SOFTWARE REFERENCE MANUAL

H8 COMPUTER

FRONT PANEL MONITOR PAM-8

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INTRODUCTION

This Manual describes the functions and operations of the Heath H8 Panel Monitor Program, PAM-8, which resides permanently in a ROM on the H8 CPU board. PAM-8 provides a sophisticated front panel display and keyboard emulation as well as handling master clear and interrupt operations. Some of the major features of PAM-8 are:

- Memory contents display and alteration.
- Register contents display and alteration.
- Program execution control (both breakpoint and single instruction operation).
- Self-contained bootstraps for program loading and dumping.
- Port input and output routines.

In addition to the above features, PAM-8 can be instructed (by means of a flag byte contained in H8 RAM) to bypass some or all of its normal functions so the sophisticated user can augment or totally replace them.

Communication with the Panel Monitor is accomplished through three devices: the keypad, the 7-segment displays, and the audio alert. The user enters commands and values through the 16-key keypad, and PAM-8 responds visually through the front panel displays. In addition to the front panel displays, PAM-8 provides the keypad entry and function feedback to the built-in speaker. Appropriate signals (short, medium, and long beeps) indicate that commands and data are accepted or rejected.

THEORY OF OPERATION

This section will supplement the information contained in the "Operation" and "Circuit Description" sections of your H8 Operation Manual. In order to fully understand how PAM-8 operates, you must be familiar with the H8 front panel and CPU. A thorough knowledge of the 8080 instruction set and its architecture is also essential.

Power Up and Master Clear

PAM-8 initializes the H8 whenever you power-up or master clear (RST). You initiate the power-up operation by turning on the rear panel Power switch. You can master clear by simultaneously depressing both the lower right-hand (RSTØ) and lower left-hand (Ø) keys of the H8 front panel keypad. Both power-up and RST cause a level zero (highest priority) interrupt and result in a long beep from the audio alert.

During initialization, PAM-8 enters a routine which determines the high limit of continuous RAM. Once the high limit of available RAM is determined, the H8 stack pointer (SP) is set to this value and control is passed to the front panel command loop. Using this feature, you can immediately determine the total amount of continuous memory above 8K by displaying stack pointer value.

Clock Interrupts

The Clock Interrupt is a crucial element in the operation of the H8 front panel system. This level one interrupt is generated by the front panel hardware every 2,000 μS. PAM-8 uses this interrupt to check for some keyboard commands, to check for user program breakpoints, and to refresh the front panel displays.

PAM-8 performs these functions using a series of subroutines which are executed as necessary when indicated by the interrupts. For this reason, all user programs must maintain a valid stack (at high memory) containing at least 80 free bytes at all times. If this stack space is not available and PAM-8 is running (it can be disabled; see the Advanced Control Section), unpredictable software damage can occur in your program. In the same manner, if your program should execute a DI (Disable Interrupt) instruction, no front panel services including the RTM (Return To Monitor) function are available until an EI (Enable Interrupt) instruction is executed or until a master clear (RST/Ø) is performed.

PAM-8 Modes/Using RST and RTM

PAM-8 is always in either the monitor mode or the user mode. In the monitor mode no user program is executing, PAM-8 loops reading the keypad and refreshing the displays. All commands entered via the keypad are valid; however, the RTM command is meaningless.

When your program is being executed, PAM-8 is in the user mode and the MON LED on the front panel is extinguished. Only two keyboard commands are valid in this mode: RST (master clear) and RTM (Return To Monitor). NOTE: Both of these commands are dual key commands. No single key command is recognized, so a user program may have free use of the entire keypad.

You can return PAM-8 to the monitor mode by using the RTM command (simultaneously press the Ø and the # keys). This command stops program execution at the end of the current instruction, stores the current value of each register, and returns PAM-8 to the monitor mode. You can then continue your program by pressing the GO key. The RST command (simultaneously press the 0 and the / keys) performs the master clear operation described earlier and does not save any register values.

Normally, when a user program is running, PAM-8 is also running. Thus, if PAM-8 is displaying the contents of the HL register pair and the user program is started, it continues to display the contents of this register pair as the program is run. If the user program changes the contents of the HL pair, the change is immediately reflected in the front panel displays. In a similar manner, if a memory location is displayed when a user program is started, it is displayed during the time the user program is run. If the user program changes the contents of the displayed memory location, the front panel display changes.

