 003           940          CALL    LRA             LOCATE P-REG ADDRESS
     002.070  176                   941          MOV     A,M
     002.071  043                   942          INX     H
     002.072  146                   943          MOV     H,M
     002.073  157                   944          MOV     L,A             (HL) = CONTENTS OF PC
     002.074  315 017 003           945          CALL    WNP             WRITE HEADER
     002.077  341                   946          POP     H               (HL) = ADDRESS
     002.100  321                   947          POP     D               (DE) = COUNT
     002.101  315 017 003           948          CALL    WNP
                                    949
     002.104  176                   950  WME2    MOV     A,M
     002.105  315 024 003           951          CALL    WNB             WRITE BYTE
```

```
                                952
                                953  *       SHOW H88 USER THAT DUMP IS DUMPING
                                954
002.110  315 024 006            955          CALL    TPDSP           DISPLAY DUMP
                                956
002.113  043                    957          INX     H
002.114  033                    958          DCX     D
002.115  172                    959          MOV     A,D
002.116  263                    960          ORA     E
002.117  302 104 002            961          JNZ     WME2            IF MORE TO GO
                                962
                                963  *       WRITE CHECKSUM
                                964
002.122  052 027 040            965          LHLD    CRCSUM
002.125  315 017 003            966          CALL    WNP             WRITE IT
002.130  315 017 003            967          CALL    WNP             FLUSH CHECKSUM
                                968  *       JMP     TFT



                                970  **      TFT - TURN OFF TAPE.
                                971  *
                                972  *       STOP THE TAPE TRANSPORT.
                                973  *
                                974
000.000                         975          ERRNZ   *-2133A
                                976
002.133  257                    977  TFT     XRA     A
002.134  323 371                978          OUT     OP.TPC          TURN OFF TAPE



                                980  **      HORN - MAKE NOISE.
                                981  *
                                982  *       ENTRY   (A) = (MILLISECOND COUNT)/2
                                983  *       EXIT    NONE
                                984  *       USES    A,F
                                985
000.000                         986          ERRNZ   *-2136A
                                987
002.136                         988  ALARM   EQU     *
002.136  030 027                989          JR      ALARMB          BRANCH TO A JUMP TO NOISE TO DING BELL
                                990
000.000                         991          ERRNZ   *-2140A
                                992
002.140  365                    993  HORN    PUSH    PSW
002.141  076 200                994          MVI     A,CB.SPK        TURN ON SPEAKER
                                995
002.143  343                    996  HRN0    XTHL                    SAVE (HL), (H) = COUNT
002.144  325                    997          PUSH    D               SAVE (DE)
002.145  353                    998          XCHG                    (D) = LOOP COUNT
002.146  041 011 040            999          LXI     H,CTLFLG
002.151  256                   1000          XRA     M
002.152  136                   1001          MOV     E,M             (E) = OLD CTLFLG VALUE
```

```
002,153  167           1002           MOV     M:A             TURN ON HORN
002.154  056 033       1003           MVI     L,#TICCNT
                       1004
002.156  172           1005           MOV     A,D             (A) = CYCLE COUNT
002.157  206           1006           ADD     M
002.160  276           1007   HRN2    CMP     M               WAIT REQUIRED TICCOUNTS
002.161  302 160 002   1008           JNE     HRN2
                       1009
002.164  303 045 006   1010           JMP     HRNX            JUMP TO AN EXTENSION OF HORN SO ROOM
                       1011   *                                       CAN BE MADE FOR A JUMP TO NIOSE
                       1012
                       1013
002.167  303 053 006   1014   ALARMB  JMP     NOISE           SEND A BELL TO THE CONSOLE
                       1015
```

```
                         1020  **      CTC - VERIFY CHECKSUM.
                         1021  *
                         1022  *       ENTRY   TAPE JUST BEFORE CRC
                         1023  *       EXIT    TO CALLER IF OK
                         1024  *               TO *TPERR* IF BAD
                         1025  *       USES    A,F,H,L
                         1026
                         1027
000.000                  1028          ERRNZ   *-2172A
                         1029
002.172  315 325 002    1030  CTC     CALL    RNP             READ NEXT PAIR
002.175  052 027 040    1031          LHLD    CRCSUM
002.200  174            1032          MOV     A,H
002.201  265            1033          ORA     L
002.202  310            1034          RZ                      RETURN OF OK
002.203  076 001        1035          MVI     A,1             CHECKSUM ERROR
                         1036  *       JMP     TPERR           (B) = CODE


                         1038  **      TPERR - PROCESS TAPE ERROR.
                         1039  *
                         1040  *       DISPLAY ERR NUMBER IN LOW BYTE OF ABUSS
                         1041  *
                         1042  *       IF ERROR NUMBER EVEN, DONT ALLOW *
                         1043  *       IF ERROR NUMBER ODD, ALLOW *
                         1044  *
                         1045  *       ENTRY   (B) = PATTERN
                         1046
000.000                  1047          ERRNZ   *-2205A
                         1048
002.205  107             1049  TPERR   MOV     B,A             (B) = CODE
002.206  315 063 006    1050          CALL    TPERMSG         DISPLAY ERROR NUMBER ON CONSOLE
002.211  315 133 002    1051          CALL    TFT             TURN OFF TAPE
                         1052
                         1053  *       IS *, RETURN (IF PARITY ERROR)
                         1054
002.214  346            1055          DB      MI,ANI          FALL THROUGH WITH CARRY CLEAR
002.215  170            1056  TER3    MOV     A,B
                         1057
002.216  017            1058          RRC
002.217  330            1059          RC                      RETURN IF OK
                         1060
                         1061  *       BEEP AND FLASH ERROR NUMBER
                         1062
002.220  334 136 002    1063  TER1    CC      ALARM           ALARM IF PROPER TIME
002.223  315 252 002    1064          CALL    TPXIT           SEE IF *
002.226  333 360        1065          IN      IF.PAD
002.230  376 057        1066          CPI     00101111B       CHECK FOR *
002.232  312 215 002    1067          JE      TER3            IF *
002.235  072 034 040    1068          LDA     TICCNT+1
002.240  037            1069          RAR                     /C/ SET IF 1/2 SECOND
002.241  303 220 002    1070          JMP     TER1
```

```
                        1072  **      TPABT - ABORT TAPE LOAD OR DUMP.
                        1073  *
                        1074  *       ENTERED WHEN LOADING OR DUMPING, AND THE '*' KEY
                        1075  *       IS STRUCK.
                        1076
                        1077
000.000                 1078          ERRNZ   *-2244A
                        1079  ~
002.244  257           1080  TPABT   XRA     A
002.245  323 371       1081          OUT     OP.TPC          OFF TAPE
002.247  303 322 000   1082          JMP     ERROR


                        1084  **      TPXIT - CHECK FOR USER FORCED EXIT.
                        1085  *
                        1086  *       TPXIT CHECKS FOR AN '*' KEYPAD ENTRY. IF SO, TAKE
                        1087  *       THE TAPE DRIVER ABNORMAL EXIT.
                        1088  *
                        1089  *       ENTRY   NONE
                        1090  *       EXIT    TO *RET* IF NOT '*'
                        1091  *                (A) = PORT STATUS
                        1092  *               TO (TPERRX) IF '*' DOWN
                        1093  *       USES    A,F
                        1094
                        1095
000.000                 1096          ERRNZ   *-2252A
                        1097
002.252  333 360       1098  TPXIT   IN      IP.PAD
002.254  376 157       1099          CPI     01101111B       *
002.256  333 371       1100          IN      IP.TPC          READ TAPE STATUS
002.260  300           1101          RNE                     NOT '*', RETURN WITH STATUS
002.261  052 031 040   1102          LHLD    TPERRX
                        1103
000.000                 1104          ERRNZ   *-2264A
                        1105
002.264  351           1106          PCHL                    ENTER (TPERRX)


                        1108  **      SRS - SCAN RECORD START
                        1109  *
                        1110  *       SRS READS BYTES UNTIL IT RECOGNIZES THE START OF A RECORD.
                        1111  *
                        1112  *       THIS REQUIRES
                        1113  *       AT LEAST 10 SYNC CHARACTERS
                        1114  *       1 STX CHARACTER.
                        1115  *
                        1116  *       THE CRC-16 IS THEN INITIALIZED.
                        1117  *
                        1118  *       ENTRY   NONE
                        1119  *       EXIT    TAPE POSITIONED (AND MOVING), CRCSUM =0
                        1120  *                (DE) = HEADER BYTES
                        1121  *                (HA) = RECORD COUNT
```

```
                        1122  *       USES    A,F,D,E,H,L
                        1123
000.000                 1124          ERRNZ   *-2265A
                        1125
002.265                 1126  SRS     EQU     *
002.265  026 000       1127  SRS1    MVI     D,0
002.267  142           1128          MOV     H,D
002.270  152           1129          MOV     L,D             (HL) = 0
002.271  315 331 002   1130  SRS2    CALL    RNB             READ NEXT BYTE
002.274  024           1131          INR     D
002.275  376 026       1132          CPI     A,SYN
002.277  312 271 002   1133          JE      SRS2            HAVE SYN
002.302  376 002       1134          CPI     A,STX
002.304  302 265 002   1135          JNE     SRS1            NOT STX - START OVER
                        1136
002.307  076 012       1137          MVI     A,10
002.311  272           1138          CMP     D               SEE IF ENOUGH SYN CHARACTERS
002.312  322 265 002   1139          JNC     SRS1            NOT ENOUGH
002.315  042 027 040   1140          SHLD    CRCSUM          CLEAR CRC-16
002.320  315 325 002   1141          CALL    RNP             READ LEADER
002.323  124           1142          MOV     D,H
002.324  137           1143          MOV     E,A
                        1144  *       JMP     RNP             READ COUNT


                        1146  **      RNP - READ NEXT PAIR.
                        1147  *
                        1148  *       RNP READS THE NEXT TWO BYTES FROM THE INPUT DEVICE.
                        1149  *
                        1150  *       ENTRY   NONE
                        1151  *       EXIT    (H,A) = BYTE PAIR
                        1152  *       USES    A,F,H
                        1153
000.000                 1154          ERRNZ   *-2325A
                        1155
002.325  315 331 002   1156  RNP     CALL    RNB             READ NEXT BYTE
002.330  147           1157          MOV     H,A
                        1158  *       JMP     RNB             READ NEXT BYTE


                        1160  **      RNB - READ NEXT BYTE
                        1161  *
                        1162  *       RNB READS THE NEXT SINGLE BYTE FROM THE INPUT DEVICE.
                        1163  *       THE CHECKSUM IS TAKEN FOR THE CHARACTER.
                        1164  *
                        1165  *       ENTRY   NONE
                        1166  *       EXIT    (A) = CHARACTER
                        1167  *       USES    A,F
                        1168
000.000                 1169          ERRNZ   *-2331A
                        1170
002.331  076 064       1171  RNB     MVI     A,UCI.RO+UCI.ER+UCI.RE  TURN ON READER FOR NEXT BYTE
```

```
002.333  323 371       1172           OUT     OP.TPC
002.335  315 252 002   1173  RNB1     CALL    TPXIT           CHECK FOR *, READ STATUS
002.340  346 002       1174           ANI     USR.RXR
002.342  312 335 002   1175           JZ      RNB1            IF NOT READY
002.345  333 370       1176           IN      IP.TPD          INPUT DATA
                       1177  *        JMP     CRC             CHECKSUM



                       1179  **       CRC - COMPUTE CRC-16
                       1180  *
                       1181  *        CRC COMPUTES A CRC-16 CHECKSUM FROM THE POLYNOMIAL
                       1182  *
                       1183  *        (X + 1) * (X^15 + X + 1)
                       1184  *
                       1185  *        SINCE THE CHECKSUM GENERATED IS A DIVISION REMAINDER,
                       1186  *        A CHECKSUMED DATA SEQUENCE CAN BE VERIFIED BY RUNNING
                       1187  *        THE DATA THROUGH CRC, AND THEN RUNNING THE PREVIOUSLY OBTAINED
                       1188  *        CHECKSUM THROUGH CRC. THE RESULTANT CHECKSUM SHOULD BE 0.
                       1189  *
                       1190  *        ENTRY   (CRCSUM) = CURRENT CHECKSUM
                       1191  *                (A) = BYTE
                       1192  *        EXIT    (CRCSUM) UPDATED
                       1193  *                (A) UNCHANGED.
                       1194  *        USES    F
                       1195
000.000                1196           ERRNZ   *-2347A
                       1197
002.347  305           1198  CRC      PUSH    B               SAVE (BC)
002.350  006 010       1199           MVI     B,8             (B) = BIT COUNT
002.352  345           1200           PUSH    H
002.353  052 027 040   1201           LHLD    CRCSUM
002.356  007           1202  CRC1     RLC
002.357  117           1203           MOV     C,A             (C) = BIT
002.360  175           1204           MOV     A,L
002.361  207           1205           ADD     A
002.362  157           1206           MOV     L,A
002.363  174           1207           MOV     A,H
002.364  027           1208           RAL
002.365  147           1209           MOV     H,A
002.366  027           1210           RAL
002.367  251           1211           XRA     C
002.370  017           1212           RRC
002.371  322 004 003   1213           JNC     CRC2            IF NOT TO XOR
002.374  174           1214           MOV     A,H
002.375  356 200       1215           XRI     200Q
002.377  147           1216           MOV     H,A
003.000  175           1217           MOV     A,L
003.001  356 005       1218           XRI     5Q
003.003  157           1219           MOV     L,A
003.004  171           1220  CRC2     MOV     A,C
003.005  005           1221           DCR     B
003.006  302 356 002   1222           JNZ     CRC1            IF MORE TO GO
003.011  042 027 040   1223           SHLD    CRCSUM
003.014  341           1224           POP     H               RESTORE (HL)
```

```
003.015  301              1225            POP     B               RESTORE (BC)
003.016  311              1226            RET                     EXIT


                          1228  **        WNP - WRITE NEXT PAIR.
                          1229  *
                          1230  *         WNP WRITES THE NEXT TWO BYTES TO THE CASSETTE DRIVE.
                          1231  *
                          1232  *.        ENTRY   (H,L) = BYTES
                          1233  *         EXIT    WRITTEN.
                          1234  *         USES    A,F
                          1235
000.000                   1236            ERRNZ   *-3017A
                          1237
003.017  174              1238  WNP       MOV     A,H
003.020  315 024 003      1239            CALL    WNB
003.023  175              1240            MOV     A,L
                          1241  *       . JMP     WNB             WRITE NEXT BYTE


                          1243  **        WNB - WRITE BYTE
                          1244  *
                          1245  *         WNB WRITES THE NEXT BYTE TO THE CASSETTE TAPE.
                          1246  *
                          1247  *         ENTRY   (A) = BYTE
                          1248  *         EXIT    NONE.
                          1249  *         USES    F
                          1250
000.000                   1251            ERRNZ   *-3024A
                          1252
003.024  365              1253  WNB       PUSH    PSW
003.025  315 252 002      1254  WNB1      CALL    TPXIT           CHECK FOR *, READ STATUS
003.030  346 001          1255            ANI     USR.TXR
003.032  312 025 003      1256            JZ      WNB1            IF MORE TO GO
003.035  076 021          1257            MVI     A,UCI.ER+UCI.TE ENABLE TRANSMITTER
003.037  323 371          1258            OUT     OP.TPC          TURN ON TAPE
003.041  361              1259            POP     PSW
003.042  323 370          1260            OUT     OP.TPD          OUTPUT DATA
003.044  303 347 002      1261            JMP     CRC             COMPUTE CRC
```

```
                        1265  **      LRA - LOCATE REGISTER ADDRESS.
                        1266  *
                        1267  *       ENTRY   NONE.
                        1268  *       EXIT    (A) = REGISTER INDEX
                        1269  *               (H,L) = STORAGE ADDRESS
                        1270  *               (D,E) = (0,A)
                        1271  *       USES    A,D,E,H,L,F
                        1272
                        1273
000.000                 1274            ERRNZ   *-3047A
                        1275
003.047 072 005 040     1276  LRA       LDA     REGI
003.052 137             1277  LRA.      MOV     E,A
003.053 026 000         1278            MVI     D,0
003.055 052 035 040     1279            LHLD    REGPTR
003.060 031             1280            DAD     D               (DE) = (REGPTR)+(REGI)
003.061 311             1281            RET


                        1283  **      IOA - INPUT OCTAL ADDRESS.
                        1284  *
                        1285  *       ENTRY   (H,L) = ADDRESS OF RECEPTION DOUBLE BYTE.
                        1286  *               (D) = TERMINATING CHARACTER
                        1287  *       EXIT    NONE
                        1288  *       USES    A,D,E,H,L,F
                        1289
                        1290
000.000                 1291            ERRNZ   *-3062A
                        1292
003.062 303 176 005     1293  IOA       JMP     IOA1
003.065 000             1294            NOP                     RETAIN H8 ORG


                        1296  **      IOB - INPUT OCTAL BYTE.
                        1297  *
                        1298  *       READ ONE OCTAL BYTE FROM THE KEYSET.
                        1299  *
                        1300  *       ENTRY   (H,L) = ADDRESS OF BYTE TO HOLD VALUE
                        1301  *               (C) SET IF FIRST DIGIT IN (A)
                        1302  *       EXIT    NONE
                        1303  *       USES    A,D,E,H,L,F
                        1304
                        1305
000.000                 1306            ERRNZ   *-3066A
                        1307
003.066 066 000         1308  IOB       MVI     M,0             ZERO OUT OLD VALUE
003.070 324 262 003     1309  IOB1      CNC     RCC             READ CONSOLE CHARACTER
                        1310
                        1311  *       SEE IF CHARACTER IS A VALID OCTAL VALUE
                        1312  *
003.073 376 060         1313            CPI     '0'             LESS THAN ZERO?
003.075 332 135 003     1314            JC      IOB2            IF (A) < 0, SEE IF A TERMINATING CHARACTER
```

```
003.100  376 070       1315           CPI     '8'             GREATER THAN 7?
003.102  322 070 003   1316           JNC     IOB1            IF TOO LARGE, TRY AGAIN
                       1317
                       1318  *        HAVE AN OCTAL DIGIT
                       1319  *
003.105  315 302 003   1320           CALL    WCC             ECHO CHARACTER
003.110  346 007       1321           ANI     00000111B       MASK FOR BINARY VALUE
003.112  137           1322           MOV     E,A             (E) = VALUE
003.113  176           1323           MOV     A,M             GET OLD VALUE
003.114  007           1324           RLC                     SHIFT 3
003.115  007           1325           RLC
003.116  007           1326           RLC
003.117  303 126 003   1327           JMP     IOB1.5          JUMP AROUND AN H88/H89 TO H8 FAKE ROUTINE
                       1328
                       1329  **       FAKE OUT ROUTINE FOR CALLERS OF *DOD* FROM THE H8 FRONT PANEL
                       1330
                       1331
000.000                1332           ERRNZ   *-3122A
                       1333
003.122  043           1334  DOD      INX     H
003.123  043           1335           INX     H
003.124  043           1336           INX     H
003.125  311           1337           RET
                       1338
                       1339
                       1340  *        CONTINUE
                       1341
003.126  346 370       1342  IOB1.5   ANI     11111000B       TOSS OLD LSB DIGIT
003.130  263           1343           ORA     E               REPLACE WITH NEW VALUE
003.131  167           1344           MOV     M,A
003.132  303 070 003   1345           JMP     IOB1            INPUT ANOTHER CHARACTER
                       1346
                       1347  *        CHECK FOR A CARRIAGE RETURN TO TERMINATE BYTE
                       1348  *
003.135  376 015       1349  IOB2     CPI     A.CR            CARRIAGE RETURN?
003.137  310           1350           RZ                      RETURN IF CARRIAGE RETURN       /JWT 790507/
003.140  257           1351           XRA     A               CLEAR CARRY                     /JWT 790507/
003.141  030 325       1352           JR      IOB1            GET A NEW CHARACTER             /JWT 790507/
                       1353
                       1433           LON     L
```

```
                        1437  **      RCK - READ CONSOLE KEYPAD
                        1438  *
                        1439  *       RCK IS CALLED TO READ A KEYSTROKE FROM THE CONSOLE FRONT PANEL KEYPAD.
                        1440  *       SINCE THE H88/89 DOES NOT HAVE A FRONT PANEL, THIS ROUTINE IS PROVIDED
                        1441  *       ONLY TO MAINTAIN COMPATIBILITY WITH PAM-8.
                        1442  *       RCK WILL IMMEDIATELY RETURN WITH A VALUE OF 0 (ZERO) IN THE ACCUMULATOR.
                        1443  *
                        1444  *       ENTRY   NONE
                        1445  *       EXIT    (A) = 0
                        1446  *       USES    A,F
                        1447
                        1448  *       RCK MUST HAVE SAME ENTRY AS RCK IN PAM-8
   000,000              1449          ERRNZ   *-3260A
                        1450
   003,260              1451  RCK     EQU     *
                        1452
   003,260  257         1453          XRA     A
   003,261  311         1454          RET
                        1455
```