Since PAM-8 does not recognize keypad commands in the user mode, the RTM command must be used before the memory location or register being displayed is changed to a new location or a different register. Once you select the new location or different register, you can resume program execution by pressing GO.

NOTE: PAM-8 requires about 10% of the H8 CPU's resources to process the display interrupts. Programs which are compute-bound may be slowed down by simultaneous operation of PAM-8. In this situation, you may wish to turn off the clock interrupts to improve execution time. See "Using Interrupts" on Page 1-24.

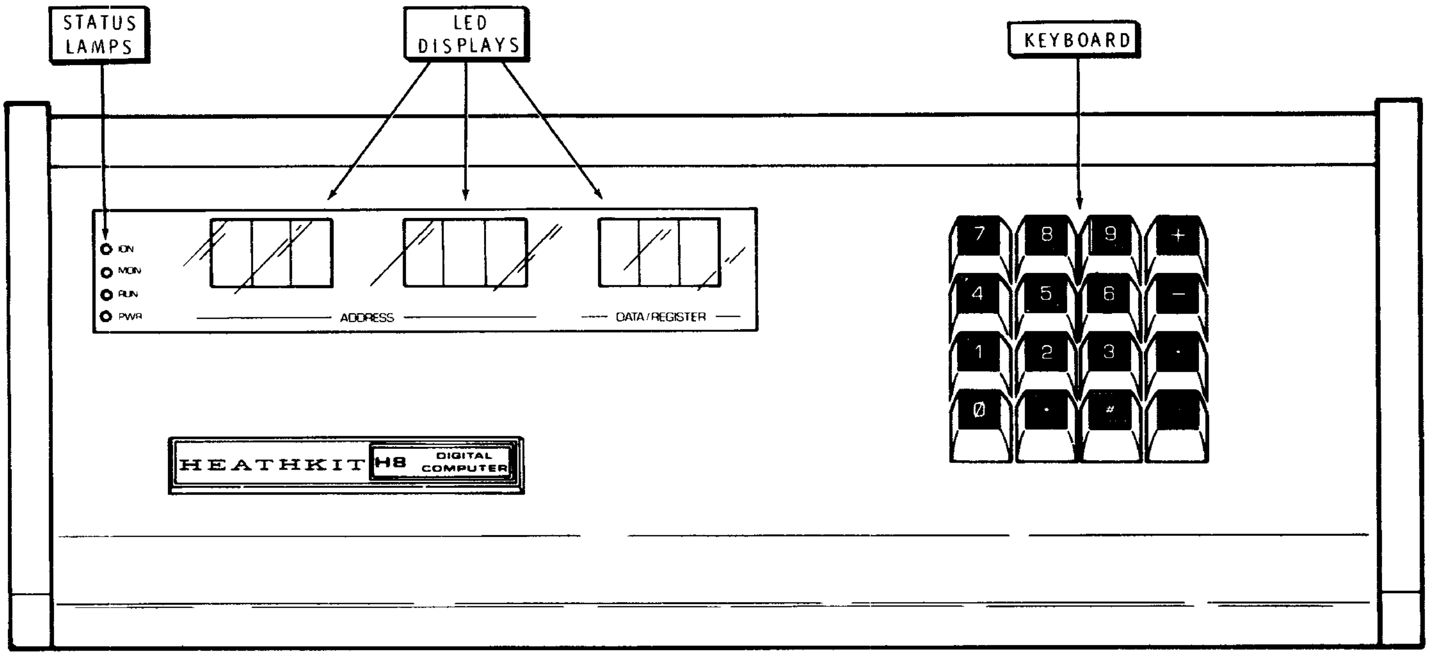

Figure 1-1

H8 Displays

You must understand the H8 front panel presentation in order to use PAM-8. The display is made up of 9 digits, in three groups of three digits each. See Figure 1-1. Each group of three digits displays one byte (eight bits) of information. This information may be the contents of a designated register or memory location, or it may be the address of a memory location itself. The register names are also displayed.

All binary numbers are converted to octal format for display on the H8 front panel. The following table shows binary to octal conversion.