```
                        1459  **      RCC - READ CONSOLE CHARACTER.
                        1460  *
                        1461  *       RCC IS CALLED TO READ A KEYSTROKE FROM THE CONSOLE.
                        1462  *       IF A RUBOUT/DELETE IS RECEIVED, EXIT IS TO *ERROR*.
                        1463  *
                        1464  *       ENTRY   NONE
                        1465  *       EXIT    TO ERROR  - IF A DELETE OR RUBOUT IS ENCOUNTERED
                        1466  *               TO CALLER - WHEN A KEY IS HIT
                        1467  *                           (A) =  ASCII KEY VALUE
                        1468  *       USES    A,F
                        1469
                        1470
                        1471
 003.262                1472  RCC     EQU     *
                        1473
 003.262  333 355       1474  RCC1    IN      SC.ACE+UR.LSR   INPUT ACE LINE STATUS REGISTER
 003.264  346 001       1475          ANI     UC.DR           SEE IF THERE IS A DATA READY
 003.266  050 372       1476          JR      Z,RCC1
                        1477
 003.270  333 350       1478          IN      SC.ACE+UR.RBR   ELSE, INPUT CHARACTER
 003.272  346 177       1479          ANI     01111111B       TOSS ANY PARITY
 003.274  376 177       1480          CPI     A.DEL
 003.276  312 322 000   1481          JZ      ERROR           IF RUBOUT, EXIT TO ERROR
                        1482
 003.301  311           1483          RET                     ELSE, EXIT TO CALLER


                        1485  **      WCC - WRITE CONSOLE CHARACTER
                        1486  *
                        1487  *       WRITE A CHARACTER TO THE CONSOLE UART PORT
                        1488  *
                        1489  *       ENTRY   (A) = ASCII CHARACTER TO OUTPUT
                        1490  *       EXIT    NONE
                        1491  *       USES    NONE
                        1492
                        1493
 003.302  365           1494  WCC     PUSH    PSW             SAVE CHARACTER
 003.303  333 355       1495  WCC1    IN      SC.ACE+UR.LSR   INPUT ACE STATUS
 003.305  346 040       1496          ANI     UC.THE          SEE IF TRANSMITTER HOLDING REGISTER IS EMPTY
 003.307  050 372       1497          JR      Z,WCC1
                        1498
 003.311  361           1499          POP     PSW             GET CHARACTER
 003.312  323 350       1500          OUT     SC.ACE+UR.THR           OUTPUT TO CONSOLE
 003.314  311           1501          RET
                        1547          LON     L
```

```
                        1550  **      IO ROUTINES TO BE COPIED INTO AND USED IN RAM.
                        1551  *
                        1552  *       MUST CONTINUE TO 3777A FOR PROPER COPY.
                        1553  *       THE TABLE MUST ALSO BE BACKWARDS TO THE FINAL RAM
                        1554
000.000                 1555          ERRNZ   4000A-7-*
                        1556
003.371                 1557  PRSROM  EQU     *
003.371 001             1558          DB      1               REFIND
003.372 000             1559          DB      0               CTLFLG
003.373 000             1560          DB      0               .MFLAG
003.374 000             1561          DB      0               DSPMOD
003.375 000             1562          DB      0               DSPROT
003.376 012             1563          DB      10              REGI
003.377 311             1564          DB      MI.RET
                        1565
000.000                 1566          ERRNZ *-4000A
                        1567
```

```
                        1570  ***   INITOX    EXTENSION OF INIT0 TO SUPPORT H88
                        1571
004.000  076 002       1572  INITOX  MVI     A,00000010B
004.002  323 362       1573          OUT     H88.CTL
                        1574
                        1575  *       SET UP ACE FOR CONSOLE COMMUNICATIONS
                        1576  *
004.004  076 200       1577          MVI     A,UC.DLA        SET DIVISOR LATCH ACCESS BIT
004.006  323 353       1578          OUT     SC.ACE+UR.LCR
004.010  041 075 004   1579          LXI     H,BRTAB         (H,L) = BEGINNING OF BAUD RATE TABLE
004.013  333 362       1580          IN      H88.SW          INPUT SWITCHES FOR DESIRED BAUD RATE
004.015  346 300       1581          ANI     H88S.BR         MASK FOR BAUD RATE SWITCHES ONLY
004.017  017           1582          RRC                     SHIFT FOR A *2 FOR TABLE
004.020  017           1583          RRC
004.021  017           1584          RRC
004.022  017           1585          RRC
004.023  017           1586          RRC
004.024  205           1587          ADD     L               ADD DISPLACEMENT FROM BEGINNING OF TABLE
004.025  157           1588          MOV     L,A
004.026  176           1589          MOV     A,M             GET MSB OF DIVISOR
004.027  323 351       1590          OUT     SC.ACE+UR.DLM
004.031  043           1591          INX     H               GET LSB
004.032  176           1592          MOV     A,M
004.033  323 350       1593          OUT     SC.ACE+UR.DLL
004.035  076 003       1594          MVI     A,UC.8BW        SET 8 BITS, 1 STOP BIT, NO PARITY
004.037  323 353       1595          OUT     SC.ACE+UR.LCR
004.041  076 000       1596          MVI     A,0             SET NO INTERRUPTS
004.043  323 351       1597          OUT     SC.ACE+UR.IER
                        1598
                        1599  *       WAIT A WHILE TO ALLOW THE CONSOLE RESET TO FINISH SO IT CAN
                        1600  *       ACCEPT THE FIRST PROMPT
                        1601  *
004.045  001 000 065   1602          LXI     B,65000A        APPROX. 100 MS
004.050  015           1603  INIT0X1 DCR     C
004.051  302 050 004   1604          JNZ     INIT0X1
                        1605
004.054  005           1606          DCR     B
004.055  302 050 004   1607          JNZ     INIT0X1
                        1608
                        1609  *       INPUT SWITCH TO SEE IF TO BEGIN OPERATION OR MEMORY TEST
                        1610  *
004.060  333 362       1611          IN      H88.SW          GET SWITCHES
004.062  346 040       1612          ANI     H88S.M          MASK FOR MEMORY TEST ONLY
004.064  312 116 007   1613          JZ      DYMEM           IF TO PERFORM MEMORY TESTS
                        1614
                        1615  *       REPLACE WHAT WAS ORIGINALLY AT THE JUMP WHICH GOT US HERE
                        1616  *
004.067  021 371 003   1617          LXI     D,PRSROM        (DE) = ROM COPY OF PRS CODE
004.072  303 003 000   1618          JMP     INIT0.0         RETURN TO ORIGINAL CODE
```

```
                                1620  **      BRTAB - BAUD RATE DIVISOR TABLE
                                1621  *
004.075                         1622  BRTAB   EQU     *
                                1623
004.075  000 014               1624  BR96    DB      0,12            9600 BAUD
004.077  000 006               1625  BR19.2  DB      0,6           19,200 BAUD
004.101  000 003               1626  BR38.4  DB      0,3           38,400 BAUD
004.103  000 002               1627  BR56.0  DB      0,2           56,000 BAUD
                                1628
000.004                         1629          SET     *!256
000.000                         1630          ERRNZ   BRTAB/256-.     TABLE MUST BE IN ONE PAGE


                                1632  ***     SAVALLX - SAVALL EXTENSION TO MAKE ROOM FOR A JUMP TO THE NMI HANDLER
                                1633
004.105                         1634  SAVALLX EQU     *               REPLACE OLD CODE
004.105  345                    1635          PUSH    H               SET ON STACK AS 'REGISTER'
004.106  325                    1636          PUSH    D               SET RETURN ADDRESS
004.107  021 011 040            1637          LXI     D,CTLFLG
004.112  032                    1638          LDAX    D
004.113  303 151 000            1639          JMP     SAVALLR         RETURN TO OLD CODE
```

```
                        1642  ****    NMI - NON MASKABLE INTERRUPT
                        1643  *
                        1644  *       NMI IS USED AS THE TRAP FOR ALL ILLEGAL PORT REQUESTS
                        1645  *
                        1646  *       PORT ADDRESSES TRAPPED ARE:
                        1647  *
                        1648  *                       IN 360Q FRONT PANEL KEYBOARD INPUT
                        1649  *                      OUT 360Q FRONT PANEL CONTROL
                        1650  *                      OUT 361Q FRONT PANEL DISPLAY CONTROL
                        1651  *                   IN/OUT 372Q CONSOLE DATA FOR AN 8251A
                        1652  *                      OUT 373Q CONSOLE CONTROL FOR AN 8251A
                        1653  *
                        1654  *
                        1655  *               THESE PORT REQUESTS ARE RESPONDED TO AS FOLLOWS:
                        1656  *
                        1657  *                       IN 360Q RETURNS WITH (A) = 377Q TO SHOW THAT
                        1658  *                            NO FRONT PANEL SWITCHES ARE PRESSED
                        1659  *
                        1660  *                       OUT 360Q MOVES BIT 6 (CB.CLI) TO BIT 1, AND
                        1661  *                            BIT 4 (CB.SSI) INVERTED, TO BIT 0, AND
                        1662  *                            OUTPUTS THESE BITS TO PORT 362Q TO
                        1663  *                            CONTROL THE CLOCK AND SINGLE STEP INTERRUPTS
                        1664  *
                        1665  *                       OUTPUTS TO 361Q, 372Q, AND 373Q JUST RETURN
                        1666  *
                        1667  *                       INPUTS FROM 361Q, 372Q, AND 373Q RETURN WITH (A) = 0
                        1668  *                            TO INDICATE AN EMPTY BUSS
                        1669  *
                        1670  *
                        1671  *               ENTRY   NONE
                        1672  *
                        1673  *               EXIT    NONE
                        1674  *
                        1675  *               USES    (A) ONLY IF "FAKING" AN INPUT
                        1676
                        1677
004.116  343           1678  NMI     XTHL                    GET RETURN ADDRESS FROM STACK
004.117  042 064 040    1679          SHLD    NMIRET          SAVE FOR LATER USE
004.122  343           1680          XTHL                    PUT RETURN ADDRESS BACK ON STACK
                        1681
004.123  345           1682          PUSH    H               SAVE REGISTERS
004.124  305           1683          PUSH    B
004.125  365           1684          PUSH    PSW
004.126  107           1685          MOV     B,A             SAVE (A) PRIOR TO I/O
004.127  052 064 040    1686          LHLD    NMIRET          GET RETURN ADDRESS
004.132  053           1687          DCX     H               BACK UP TO PORT # WHICH GOT US HERE
004.133  176           1688          MOV     A,M             GET PORT #
                        1689
004.134  376 360       1690          CPI     360Q            PORT 360?
004.136  312 202 004    1691          JZ      NMI1            IF PORT WAS 360Q
                        1692
                        1693  *       PORT REFERENCED WAS 361Q, 372Q, OR 373Q
                        1694  *
004.141  376 361       1695          CPI     361Q            MAKE SURE PORT IS LEGAL
004.143  312 160 004    1696          JZ      NMI0.5          IF LEGAL
                        1697
```