BINARY NUMBER	OCTAL NUMBER
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.

```
00   000   000
|     |     |
|     |     └── Least significant octal digit (0-7),
|     └──────── Middle octal digit (0-7).
└────────────── Most significant octal digit (0-3).
```

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 H8 front panel representation of the number 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**, and is used consistantly throughout all H8 displays of 16-bit numbers. Offset octal must not be confused with octal. For example:

```
11 111 111  11 111 111    A 16-bit binary number
 |  |   |    |  |   |
 3  7   7    3  7   7     Offset octal representation (377   377)

 1 111 111 111 111 111    A 16-bit binary number
 |  |   |   |   |   |
 1  7   7   7   7   7     True Octal representation (177777)
```

The lower example shows true octal representation of a 16-bit binary number. This is **not** used by the H8 front panel displays or any H8 software. Occasionally you will see offset octal numbers printed with a decimal point separating the upper and lower bytes. For example:

```
      377.377

Hi Byte     Lo Byte
```

H8 Keypad

The H8 Keypad consists of 16 keys, as shown in Figure 1-1. When the keypad is operating under the control of PAM-8, it exhibits a number of unique properties.

- Each keystroke is verified by a short beep from the audio alert.
- Octal digits are entered using the keys 0 through 7.
- Holding a key down continuously repeats the key's function.
- The + key increments memory port or register locations.
- The – key decrements memory port or register locations.
- The ☆ key cancels previous keypad entries.
- The ALTER key causes PAM-8 to enter the alter mode.
- The MEM key causes PAM-8 to enter the display memory mode.
- The REG key causes PAM-8 to enter the register mode.

Many of the keys on the keypad have multiple functions, depending on the PAM-8 mode being used. In the register mode, for example, the numeric keys (1-6) call the register indicated in the upper left-hand corner of the key. When the PAM-8 is in neither the register nor the memory mode, the keys perform the functions indicated in the lower right-hand corner of the key.

The # and / keys have additional special functions, as indicated earlier. When the / key is pressed simultaneously with the 0 key, the RST (master clear) sequence is initiated. When the # sign key is depressed simultaneously with the 0 key, the RTM (Return To Monitor) function is initiated, the user program is stopped, and PAM-8 regains control.

Each key is covered in greater detail as the various function are discussed.

DISPLAYING AND ALTERING MEMORY LOCATIONS

One of the major features of PAM-8 is its ability to examine the contents of any H8 memory location and to modify the contents of that memory location if it is RAM.

When the H8 is first powered up, PAM-8 is in the display memory mode. This mode is indicated by all digits displaying octal numbers and no decimal points being on.

Specifying a Memory Address

If you wish to display or alter the contents of a memory location. You must first place PAM-8 in the memory address mode and then enter the desired memory address. Place PAM-8 in the memory address mode (if not already there) by pressing the MEM (Memory) key. Specify the address to be displayed or altered by entering the 6-digit address (offset octal).

When you press the MEM key, all the decimal points will light. This indicates that the address may now be entered. Once the full 6-digit address is entered, the decimal points turn off, indicating that address entry is completed. After all 6 digits are entered, the address is displayed in the left-most six displays, and the contents of the addressed memory location are displayed in the right-hand 3 digits.

NOTE: As you press each key, including the MEM key, a short beep indicates successful entry. As each group of three octal digits is successfully entered, a medium beep is sounded. The sequence by which you specify a memory address is shown in Figure 1-2.