```
004.146 376 372          1698           CPI     3720
004.150 312 160 004      1699           JZ      NMI0.5
                         1700
004.153 376 373          1701           CPI     373Q
004.155 302 251 004      1702           JNZ     NMI2.5          IF NONE OF THE ABOVE, EXIT
                         1703
004.160 053              1704  NMI0.5   DCX     H               POINT TO IN/OUT INSTRUCTION
004.161 176              1705           MOV     A,M             SEE IF INPUT OR OUTPUT
004.162 376 323          1706           CPI     MI.OUT
004.164 312 251 004      1707           JZ      NMI2.5          IF OUTPUT, JUST EXIT
                         1708
004.167 376 333          1709           CPI     MI.IN
004.171 302 251 004      1710           JNZ     NMI2.5          IF NOT INPUT EITHER, ILLEGAL SO EXIT
                         1711
004.174 361              1712           POP     PSW             RESTORE FLAGS
004.175 076 000          1713           MVI     A,0             ELSE, RETURN LIKE AN EMPTY BUSS
004.177 303 252 004      1714           JMP     NMI3            EXIT
                         1715
004.202 053              1716  NMI1     DCX     H               POINT TO IN/OUT INSTRUCTION
004.203 176              1717           MOV     A,M             GET I/O INSTRUCTION
004.204 376 333          1718           CPI     MI.IN           INPUT?
004.206 302 217 004      1719           JNZ     NMI1.5          IF NOT 'IN'
                         1720
004.211 361              1721           POP     PSW             RESTORE FLAGS
004.212 076 377          1722           MVI     A,11111111B     SHOW 'NO KEYS PRESSED'
004.214 303 252 004      1723           JMP     NMI3            EXIT
                         1724
004.217 376 323          1725  NMI1.5   CPI     MI.OUT          MAKE SURE INTRUCTION IS AN 'OUT'
004.221 302 251 004      1726           JNZ     NMI2.5          IF NOT
                         1727
004.224 170              1728  NMI2     MOV     A,B             GET OUTPUT DATA AGAIN
004.225 346 100          1729           ANI     CB.CLI          MOVE CLOCK INFO TO BIT 1
004.227 017              1730           RRC
004.230 017              1731           RRC
004.231 017              1732           RRC
004.232 017              1733           RRC
004.233 017              1734           RRC
004.234 117              1735           MOV     C,A             SAVE IN C
004.235 170              1736           MOV     A,B             GET OUTPUT DATA AGAIN
004.236 346 020          1737           ANI     CB.SSI          GET SINGLE STEP INFO
004.240 017              1738           RRC                     MOVE TO BIT 0
004.241 017              1739           RRC
004.242 017              1740           RRC
004.243 017              1741           RRC
004.244 261              1742           ORA     C               ADD TO CLOCK DATA
004.245 356 001          1743           XRI     00000001B       INVERT THIS BIT PRIOR TO OUTPUT
004.247 323 342          1744           OUT     H88.CTL         SET IN HARDWARE
                         1745
004.251 361              1746  NMI2.5   POP     PSW             RESTORE (A,F)
                         1747
004.252 301              1748  NMI3     POP     B
004.253 341              1749           POP     H
                         1750  *        RETN                    ;GO RETURN FROM NMI
004.254 355 105          1751           DB      355Q,105Q
```

```
                                1754  **      BOOT HDOS ENTRY POINT FOR H88
                                1755  *
                                1756  *       ENTRY   NONE
                                1757  *       EXIT    TO HDOS BOOT ROM
                                1758  *       USES    ALL
                                1759
004.256  041 234 006            1760  BOOT    LXI     H,MSG.BT        COMPLETE BOOT MESSAGE
004.261  315 100 006            1761          CALL    TYPMSG
004.264  315 003 006            1762          CALL    WCR             WAIT FOR A CARRIAGE RETURN
004.267  076 012                1763          MVI     A,10
004.271  315 052 003            1764          CALL    LRA.            GET LOCATION OF USER PC
004.274  021 000 030            1765          LXI     D,ROMDD         SET ITS VALUE TO THE BOOT ROM
004.277  163                    1766          MOV     M,E
004.300  043                    1767          INX     H
004.301  162                    1768          MOV     M,D
                                1769
                                1770  *       TELL USER TO 'TYPE SPACES TO DETERMINE BAUD RATE'
                                1771  *
004.302  041 122 006            1772          LXI     H,MSG.SP
004.305  315 100 006            1773          CALL    TYPMSG
                                1774
004.310  303 063 000            1775          JMP     GO.             DO IT


                                1777  **      SWMEM - SET UP FOR WMEM TO DUMP A CASSETTE FROM THE MONITOR LEVEL
                                1778  *
                                1779  *       SWMEM ALLOWS THE USER TO EITHER ENTER A NEW STARTING AND
                                1780  *       ENDING ADDRESS FOR THIS DUMP OR USE THE ADDRESS OF THE
                                1781  *       PREVIOUS LOAD OR DUMP.  THE PREVIOUS ADDRESSES ARE USED IF
                                1782  *       THE FIRST CHARACTER IS AN ASCII CARRIAGE RETURN.  IF THE
                                1783  *       FIRST CHARACTER IS AN OCTAL CHARACTER, BOTH BEGINNING AND
                                1784  *       ENDING ADDRESSES MUST BE ENTERED SEPARATED BY A DASH AND
                                1785  *       FOLLOWED BY A CARRIAGE RETURN
                                1786  *
                                1787  *
                                1788  *       ENTRY   USER PC VALUE ON STACK = PROGRAM START ADDRESS FOR THIS TAPE
                                1789  *       EXIT    TO WMEM
                                1790  *       USES    ALL
                                1791
                                1792
004.313  041 174 006            1793  SWMEM   LXI     H,MSG.DMP       COMPLETE DUMP MESSAGE
004.316  315 100 006            1794          CALL    TYPMSG
004.321  315 150 005            1795          CALL    IROC            INPUT FIRST CHARACTER
004.324  322 351 004            1796          JNC     SWMEM4          IF FIRST CHARACTER IS OCTAL
                                1797
004.327  041 001 040            1798          LXI     H,START+1       ELSE, INPUT STARTING ADDRESS
004.332  026 055                1799          MVI     D,'-'           FIRST BYTE MUST END WITH A DASH
004.334  315 062 003            1800          CALL    IOA
004.337  041 025 040            1801  SWMEM2  LXI     H,ABUSS+1       ENTER ENDING ADDRESS
004.342  067                    1802          STC                     SHOW NO CHARACTER IN (A)
004.343  077                    1803          CMC
004.344  026 015                1804          MVI     D,A.CR          LAST CHARACTER MUST BE A RETURN
004.346  315 062 003            1805          CALL    IOA
004.351  076 012                1806  SWMEM4  MVI     A,10            GET USER PC VALUE FOR DISPLAY
```

```
004.353 315 052 003 1807          CALL    LEA,
004.356 136         1808          MOV     E,M
004.357 043         1809          INX     H
004.360 126         1810          MOV     D,M
004.361 353         1811          XCHG                    (H,L) = USER PC VALUE
004.362 315 313 005 1812          CALL    TOA             TYPE OCTAL ADDRESS
004.365 303 374 001 1813          JMP     WMEM            DO THE DUMP
                    1814

                    1816  **      SUBM - SUBSTITUTE MEMORY
                    1817  *
                    1818  *       SUBM INPUTS A MEMORY ADDRESS FROM THE CONSOLE AND THEN DISPLAYS
                    1819  *       THAT ADDRESS AND ITS CONTENTS.  IF A CARRIAGE RETURN IS THEN TYPED,
                    1820  *       CONTROL RETURNS TO THE MONITOR.  IF A SPACE IS TYPED, THE NEXT
                    1821  *       MEMORY LOCATION AND CONTENTS ARE DISPLAYED.  IF A MINUS SIGN IS
                    1822  *       TYPED, THE PREVIOUS MEMORY LOCATION AND CONTENTS ARE DISPLAYED.
                    1823  *       IF AN OCTAL CHARACTER IS TYPED, A BYTE IS ENTERED AN PLACED AT THE
                    1824  *       CURRENT MEMORY LOCATION.
                    1825  *
                    1826  *
                    1827  *       ENTRY   NONE
                    1828  *       EXIT    NONE
                    1829  *       USES    A,E,H,L,F
                    1830
                    1831
004.370 041 201 006 1832  SUBM    LXI     H,MSG.SUB       COMPLETE SUBSTITUTE MESSAGE
004.373 315 100 006 1833          CALL    TYPMSG
004.376 315 150 005 1834          CALL    IROC            INPUT FIRST CHARACTER
005.001 320         1835          RNC                     IF A RETURN, EXIT
                    1836
005.002 041 003 040 1837          LXI     H,IOWRK+1       ELSE, INPUT STARTING ADDRESS
005.005 026 015     1838          MVI     D,A,CR          ENDING WITH A RETURN
005.007 315 062 003 1839          CALL    IOA
005.012 353         1840          XCHG                    (H,L) = INPUT ADDRESS
                    1841
005.013 315 313 005 1842  SUBM1   CALL    TOA             TYPE CRLF, ADDRESS, AND A SPACE
005.016 176         1843          MOV     A,M             GET MEMORY CONTENTS FOR DISPLAY
005.017 315 343 005 1844          CALL    TOB
005.022 076 040     1845          MVI     A,' '           SPACE
005.024 315 302 003 1846          CALL    WCC
                    1847
005.027 315 301 005 1848  SUBM2   CALL    IOC             INPUT FIRST CHARACTER
005.032 322 075 005 1849          JNC     SUBM7           IF FIRST CHARACTER IS OCTAL
                    1850
005.035 376 040     1851          CPI     ' '             SPACE?
005.037 302 046 005 1852          JNZ     SUBM4           IF NOT A SPACE
                    1853
005.042 043         1854  SUBM3   INX     H               POINT TO NEXT ADDRESS
005.043 303 013 005 1855          JMP     SUBM1           DISPLAY NEXT
                    1856
005.046 376 055     1857  SUBM4   CPI     '-'             MINUS?
005.050 302 062 005 1858          JNZ     SUBM6           IF NOT
                    1859
```

```
005.053  315 302 003  1860  SUBM5   CALL    WCC             ECHO HYPHEN
005.056  053         1861           DCX     H               POINT TO PREVIOUS ADDRESS
005.057  303 013 005  1862           JMP     SUBM1           DISPLAY PREVIOUS
                      1863
005.062  376 015      1864  SUBM6    CPI     A.CR            RETURN?
005.064  310         1865           RZ                      IF RETURN, EXIT
                      1866
005.065  076 007      1867           MVI     A,A.BEL         ELSE, DING BELL
005.067  315 302 003  1868           CALL    WCC
005.072  303 027 005  1869           JMP     SUBM2           TRY AGAIN
                      1870
005.075  066 000      1871  SUBM7    MVI     M,0             ZERO BYTE TO BE BUILT
                      1872
005.077  315 302 003  1873  SUBM8    CALL    WCC             ECHO OCTAL CHARACTER
005.102  346 007      1874           ANI     00000111B       GET BINARY VALUE
005.104  137         1875           MOV     E,A             SAVE PARTIAL
005.105  176         1876           MOV     A,M             GET CURRENT
005.106  007         1877           RLC                     MAKE ROOM FOR NEW CHARACTER
005.107  007         1878           RLC
005.110  007         1879           RLC
005.111  346 370      1880           ANI     11111000B       TOSS PREVIOUS LSB
005.113  263         1881           ORA     E               ADD NEW
005.114  167         1882           MOV     M,A             SAVE NEW TOTAL
005.115  315 301 005  1883  SUBM9    CALL    IOC             INPUT NEXT CHARACTER
005.120  322 077 005  1884           JNC     SUBM8           IF OCTAL
                      1885
005.123  376 040      1886           CPI     ' '             SPACE?
005.125  312 042 005  1887           JZ      SUBM3           IF SPACE, DISPLAY NEXT BYTE
                      1888
005.130  376 055      1889           CPI     '-'             MINUS?
005.132  312 053 005  1890           JZ      SUBM5           IF MINUS, DISPLAY PREVIOUS
                      1891
005.135  376 015      1892           CPI     A.CR            RETURN?
005.137  310         1893           RZ                      IF RETURN, EXIT
                      1894
005.140  076 007      1895           MVI     A,A.BEL         ELSE, DING BELL
005.142  315 302 003  1896           CALL    WCC
005.145  303 115 005  1897           JMP     SUBM9           TRY AGAIN
```