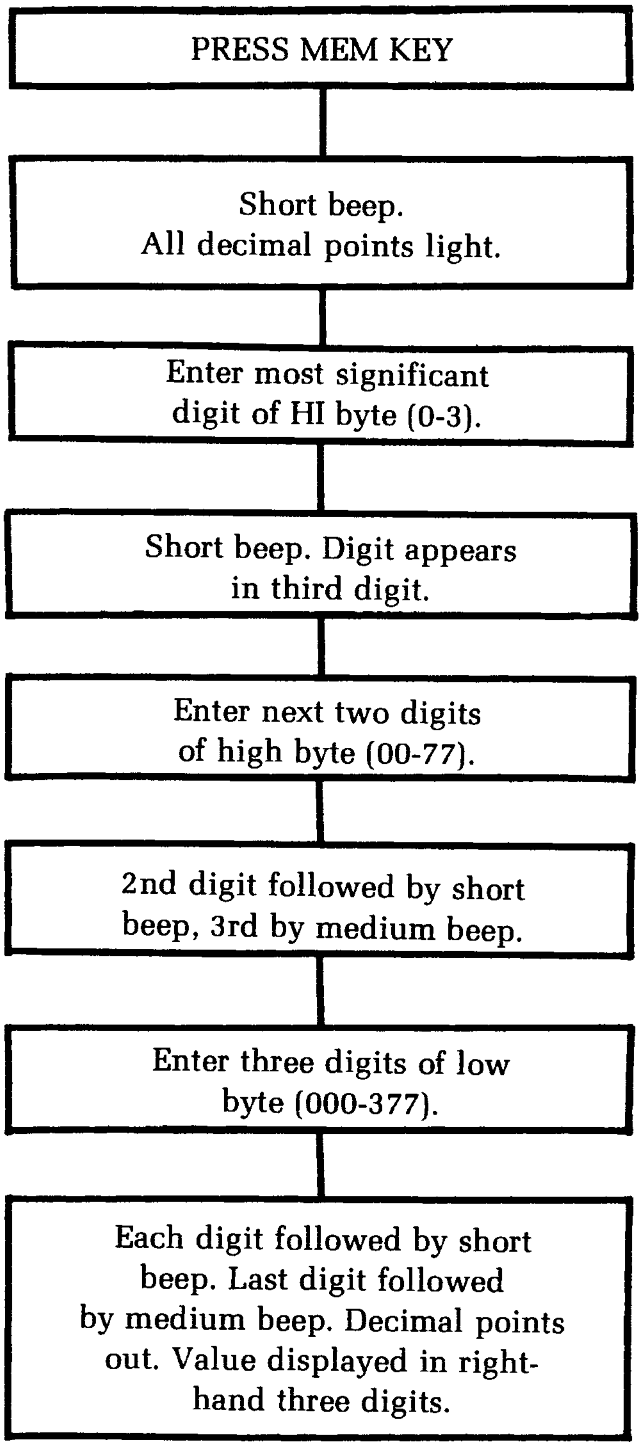

Figure 1-2
Entering a memory address through PAM-8.

NOTE: If you press a non-octal digit key as one of the six address digits, an error is flagged (a long beep). Once this error is flagged, the PAM-8 considers the address complete and extinguishes the decimal points. The entire sequence must be repeated.

Altering a Memory Location

Before you can alter a memory location, you must first display the contents of the memory location by specifying the memory address as described in the preceding paragraphs. After you specify the memory address, press the ALTER key. This will cause PAM-8 to enter the memory alter mode.

When PAM-8 enters the memory alter mode, a single decimal point rotates from right to left through all 9 digits. You can now alter the contents of the displayed location by entering the new octal value (three digits on the keypad). When the three digits have been entered, acoustical verification (a short beep) is given **and the memory address is incremented.** You can then alter this new location by entering three more digits or pressing one of the following keys, causing the monitor to perform the indicated function:

KEY	FUNCTION
+	Increment the address.
–	Decrement the address.
MEM	Specify a new memory address (leave memory alter mode).
REG	Specify a register for display (leave memory alter mode).
ALTER	Exit from the alter mode (into the display mode).

NOTE: PAM-8 automatically increments the memory address as each entry (3 octal digits) is complete. Therefore, you may load a program in sequential locations very rapidly. Each location is modified by simply entering the three octal digits.

The following example reviews each step as the H8 is turned on; the memory address mode is entered; and the location 040 123 is addressed, altered to 345, checked, and closed.