```
                      1899  **       IROC - INPUT A RETURN OR AN OCTAL CHARACTER
                      1900  *
                      1901  *        IROC INPUTS A CHARACTER FROM THE CONSOLE AND WAITS UNTIL IT
                      1902  *        RECEIVES EITHER A VALID OCTAL CAHRACTER OR A CARRIAGE RETURN
                      1903  *
                      1904  *        ENTRY   NONE
                      1905  *        EXIT    (A) = INPUT CHARACTER
                      1906  *                'C' = SET IF CHARACTER IS OCTAL
                      1907  *        USES    A,F
                      1908
                      1909
005.150  315 262 003  1910  IROC     CALL    RCC             INPUT CHARACTER
005.153  376 015      1911           CPI     A.CR            RETURN?
005.155  310         1912           RZ                      IF A CR
```

```
                          1913
005.156  376 060          1914          CPI     '0'             < 0?
005.160  332 166 005      1915          JC      IROC1           IF < OCTAL
                          1916
005.163  376 070          1917          CPI     '8'             > 8?
005.165  330              1918          RC                      IF OCTAL
                          1919
005.166  076 007          1920  IROC1   MVI     A,A.BEL         ELSE, RING BELL
005.170  315 302 003      1921          CALL    WCC
005.173  303 150 005      1922          JMP     IROC            TRY AGAIN


                          1924  **      IOA1 - INPUT OCTAL ADDRESS
                          1925  *
                          1926  *       IOA1 IS A CONTINUATION OF *IOA* AND INPUTS A SPLIT OCTAL ADDRESS
                          1927  *       WITHOUT REQUIRING LEADING ZEROS
                          1928  *
                          1929  *       ENTRY   (H,L) = ADDRESS + 1 WHERE INPUT ADDRESS IS TO BE PLACED
                          1930  *               (A) = FIRST OCTAL CHARACTER IF 'C' IS SET
                          1931  *       EXIT    (D,E) = INPUT ADDRESS
                          1932  *               (A) = LAST INPUT CHARACTER
                          1933  *       USES    A,D,E,H,L,F
                          1934
                          1935
005.176  305              1936  IOA1    PUSH    B               SAVE (B,C)
005.177  102              1937          MOV     B,D             (B) = TERMINATION CHARACTER
005.200  345              1938          PUSH    H               SAVE ADDRESS WHERE INPUT IS TO BE PLACED
005.201  041 000 000      1939          LXI     H,0             SET NEW VALUE TO ZERO
005.204  324 262 003      1940  IOA2    CNC     RCC             IF CARRY SET, FIRST CHARACTER IS IN ACC
005.207  376 060          1941          CPI     '0'             MAKE SURE CHARACTER IS OCTAL
005.211  332 242 005      1942          JC      IOA3            IF < OCTAL
                          1943
005.214  376 070          1944          CPI     '8'
005.216  322 242 005      1945          JNC     IOA3            IF > OCTAL
                          1946
005.221  315 302 003      1947          CALL    WCC             ECHO OCTAL CHARACTER
005.224  346 007          1948          ANI     00000111B       GET BINARY VALUE
005.226  365              1949          PUSH    PSW             SAVE NEW CHARACTER VALUE
005.227  051              1950          DAD     H               SHIFT THREE TO MAKE ROOM FOR NEW CHARACTER
005.230  051              1951          DAD     H
005.231  051              1952          DAD     H
005.232  365              1953          PUSH    PSW             SAVE CARRY FROM DAD
005.233  321              1954          POP     D               SAVE FLAG RESULT IN E
005.234  361              1955          POP     PSW             RETURN NEW CHARACTER VALUE TO (A)
005.235  205              1956          ADD     L
005.236  157              1957          MOV     L,A
005.237  303 204 005      1958          JMP     IOA2            SEE IF MORE CHARACTERS
                          1959
005.242  270              1960  IOA3    CMP     B               TERMINATING CHARACTER?
005.243  312 260 005      1961          JZ      IOA4            IF EQUAL
                          1962
005.246  076 007          1963          MVI     A,A.BEL         ELSE, DING BELL
005.250  315 302 003      1964          CALL    WCC
005.253  067              1965          STC                     TRY AGAIN
```

```
005.254  077           1966           CMC
005.255  303 204 005   1967           JMP     IOA2
                       1968
                       1969  *        END OF INPUT, PUT VALUE IN MEMORY AND EXIT
                       1970
005.260  315 302 003   1971  IOA4     CALL    WCC             ECHO CHARACTER
005.263  127           1972           MOV     D,A             LAST CHARACTER TO D
005.264  325           1973           PUSH    D
005.265  361           1974           POP     PSW             (PSW) = RESULT OF DAD
005.266  174           1975           MOV     A,H             MAKE (H) INTO SPLIT OCTAL
005.267  037           1976           RAR
005.270  147           1977           MOV     H,A
005.271  172           1978           MOV     A,D             RESTORE LAST INPUT CHARACTER
005.272  353           1979           XCHG                    (D,E) = INPUT ADDRESS
005.273  341           1980           POP     H               (H,L) = LOCATION TO PLACE THIS ADDRESS
005.274  162           1981           MOV     M,D
005.275  053           1982           DCX     H
005.276  163           1983           MOV     M,E
005.277  301           1984           POP     B               RESTORE (B,C)
005.300  311           1985           RET


                       1987  **       IOC - INPUT OCTAL CHARACTER
                       1988  *
                       1989  *
                       1990  *        ENTRY   NONE
                       1991  *        EXIT    (A) = INPUT CHARACTER
                       1992  *                'C' = SET IF CHARACTER NOT OCTAL
                       1993  *        USES    A,F
                       1994
                       1995
005.301  315 262 003   1996  IOC      CALL    RCC             INPUT CHARACTER
005.304  376 060       1997           CPI     '0'
005.306  330           1998           RC                      IF CHARACTER < OCTAL
                       1999
005.307  376 070       2000           CPI     '8'             CHARACTER > OCTAL?
005.311  077           2001           CMC                     'C' IF GREATER THAN
005.312  311           2002           RET


                       2004  **       TOA - TYPE OCTAL ADDRESS
                       2005  *
                       2006  *        TOA OUTPUTS TO THE CONSOLE A CRLF, THE SPCECIFIED ADDRESS AND A SPACE
                       2007  *
                       2008  *        ENTRY   (H,L) = ADDRESS TO BE DISPLAYED
                       2009  *        EXIT    NONE
                       2010  *        USES    A,B,C,F
                       2011
                       2012
005.313  076 015       2013  TOA      MVI     A,A.CR          CRLF
005.315  315 302 003   2014           CALL    WCC
005.320  076 012       2015           MVI     A,A.LF
```

```
005.322 315 302 003  2016          CALL    WCC
                     2017
005.325 174          2018  TOA.    MOV     A,H             ADDRESS
005.326 315 343 005  2019          CALL    TOB
005.331 175          2020          MOV     A,L
005.332 315 343 005  2021          CALL    TOB
                     2022
005.335 076 040      2023          MVI     A,' '           SPACE
005.337 315 302 003  2024          CALL    WCC
005.342 311          2025          RET


                     2027  **      TOB - TYPE OCTAL BYTE
                     2028  *
                     2029  *       TOB OUTPUTS TO THE CONSOLE IN OCTAL, THE BYTE IN A
                     2030  *
                     2031  *       ENTRY   (A) = BYTE TO BE OUTPUT
                     2032  *       EXIT    NONE
                     2033  *       USES    A,F
                     2034
                     2035
005.343 305          2036  TOB     PUSH    B
005.344 006 002      2037          MVI     B,2             NUMBER OF CHARACTERS - 1
005.346 117          2038          MOV     C,A             SAVE ORIGINAL BYTE
005.347 267          2039          ORA     A               ASSURE 'C' = ZERO
005.350 037          2040          RAR
005.351 037          2041          RAR                     SHIFT TOP BYTE TO LSB
005.352 037          2042          RAR
005.353 037          2043  TOB1    RAR                     SHIFT MIDDLE BYTE TO LSB
005.354 037          2044          RAR
005.355 037          2045          RAR
005.356 346 007      2046          ANI     00000111B       MASK FOR HALF ASCII
005.360 366 060      2047          ORI     00110000B       MAKE WHOLE ASCII
005.362 315 302 003  2048          CALL    WCC             OUTPUT TO CONSOLE
005.365 171          2049          MOV     A,C             GET ORIGINAL BYTE
005.366 005          2050          DCR     B
005.367 302 353 005  2051          JNZ     TOB1            IF SECOND BYTE STILL NEEDS TO BE OUTPUT
                     2052
005.372 346 007      2053          ANI     00000111B       ELSE, OUTPUT LAST CHARACTER
005.374 366 060      2054          ORI     00110000B
005.376 315 302 003  2055          CALL    WCC
006.001 301          2056          POP     B
006.002 311          2057          RET


                     2059  **      WCR - WAIT FOR A CARRIAGE RETURN
                     2060  *
                     2061  *       WCR INPUTS CHARACTERS FROM THE CONSOLE UNTIL A CARRIAGE RETURN
                     2062  *       IS RECEIVED AND THEN ECHOS A CRLF
                     2063  *
                     2064  *
                     2065  *       ENTRY   NONE
```

```
                          2066  *       EXIT    NONE
                          2067  *       USES    A;F
                          2068
                          2069
006.003  315 262 003      2070  WCR     CALL    RCC             INPUT CHARACTER
006.006  376 015          2071          CPI     A,CR
006.010  302 003 006      2072          JNZ     WCR             IF NOT A CR
                          2073
006.013  315 302 003      2074          CALL    WCC             ELSE, ECHO CR
006.016  076 012          2075          MVI     A,A.LF          LINE FEED
006.020  315 302 003      2076          CALL    WCC
006.023  311              2077          RET


                          2079  **      TPDSP - TAPE DISPLAY
                          2080  *
                          2081  *       SHOW H88 USER THAT THERE IS SOME ACTIVITY DURING A LOAD OR A DUMP
                          2082
006.024  042 024 040      2083  TPDSP   SHLD    ABUSS           UPDATE ABUSS
                          2084
006.027  076 015          2085          MVI     A,A.CR          RETURN
006.031  315 302 003      2086          CALL    WCC
                          2087
006.034  174              2088          MOV     A,H             ADDRESS
006.035  315 343 005      2089          CALL    TOB
006.040  175              2090          MOV     A,L
006.041  315 343 005      2091          CALL    TOB
                          2092
006.044  311              2093          RET


                          2095  **      HRNX - HORN EXTENSION ROUTINE
                          2096  *
                          2097  *       THIS IS AN EXTENSION TO *HORN* TO MAKE ROOM FOR A JUMP
                          2098
006.045  056 011          2099  HRNX    MVI     L,#CTLFLG
006.047  163              2100          MOV     M,E             TURN OFF HORN
006.050  321              2101          POP     D
006.051  341              2102          POP     H
006.052  311              2103          RET


                          2105  **      NOISE - DING BELL ON CONSOLE
                          2106  *
                          2107  *       THIS IS A MODIFICATION TO ALLOW THE H88/H89 TO USE THE CONSOLE BELL
                          2108
006.053  076 007          2109  NOISE   MVI     A,A.BEL
006.055  315 302 003      2110          CALL    WCC
006.060  303 140 002      2111          JMP     HORN            CONTINUE WITH NORMAL HORN DELAY
```

```
                                2113  **      TPERMSG - TAPE ERROR MESSAGE
                                2114  *
                                2115  *       DISPLAY THE TAPE ERROR NUMBER ON THE CONSOLE
                                2116
006.063  062 024 040           2117  TPERMSG STA     ABUSS           SAVE ERROR NUMBER
006.066  076 040               2118          MVI     A,' '           OUTPUT A SPACE
006.070  315 302 003           2119          CALL    WCC
006.073  170                   2120          MOV     A,B             OUTPUT NUMBER
006.074  315 343 005           2121          CALL    TOB
006.077  311                   2122          RET


                                2124  **      TYPMSG - TYPE MESSAGE TO CONSOLE
                                2125  *
                                2126  *       TYPMSG OUTPUTS AN ASCII MESSAGE FROM MEMORY TO THE CONSOLE
                                2127  *       UNTIL A NULL IS SENSED
                                2128  *
                                2129  *       ENTRY   (H,L) = ADDRESS OF MESSAGE
                                2130  *       EXIT    NONE
                                2131  *       USES    A,H,L,F
                                2132
                                2133
006.100  176                   2134  TYPMSG  MOV     A,M             GET CHARACTER
006.101  267                   2135          ORA     A               SEE IF A NULL
006.102  310                   2136          RZ                      IF NULL, EXIT
                                2137
006.103  315 302 003           2138          CALL    WCC             ELSE OUTPUT CHARACTER TO CONSOLE
006.106  043                   2139          INX     H               POINT TO NEXT CHARACTER
006.107  303 100 006           2140          JMP     TYPMSG          OUTPUT IT


                                2142  **      MSG.PR - MESSAGE FOR MONITOR PROMPT
                                2143  *
                                2144  *       CRLF, '  H: '
                                2145
                                2146
006.112  015 012 040           2147  MSG.PR  DB      A.CR,A.LF,'  H: ',0


                                2149  **      MSG.SP - MESSAGE TO TELL USER TO TYPE SPACES
                                2150  *
                                2151  *       'Type spaces to determine baud rate'
                                2152
006.122  124 171 160           2153  MSG.SP  DB      'Type SPACES to determine baud rate',0
```

```
                        2155  **      MSG.GO - (G)O
                        2156  *
                        2157  *       'GO'
                        2158
006.165  157 040 000   2159  MSG.GO  DB      'o ',0


                        2161  **      MSG.LD - (L)OAD
                        2162  *
                        2163  *       'LOAD'
                        2164
006.170  157 141 144   2165  MSG.LD  DB      'oad',0


                        2167  **      MSG.DMP - (D)UMP
                        2168  *
                        2169  *       'DUMP'
                        2170
006.174  165 155 160   2171  MSG.DMP DB      'ump ',0


                        2173  **      MSG.SUB - (S)UBSTITUTE
                        2174  *
                        2175  *       'SUBSTITUTE'
                        2176
006.201  165 142 163   2177  MSG.SUB DB      'ubstitute ',0


                        2179  **      MSG.PC - (P)ROGRAM COUNTER
                        2180  *
                        2181  *       'PROGRAM COUNTER'
                        2182
006.214  162 157 147   2183  MSG.PC  DB      'rogram Counter ',0


                        2185  **      MSG.BT - (B)OOT
                        2186  *
                        2187  *       'BOOT'
                        2188
006.234  157 157 164   2189  MSG.BT  DB      'oot',0
                        2478          LON     L
```

```
                          2481  **      ENTRY POINT FOR FLOPPY DISK ROTATIONAL SPEED TEST
                          2482  *
000.000                   2483          ERRNZ   10000A-6-*      MUST BE SIX BYTES BEFORE END
                          2484
007.372 303 240 006       2485  ESPEED  JMP     SPEED


                          2487  **      ENTRY POINT FOR DYNAMIC MEMORY TEST
                          2488  *
000.000                   2489          ERRNZ   10000A-3-*      MUST BE THREE BYTES BEFORE END
                          2490
007.375 303 116 007       2491  EDYMEM  JMP     DYMEM
                          2492
000.000                   2493          ERRNZ   *-10000A        MUST NOT EXCEED 2K BYTES
                          2494
```