DISPLAY			COMMENTS
X X X	X X X	X X X	Random memory display at power up (X=random number.)
X.X.X.	X.X.X.	X.X.X.	MEM key pressed. (In memory address mode, a short beep.)
X.X.0.	X.X.X.	X.X.X.	0 key pressed. (Short beep.)
X.0.4.	X.X.X.	X.X.X.	4 key pressed. (Short beep.)
0.4.0.	X.X.X.	X.X.X.	0 key pressed. (Medium beep.) Contents of location 040 XXX displayed.)
0.4.0.	X.X.1.	X.X.X.	1 key pressed. (Short beep. Contents of 040 XX1 displayed.)
0.4.0.	X.1.2.	X.X.X.	2 key pressed. (Short beep. Contents of 040 X12 displayed.)
0 4 0	1 2 3	X X X	3 key pressed. (Medium beep. Contents of desired location 040 123 displayed, decimal points out.)
0.4.0	1.2.3	X.X.X	ALTER key pressed. (Short beep. Decimal points **rotate**.)
0.4.0.	1.2.3.	X.X.3.	3 key pressed. (Short beep. Decimal points **rotate**.)
0.4.0.	1.2.3.	X.3.4.	4 key pressed. (Short beep. Decimal points **rotate**.)
0.4.0.	1.2.4.	X.X.X.	5 key pressed. (Medium beep. Address increments one location. Decimal points **rotate**.)
0.4.0	1.2.3	3.4.5	−key pressed. (Short beep. Address decrements one location. Decimal points **rotate**.)
0 4 0	1 2 3	3 4 5	ALTER key pressed. (Short beep. Decimal points go out.)

Stepping Through Memory

When PAM-8 is either in the display memory or alter memory modes, the +and −keys increment and decrement the memory address. Each time you press the key, PAM-8 increments (or decrements) the memory address one location. If you hold the key down, the auto-repeat function of PAM-8 causes the memory address to increment or decrement repeatedly (approximately one location every second).

DISPLAYING AND ALTERING REGISTERS

PAM-8 can display and alter the contents of the 8080 CPU registers, just as it displays and alters the contents of H8 memory locations. Although the process is quite similar, a few special features should be noted.

Specifying a Register for Display

Press the REG key to specify that a register is to be displayed. After you press the REG key, press a second key (SP through PC, see the Table below) to specify the desired register or register pair.

When the REG key is pressed, six decimal points light, indicating that you must now select a register. NOTE: Simply pressing the REG key causes a register name to appear in the right-hand digits. However, you must select a register using the Register Select key before a register is definitely selected and its true contents are displayed. Once a register is selected, the decimal points are extinguished.

The contents of the selected register pair are displayed in the six left-most displays. The register name (or names) are displayed in the two right-most digits of the right-hand three displays. The registers are selected and displayed in accordance with the following table:

KEY	LEFT 3 DIGITS	MIDDLE 3 DIGITS	RIGHT PAIR	COMMENTS
SP (1)	000 to 377	000 to 377	SP	Stack pointer
AF (2)	000 to 377	000 to 377	AF	AF Register pair
BC (3)	000 to 377	000 to 377	bC	BC Register pair
DE (4)	000 to 377	000 to 377	dE	DE Register pair
HL (5)	000 to 377	000 to 377	HL	HL Register pair
PC (6)	000 to 377	000 to 377	Pc	Program counter

NOTE: The contents of any single eight-bit register may lie in the range of 000 to 377 octal. The stack pointer (SP) and the program counter (PC) are 16-bit registers and are displayed as two sets of three octal numbers. Each 3-digit grouping corresponds to one byte (8 bit number). When a register pair is displayed, the left three digits correspond to the left register and the middle three digits correspond to the right register. For example:

256 312 AF

Register A contains 256 and F contains 312.

Altering the Contents of a Selected Register

To alter the contents of a register (or register pair), you must first specify it as described in the preceding paragraphs. After you select the register or register pair, press the ALTER key. This will cause the six left-hand decimal points to rotate right to left, indicating that you may enter 6 digits to alter the contents of the indicated register or register pair.

Alternatively, you may press one of the following command keys:

KEY	FUNCTION
+	Changes the register pair being displayed.
–	Changes the register pair being displayed.
MEM	Specify a new memory address (leave the alter register mode).
REG	Specify a new register for display (leave alter register mode).
ALTER	Exit the register alter mode.

NOTE: Stack pointer register (SP) is not a direct display of the real stack pointer register, but simply a copy of the real stack pointer register and is used for display purposes only. The stack pointer cannot be altered from the front panel. To alter the stack pointer register, an SPHL (SPHL = 371) instruction must be written into memory. The desired new stack pointer value is then placed in the HL register pair. PAM-8's single instruction mode is used to execute the SPHL swap instructions, loading the stack pointer with the contents loaded in the HL register pair.