```
                    2497  **      THE FOLLOWING ARE CONTROL CELLS AND FLAGS USED BY THE KEYSET
                    2498  *       MONITOR.
                    2499
    040.000         2500          ORG     40000A          8192
    040.000         2501  START   DS      2               DUMP STARTING ADDRESS
    040.002         2502  IOWRK   DS      2               IN OR OUT INSTRUCTION
    040.004         2503  PRSRAM  EQU     *               FOLLOWING CELLS INITIALIZED FROM ROM
    040.004         2504          DS      1               RET
                    2505
    040.005         2506  REGI    DS      1               INDEX OF REGISTER UNDER DISPLAY
    040.006         2507  DSPROT  DS      1               PERIOD FLAG BYTE
    040.007         2508  DSPMOD  DS      1               DISPLAY MODE
                    2509
    040.010         2510  .MFLAG  DS      1               USER FLAG OPTIONS
                    2511  *                               SEE *UO.XXX* BITS DESCRIBED AT FRONT
                    2512
    040.011         2513  CTLFLG  DS      1               FRONT PANEL CONTROL BITS
    040.012         2514  REFIND  DS      1               REFRESH INDEX (0 TO 7)
    000.007         2515  PRSL    EQU     *-PRSRAM        END OF AREA INITIALIZED FROM ROM
                    2516
    040.013         2517  FPLEDS  EQU     *               FRONT PANEL LED PATTERNS
    040.013         2518  ALEDS   DS      1               ADDR 0
    040.014         2519          DS      1               ADDR 1
    040.015         2520          DS      1               ADDR 2
                    2521
    040.016         2522          DS      1               ADDR 3
    040.017         2523          DS      1               ADDR 4
    040.020         2524          DS      1               ADDR 5
                    2525
    040.021         2526  DLEDS   DS      1               DATA 0
    040.022         2527          DS      1               DATA 1
    040.023         2528          DS      1               DATA 2
                    2529
    040.024         2530  ABUSS   DS      2               ADDRESS BUSS
    040.026         2531  RCCA    DS      1               RCC SAVE AREA
    040.027         2532  CRCSUM  DS      2               CRC-16 CHECKSUM
    040.031         2533  TPERRX  DS      2               TAPE ERROR EXIT ADDRESS
    040.033         2534  TICCNT  DS      2               CLOCK TIC COUNTER
                    2535
    040.035         2536  REGPTR  DS      2               REGISETR CONTENTS POINTER
                    2537
    040.037         2538  UIVEC   DS      0               USER INTERRUPT VECTORS
    040.037         2539          DS      3               JUMP TO CLOCK PROCESSOR
    040.042         2540          DS      3               JUMP TO SINGLE STEP PROCESSOR
    040.045         2541          DS      3               JUMP TO I/O 3
    040.050         2542          DS      3               JUMP TO I/O 4
    040.053         2543          DS      3               JUMP TO I/O 5
    040.056         2544          DS      3               JUMP TO I/O 6
    040.061         2545          DS      3               JUMP TO I/O 7
                    2546
                    2547  **      H88/H89 RAM USAGE BEYOND THAT OF H8MTRF
                    2548  *
    040.064         2549  NMIRET  DS      2
    040.066         2550          END
ASSEMBLY COMPLETE
  2550 STATEMENTS
    0 ERRORS DETECTED
 12984 BYTES FREE
```

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MTR88 - H88 MONITOR  #09.00.00                                    XREF V1.1
CROSS REFERENCE TABLE                                             PAGE   47

            000004   343S    504S    673S    815S   1629S   1630
.MFLAG      040010   504     546     619     625    2510L
A.BEL       000007   121E    564     658    1540    1867    1895   1920   1963   2109
A.BKS       000010   122E   2397
A.CR        000015   124E    699     755     776    1349    1429   1804   1838   1864   1892   1911   2013
                    2071    2085    2147    2282    2467
A.DEL       000177   126E   1480
A.ESC       000033   125E   2281    2290    2292    2298    2300   2465
A.LF        000012   123E    699     699     779    1429    2015   2075   2147   2281   2282   2282   2467
                    2467
A.STX       000002   120E    920    1134
A.SYN       000026   119E    915    1132
ABUSS       040024   713     928    1801    2083    2117   2530L
AC.DLY      000110   244E
ALARM       002136   629     988E   1063
ALARMB      002167   989    1014L
ALEDS       040013  2518L
BLKSIZ      002000   154E
BOOT        004256   690    1760L
BR19.2      004077  1625L
BR38.4      004101  1626L
BR56.0      004103  1627L
BR96        004075  1624L
BRTAB       004075  1579    1622E   1630
CB.CLI      000100   132E    188     391    624    1729
CB.MTL      000040   131E    490     543    624     817
CB.SPK      000200   133E    391     624    994
CB.SSI      000020   130E    391     490    624     802    813   1737
CLK4        000270   550     574E
CLOCK       000201   327     328     532L
CRC         002347  1198L   1261
CRC1        002356  1202L   1222
CRC2        003004  1213    1220L
CRCSUM      040027   923     965    1031    1140    1201   1223  2532L
CTC         002172   885    1030L
CTLFLG      040011   343     536     541    546     625    801    804    815    999   1637   2099   2513L
CUI1        000165   505L    562     575
DLEDS       040021  2526L
DLY         000053   381L
DM.MR       000000   137E
DM.MW       000001   138E
DM.RR       000002   139E
DM.RW       000003   140E
DOD         003122  1334L
DS.HOLE     000001  2216E   2241    2247
DSPMOD      040007  2508L
DSPROT      040006  2507L
DUMP        002002   913L
DY10.5      007265  1544    2424L
DY3.3       007153  2341    2345L
DY3.5       007163  2349    2353L
DY3.7       007173  2357    2361L
DY5.53      007251  2403    2407L
DY9.3       003315   597    1506L
DY9.4       003326  1511    1515L
DY9.5       003335  1519    1523L
DY9.8       003350  1528    1532L
DYASC       003143  1363E   1397    1410    1420    1546   2405   2453
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DYASC1  003144  1366L  1368
DYBYT   003160  1383L  1513  1521  1538  2351  2359  2417
DYBYT.2 003202  1395   1399L
DYBYT.4 003221  1408   1412L
DYBYT.6 003235  1418   1422E
DYME5.5 007242  2399E  2408
DYMEM   007116  1613   2319L 2491
DYMEM1  007122  2324L
DYMEM10 003360  1536   1540L 2435
DYMEM11 007272  2426L  2427  2430  2433
DYMEM2  007127  2326L  2332
DYMEM3  007140  2329   2335L
DYMEM4  007207   588   2370  2374L
DYMEM5  007212  2375L  2387  2391
DYMEM6  000273   582L  2415
DYMEM7  000276   583L   586
DYMEM9  000307   592L  2377  2382
DYMSG   007306   599   1530  2343  2372  2447L 2457
DYMSG.5 007316  2451   2455L
EDYMEM  007375  2491L
ERROR   000322   438    568   618E  1082  1481
ESPEED  007372  2485L
FPLEDS  040013  2517E
GO      001222   781   791L
GO.     000063   391L  791   1775
GO88    001146   675   766L
GO88.1  001177   769   778L
H88.CTL 000362   102E  1573  1744  2320
H88.SW  000362   106E  1580  1611
H88B.CK 000002   103E
H88B.SS 000001   104E
H88S.BR 000300   107E  1581
H88S.M  000040   108E  1612
HORN    002140   993L  2111
HRN0    002143   383   996L
HRN2    002160  1007L  1008
HRNX    006045  1010   2099L
INIT    000073   314   316   413L  417
INIT0   000000   312L
INIT0.0 000003   313L  1618
INITOX  004000   312   1572L
INITOX1 004050  1603L  1604  1607
INIT1   000107   426L   431
INIT2   000117   433L
INT1    000010   321E
INT2    000020   337E
INT3    000030   356L
INT4    000040   363L
INT5    000050   370L
INT6    000060   388L
INT7    000070   397L
INTXIT  000172   514L   544   806
IOA     003062   756    777   1293L 1800  1805  1839
IOA1    005176  1293   1936L
IOA2    005204  1940L  1958  1967
IOA3    005242  1942   1945  1960L
IOA4    005260  1961   1971L
IOB     003066  1308L
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IOB1     003070   1309L   1316    1345    1352
IOB1.5   003126   1327    1342L
IOB2     003135   1314    1349L
IOC      005301   1848    1883    1996L
IOWRK    040002   1837    2225    2263    2265    2502L
IP.DS    000177   2212E   2240    2246
IP.PAD   000360     96E   1065    1098
IP.TPC   000371    112E   1100
IP.TPD   000370    114E   1176
IROC     005150    745     749     768    1795    1834    1910L   1922
IROC1    005166   1915    1920L
LOA0     001272    846L    893
LOA1     001342    872L    883
LOAD     001267    844E
LRA      003047   1276L
LRA.     003052    555     739     773     863     940    1277L   1764    1807
MI.ANI   000346    170E   1055
MI.EXAF  000010    177E   1365    1371
MI.HLT   000166    165E    561
MI.IN    000333    167E   1709    1718
MI.JIXA  000335    178E   1424    2460
MI.JIXB  000351    179E   1424    2460
MI.JIYA  000375    180E   1374
MI.JIYB  000351    181E   1374
MI.JMP   000303    172E
MI.LDA   000072    169E
MI.LDXA  000335    173E    596    1510    1518    1527    1535    2340    2348    2356    2369    2414
MI.LDXB  000041    174E    596    1510    1518    1527    1535    2340    2348    2356    2369    2414
MI.LDYA  000375    175E   1394    1407    1417    1543    2402    2450
MI.LDYB  000041    176E   1394    1407    1417    1543    2402    2450
MI.LXID  000021    171E
MI.OUT   000323    168E   1706    1725
MI.RET   000311    166E   1564
MSG.BT   006234   1760    2189L
MSG.DMP  006174   1793    2171L
MSG.EQ   007362   1524    2474L
MSG.ERR  001047    593     699L
MSG.GO   006165    766    2159L
MSG.HSS  007100   2268    2298L
MSG.LD   006170    720    2165L
MSG.PAS  003237   1429L   2366
MSG.PC   006214    736    2183L
MSG.PR   006112    642    2147L
MSG.RAM  007324   2337    2465L
MSG.SP   006122   1772    2153L
MSG.SPD  006371   2222    2281L
MSG.SUB  006201   1832    2177L
MSG.WRK  007062   2262    2290L
MTR      000344    636E    818
MTR.2    000357    645L    660
MTR.3    000371    649L    656
MTR.4    001014    650     662L
MTR1     000345    639E    640
MTRA     001025    647     672E    692
MTRAL    000006    648     692E
NMI      004116    483    1678L
NMI0.5   004160   1696    1699    1704L
NMI1     004202   1691    1716L
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NMI1.5   004217   1719    1725L
NMI2     004224   1728L
NMI2.5   004251   1702    1707    1710    1726    1746L
NMI3     004252   1714    1723    1748L
NMIENT   000146    483L
NMIRET   040064   1679    1686    2549L
NOISE    008053   1014    2109L
ONDRO    000022   2220E   2226
OP.CTL   000360     97E    537     803     814
OP.DC    000177   2211E   2227
OP.DIG   000360     98E
OP.SEG   000361     99E
OP.TPC   000371    113E    444     914     978     1081    1172    1258
OP.TPD   000370    115E    1260
PCA      001103    687     736L
PCA1     001137    746     754L
PRSL     000007    313     2515E
PRSRAM   040004    313     2503E   2515
PRSROM   003371   1557E    1617
RCC      003262    645     1309    1472E   1910    1940    1996    2070
RCC1     003262   1474L    1476
RCCA     040026   2531L
RCK      003260   1451E
REFIND   040012   2514L
REGI     040005   1276    2506L
REGPTR   040035    494     627     1279    2536L
RMEM     001261    723     826L
RNB      002331    872     1130    1156    1171L
RNB1     002335   1173L    1175
RNP      002325    858     868     1030    1141    1156L
ROMDD    030000     26E    1765
RT.BD    000005    149E
RT.BP    000002    146E
RT.CT    000003    147E
RT.MI    000001    145E     845     924
RT.NB    000004    148E
RT.PD    000006    150E
SAE      001063    713L
SAVALL   000132    325      341     460L
SAVALLR  000151    485      487E    1639
SAVALLX  004105    475     1634E
SC.ACE   000350    243E    1366    1372    1474    1478    1495    1500    1578    1590    1593    1595    1597
SC.UART  000372    203E
SINCR    004000    419E     421     422
SPEED    006240   2222L    2485
SPEED1   006257   2228L    2272
SPEED2   006275   2236     2239L
SPEED3   006300   2240L    2242    2253
SPEED4   006307   2246L    2248
SPEED5   006357   2266     2269L
SRMEM    001067    678      720L
SRS      002265    846     1126E
SRS1     002265   1127L    1135    1139
SRS2     002271   1130L    1133
SST1     001235    392      804L
SSTEP    001225    799E
START    040000    422      870     926     1798    2324    2374    2501L
STPRTN   001244    344      812E
```

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CROSS REFERENCE TABLE PAGE 51

SUBM	004370	684	1832L										
SUBM1	005013	1842L	1855	1862									
SUBM2	005027	1848L	1869										
SUBM3	005042	1854L	1887										
SUBM4	005046	1852	1857L										
SUBM5	005053	1860L	1890										
SUBM6	005062	1858	1864L										
SUBM7	005075	1849	1871L										
SUBM8	005077	1873L	1884										
SUBM9	005115	1883L	1897										
SWMEM	004313	681	1793L										
SWMEM2	004337	1801L											
SWMEM4	004351	1796	1806L										
TD.IN	000370	158E											
TD.OUT	000370	159E											
TER1	002220	1063L	1070										
TER3	002215	1056L	1067										
TFT	002133	892	977L	1051									
TICCNT	040033	532	534	1003	1068	2228	2257	2534L					
TOA	005313	748	1812	1842	2013L								
TOA.	005325	2018L	2271										
TOB	005343	1844	2019	2021	2036L	2089	2091	2121					
TOB1	005353	2043L	2051										
TPABT	002244	826	908	1080L									
TPDSP	006024	877	955	2083L									
TPERMSG	006063	1050	2117L										
TPERR	002205	857	1049L										
TPERRX	040031	827	909	1102	2533L								
TPXIT	002252	1064	1098L	1173	1254								
TS.IN	000371	160E											
TS.OUT	000371	161E											
TYPMSG	006100	643	721	737	767	1761	1773	1794	1833	2134L	2140	2223	2269
UC.2SB	000004	269E											
UC.5BW	000000	265E											
UC.6BW	000001	266E											
UC.7BW	000002	267E											
UC.8BW	000003	268E	1594										
UC.BI	000020	288E											
UC.CTS	000020	297E											
UC.DCS	000001	293E											
UC.DDR	000002	294E											
UC.DLA	000200	274E	1577										
UC.DR	000001	284E	1475										
UC.DRL	000010	296E											
UC.DSR	000040	298E											
UC.DTR	000001	277E											
UC.EDA	000001	255E											
UC.EPS	000020	271E											
UC.FE	000010	287E											
UC.IID	000006	262E											
UC.IIP	000001	261E											
UC.LOO	000020	281E											
UC.MSI	000010	258E											
UC.OR	000002	285E											
UC.OU1	000004	279E											
UC.OU2	000010	280E											
UC.PE	000004	286E											
UC.PEN	000010	270E											

```
UC.RI    000100   299E
UC.RLS   000200   300E
UC.RSI   000004   257E
UC.RTS   000002   278E
UC.SB    000100   273E
UC.SKP   000040   272E
UC.TER   000004   295E
UC.THE   000040   289E  1367  1496
UC.TRE   000002   256E
UC.TSE   000100   290E
UCI.ER   000020   225E  1171  1257
UCI.IE   000002   227E
UCI.IR   000100   223E
UCI.RE   000004   226E  1171
UCI.RO   000040   224E  1171
UCI.TE   000001   228E   913  1257
UDR      000000   200E
UIVEC    040037   356   363   370   388   397   508   819  2538L
UMI.16X  000002   218E   443
UMI.1B   000100   208E   443
UMI.1X   000001   217E
UMI.2B   000300   210E
UMI.64X  000003   219E
UMI.HB   000200   209E
UMI.L5   000000   213E
UMI.L6   000004   214E
UMI.L7   000010   215E
UMI.L8   000014   216E   443
UMI.PA   000020   212E
UMI.PE   000040   211E
UO.CLK   000001   190E   506
UO.DDU   000002   189E   621
UO.HLT   000200   187E   548
UO.NFR   000100   188E   621
UR.DLL   000000   250E  1593
UR.DLM   000001   252E  1590
UR.IER   000001   254E  1597
UR.IIR   000002   260E
UR.LCR   000003   264E  1578  1595
UR.LSR   000005   283E  1366  1474  1495
UR.MCR   000004   276E
UR.MSR   000006   292E
UR.RBR   000000   246E  1478
UR.THR   000000   248E  1372  1500
USR      000001   201E
USR.FE   000040   232E
USR.OE   000020   233E
USR.PE   000010   234E
USR.RXR  000002   236E  1174
USR.TXE  000004   235E
USR.TXR  000001   237E  1255
WCC      003302   565   567   659   662   778   780  1320  1494L 1846  1860  1868  1873
                  1896  1921  1947  1964  1971  2014  2016  2024  2048  2055  2074  2076  2086
                  2110  2119  2138
WCC1     003303  1495L 1497
WCR      006003   722  1762  2070L 2072
WME1     002012   917L  919
WME2     002104   950L  961
```

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CROSS REFERENCE TABLE PAGE 53

WMEM	001374	907E	1813					
WNB	003024	917	921	951	1239	1253L		
WNB1	003025	1254L	1256					
WNP	003017	925	936	945	948	966	967	1238L

24284 BYTES FREE

APPENDIX B

MTR-88 DEMO

The sample program that follows shows some of the advanced features that are available to you with MTR-88. The program is not designed to be efficient or particularly useful by itself. It uses the H88 clock, console terminal, and interrupt capability to create an accurate interval timer that will time up to 377(octal) seconds. When the interval ends, the H88 audio alarm is sounded.

Use the H88 keyboard and the "Substitute" command to enter the machine code and start the program. You will also use the keyboard to enter the octal time.

The demo uses the MTR-88 firmware (program in a ROM) for most of the working routines, and you should look up the details of these routines (in Appendix A). The listing of the demo was prepared using the text editor and assembler that are available for the H88. However, the program should be loaded by hand using the "Substitute" command.

THE SAMPLE PROGRAM

This program initially blanks the screen and then waits for you to enter an octal value. The MTR-88 routine WCC is used to send characters to the screen, and IOB is used to Input an Octal Byte.

The most subtle part of the program is the interrupt processing. First, a jump to the interrupt processor is planted in UIVEC to allow processing of the clock interrupts. Then .MFLAG is set so MTR-88 will pass interrupts to the program. Finally, interrupts are enabled.

The main part of the program is a "do-nothing" loop that waits for the time to count down to zero. When the time is exhausted, the program restores the original state of .MFLAG and stops.

The interrupt processor keeps its own local TICCNT and counts it down from 500. When this count reaches zero, one second has elapsed and the new reduced time is displayed on the screen using TOB (Type Octal Byte). The local TICCNT is reset to 500. When the time is exhausted, the main program stops clock processing, so the processor is not called again.

```
                        ***  ************************************************
                        *
                        *       DEMO: MTR-88
                        *
                        *       SYSTEM DEFINITIONS
                        *
002.136                 ALARM   EQU     2136A   MAKE NOISE
003.302                 WCC     EQU     3302A   WRITE CHAR TO CONSOLE
040.010                 .MFLAG  EQU     40010A  USER FLAG OPTIONS
040.037                 UIVEC   EQU     40037A  USER INTERRUPT VECTOR
000.001                 UO.CLK  EQU     1A      ALLOW CLOCK INTERRUPT PROCESSING
000.303                 MI.JMP  EQU     303A    MACHINE INSTRUCTION JUMP
003.066                 IOB     EQU     3066A   INPUT OCTAL BYTE
005.343                 TOB     EQU     5343A   TYPE OCTAL BYTE

000.033                 ESC     EQU     33A
000.015                 CR      EQU     15A
000.012                 LF      EQU     12A

040.100                         ORG     40100A

                        ***  ************************************************
                        *
                        *       ERASE SCREEN
                        *
040.100  076 033        MTR88   MVI     A,ESC           ESCAPE SEQUENCE TO
040.102  315 301 003            CALL    WCC
040.105  076 105                MVI     A,'E'                   ERASE SCREEN
040.107  315 301 003            CALL    WCC

                        ***  ************************************************
                        *
                        *       READ A OCTAL INTEGER FROM KEYBOARD
                        *         STORE THE NUMBER.
                        *
040.112  041 234 040            LXI     H,NUMBER        SET ADDRESS OF NUMBER
040.115  247                    ANA     A               CLEAR CARRY (SIDE EFFECT)
040.116  315 066 003            CALL    IOB             INPUT OCTAL BYTE
040.121  315 223 040            CALL    SETICK          SETUP TICK TO 500 FOR ONE SEC

                        ***  ************************************************
                        *
                        *       INITIALIZE SERVICE INTERRUPT ROUTINE
                        *          LOAD THE USER INTERRUPT VECTOR (UIVEC) WITH A
                        *          JUMP INSTRUCTION AND THE ADDRESS OF THE SERVICE
                        *          ROUTINE.  ENABLE USER CLOCK INTERRUPT!
                        *
040.124  076 303                MVI     A,MI.JMP        SET-UP JUMP INSTRUCTION
040.126  062 037 040            STA     UIVEC           STORE 'JMP' INSTRUCTION
040.131  041 165 040            LXI     H,INTRP             USER INTERRUPT ADDRESS
040.134  042 040 040            SHLD    UIVEC+1                 POSITIONED
040.137  076 001                MVI     A,UO.CLK
040.141  062 010 040            STA     .MFLAG          ENABLE CLOCK INTERRUPT
```

```
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                        ***  ****************************************************************
                        *
                        *       WAIT FOR CLOCK TO REACH ZERO
                        *
040.144  072 234 040 LOOP    LDA     NUMBER          DO NOTHING LOOP.
040.147  376 000             CPI     0                 WAIT FOR END
040.151  302 144 040         JNZ     LOOP              OF COUNT DOWN.

                        ***  ****************************************************************
                        *
                        *       RETURN TO NORMAL INTERRUPT STATUS & HALT
                        *          DISABLE INTERRUPT & TURN ON SPEAKER
                        *
040.154  076 000             MVI     A,0
040.156  062 010 040         STA     .MFLAG          DISABLE CLOCK INTERRUPT
040.161  315 136 002         CALL    ALARM
040.164  166                 HLT

                        ***  ****************************************************************
                        *
                        *       INTERRUPT ROUTINE
                        *          CLOCK AND DISPLAY INTERRUPT
                        *
040.165  052 232 040 INTRP   LHLD    TICK            GET COUNT (BETWEEN 0 & 500)
040.170  053                 DCX     H               TICK=TICK-1
040.171  042 232 040         SHLD    TICK            STORE COUNT
040.174  175                 MOV     A,L             TEST FOR ZERO
040.175  264                 ORA     H                  COMPARE WITH 'H'
040.176  300                 RNE                        EXIT IF .NE. 0

                        ***  ****************************************************************
                        *
                        *       UPDATE DISPLAY FOR 'NEW' NUMBER.
                        *
040.177  076 015             MVI     A,CR            DO CARRIAGE RETURN
040.201  315 302 003         CALL    WCC
040.204  076 012             MVI     A,LF               AND LINE FEED
040.206  315 302 003         CALL    WCC
040.211  072 234 040         LDA     NUMBER          GET NUMBER
040.214  075                 DCR     A               NUMBER=NUMBER-1
040.215  062 234 040         STA     NUMBER          SAVE NUMBER
040.220  315 343 005         CALL    TOB             TYPE OCTAL BYTE
040.223  041 364 001 SETICK  LXI     H,500           RESTORE COUNT
040.226  042 232 040         SHLD    TICK              WITH 500
040.231  311                 RET
                        *               STORAGE AREA & END ASSEMBLY
040.232                 TICK    DS      2
040.234                 NUMBER  DS      1
040.235  000                    END     MTR88

>
```

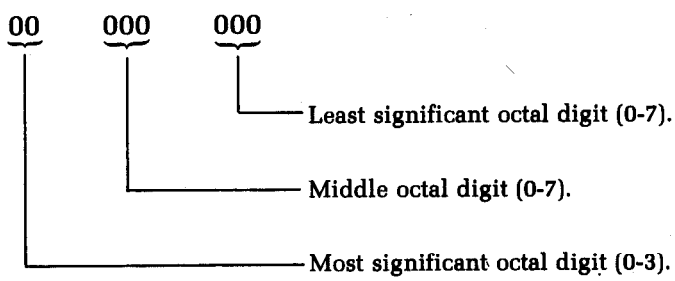
APPENDIX C

OCTAL DEFINITIONS

Binary numbers are converted to octal format for display. The following table shows binary to octal conversion.

BINARY NUMBER	OCTAL DIGIT
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

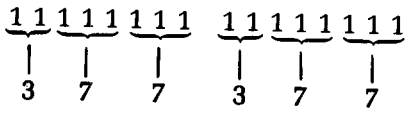
Each byte is displayed as two-and-one-half octal digits. The octal numbers lie in the range of 000 to 377 for binary numbers in the range 00000000 to 11111111, as shown below.



NOTE: As there are only eight bits in a byte, the most significant octal digit only represents two bits and is therefore displayed as 0 to 3. If the user should inadvertently enter the octal digits 4 to 7 into the most significant digit, the most significant bit is lost. Losing this bit converts 4 through 7 into the digits 0 through 3 respectively.

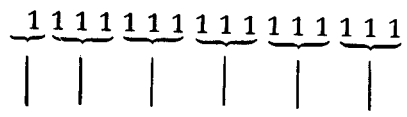
Also note that 16-bit numbers, such as memory addresses and certain register contents, are still displayed as two eight-bit numbers. Therefore, the representation of 16-bit numbers is made up of **two** groups of three octal numbers in the range of 000 to 377. This representation of 16-bit binary numbers is known as offset octal or **split-octal**, and is used consistantly for displays of 16-bit numbers.

Split-octal must not be confused with octal. For example:



A 16-bit binary number

Split-octal representation (377 377)



A 16-bit binary number

True Octal representation (177777)

The lower example shows true octal representation of a 16-bit binary number. True octal representation is never used in standard Heath software. Occasionally you will see split-octal numbers printed with a decimal point separating the upper and lower bytes. For example:

377.377

Hi Byte Lo Byte

Note that 001.000 follows 000.377.