Stepping Through the Registers

Use + and – keys to change the register pair being displayed. For example, if the DE register pair is being displayed, press the + key causes the next sequential register pair to be displayed (the HL pair). In the same manner, pressing the – key causes the register to decrement to the preceding pair. For example, if the DE pair is being displayed, pressing the – key displays the BC register pair. NOTE: Holding down either the + key or the – key causes the display to continuously increment or decrement through all the six registers/register pairs.

PROGRAM EXECUTION CONTROL

PAM-8 supports three basic program execution control facilities:

- Beginning or starting execution.
- Breakpointing.
- Single instruction.

Each of these execution controls permits the programmer to execute the desired portions of a program and examine its effects. He may execute the entire program, or a small group of instructions, or a single program instruction.

Initiating Program Execution

To begin the execution of a program residing in H8 memory, place the address of the first instruction to be executed in the PC (program counter). Use the methods described in "Displaying and Altering Registers" (Page 1-14). Once the address of this first instruction is placed in the program counter, press the GO key and program execution will begin. NOTE: Unless the program disables the front panel, the display continues to be actively updated, although the front panel commands are no longer active (except for RST and RTM). If the program counter is displayed when you press the GO key, PAM-8 continuously monitors the program counter.

Breakpointing

Breakpointing permits the programmer to execute small portions of a program and then return to PAM-8. Breakpointing is especially useful when a program is being "debugged." Small portions of the program may be executed and their results observed. If there is an error, it may be corrected before an entire program is involved.

When the H8 executes a program and encounters a halt instruction, it re-enters PAM-8 and sounds the alarm. All of the registers are preserved and the program counter points to the address **following** the address of the halt instruction. Thus, you can breakpoint a program from the front panel by inserting halt instructions (HLT = 166) at the desired points throughout the program. When a particular section of the program is tested and the breakpoint feature is no longer required, you can change the halt to a NOP (NOP = 000). Once the halts are changed to NOPs, execution of the NOP simply passes control to the next successive instruction. Program execution for breakpointing uses the GO key as described above.

NOTE: If you temporarily replace an existing instruction with a halt, you must restore the instruction before resuming program execution. The contents of the program counter point to the address **following** the halt. Therefore, if the instruction which replaced the halt is to be executed, when the program continues, the contents of the program counter must be decremented one location before execution is resumed.

Single Instruction Operation

Any user program may be operated in the single instruction mode. This procedure is identical to the GO command, except that the SI key is pressed rather than the GO key. When the SI key is pressed, a single **instruction** (not a single machine cycle) is executed and then control is returned to PAM-8. Single instruction operation is available for careful inspection of program results and for executing special programs, such as swapping the HL register pair with the stack pointer as discussed in "Altering the Contents of a Selected Register" (Page 1-15).

Interrupting a Program During Execution

You can interrupt a running program (with all registers preserved at the point of interruption) by pressing RTM & 0. You can then examine and/or alter the contents of various memory locations and all the registers as required. Resume execution of the program at the next sequential instruction by simply pressing the GO key. NOTE: Although all registers and memory locations are preserved when RTM & 0 are pressed, it is very difficult to stop a program at an exact location. Therefore, use the breakpoint feature if you want to stop the program at an exact location.

LOAD/DUMP ROUTINES

PAM-8 contains a routine that lets you load and dump memory contents from or to a tape. This feature is especially important, as most computers require one or two successive "boot strap" routines to be hand-loaded before a desired program can be loaded into the main memory. All these "boot strap" routines are contained within the PAM-8 ROM, and use sophisticated error checking techniques. Thus, a program can be loaded or dumped by simply pressing a single key.

Loading From Tape

To load from a tape, ready the reader device with the tape to be loaded prior to executing the load command. Place PAM-8 in the display memory mode and press the LOAD key. Once the LOAD key is pressed, PAM-8 starts the tape transport and scans the tape for the first file record.

No change will be seen on the front panel displays until PAM-8 finds the first file. When the first file record is located, PAM-8 checks it to see if it is the first (or only) record in a sequence, and the record is a memory dump record. If it is not a memory dump record, a number two error is flagged (see "Tape Errors" on Page 1-20).

Once a correct record is found, loading proceeds. The loading procedure places the entry point address of the program being loaded in the H8 program counter. The H8 memory is then loaded. The displays continuously show the address being loaded and the data being loaded at these addresses. When the load is complete, PAM-8 sounds a long beep and displays the final memory address. If the load is faulty, a number one error is displayed and the audio alert continuously beeps. (See "Tape Errors," Page 1-20.)

NOTE: You may abort a partial load by using the CANCEL key. Naturally, the load image resulting from this action is incorrect, and should not be executed.

Dumping to Tape

Before dumping a memory image onto tape, the following three dump parameters are required:

- The entry point address (the program starting address).
- The dump starting address.
- The dump ending address.

Set the desired entry point address by placing this value in the program counter (PC). This value will be placed in the program counter whenever you load the program so execution will begin at this address when you press the GO key.

Place the dump starting address into the first two H8 RAM cells. These are: 040 000 (offset octal) and 040 001 (offset octal). NOTE: The low order byte of the address should be placed into location 040 000 and the high order byte of the starting address should be placed into location 040 001.

Enter the dump ending address as a memory address using the # (MEM) key. Then ready the tape transport and press the DUMP key. As the tape dump takes place, the number of bytes left to be dumped and the contents of the memory location being dumped are displayed on the front panel. You can abort a dump by using the CANCEL key. If the CANCEL key is used, an incomplete dump image is left on the tape. This cannot be loaded at a future date. NOTE: A successful load automatically sets up the following three dump parameters:

A. The program starting locations are stored in locations 040 000 and 040 001.
B. The program ending location is displayed.
C. The program counter contains the program entry point.

Figure 1-3A shows the steps of a typical dump sequence and Figure 1-3B shows the steps of a typical load sequence.

1. Set PC to 040 100; (040 100 = entry address).
2. Set 040 000 to 100 (100 = low byte of dump start).
3. Set 040 001 to 040 (040 = high byte of dump start).
4. Enter memory address 052 340 (052 340 = end address of dump).
5. Be sure tape is ready.
6. Press DUMP.

Figure 1-3A
The H8 memory image dump.

1. Be sure tape is ready.
2. Press LOAD.

Figure 1-3B
The H8 memory image load.

Copying a Tape

The beginning and final address of the load image are placed at the appropriate points. Thus, to copy a tape, simply load the tape as described in "Loading From Tape" (Page 1-18). Then ready the dump tape drive and press the DUMP key. A dump then takes place, including entry point, initial address, and final address.

In a similar manner, to load, alter, and then dump, enter only the ending address. The other paramters are unchanged from the load if locations 040 000, 040 001 or the program counter have not been modified during the altering procedure.

Tape Errors

PAM-8 detects two types of tape errors: record errors and checksum errors. In either case, when an error is detected, the tape transport is halted. The error number is then displayed in the center three digits (001 for a checksum error, 002 for a record error) and the alarm is repeatedly sounded. To halt the alarm and return to the command mode, press the CANCEL key.

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 load image. Therefore missing the initialization information at the start of the file.
- A tape error which causes a portion of the load image to be missed so the next record read is not in the proper sequence.

CHECKSUM ERRORS

A checksum error is flagged when the CRC (Cyclical Redundancy Check) checksum following a record does not match the CRC calculated by PAM-8. This error means that the record is either incorrectly recorded or the load is faulty. In either case, the load should be attempted again. If successive loads result in repeated failures, the original tape must be suspected as faulty.

I/O FACILITIES

PAM-8 supports two commands that allow you to perform input and output functions on H8 I/O ports. These front panel instructions permit simple manipulation of the H8 I/O ports without your having to write extensive routines to perform these functions.

Inputting From a Port

To input from a port, press the # key. Then enter three zero digits and the three-digit address (octal) of the desired port. NOTE: The front panel should now display 000 AAA, where AAA is the port address and 000 is meaningless. Press the IN key to read the port, the value is displayed in the three left-most digits of the front panel display.

Outputting to a Port

To output to a specified port, press the # key. Then enter the value to be supplied to the port in the three left-most displays. The port address is entered into the middle three displays. The display is of the form VVV AAA, where V stands for value, and A for address. Pressing the OUT key causes the value to be outputted to the indicated port.

Addressing Port Pairs

Frequently, ports are assigned in pairs, where one of the two port addresses is the control and status register and the other port is the data port. Address port pairs by using the + and − key to change ports. Once the initial port has been defined, the + key increments the port address to a new higher numbered port, and the − key is used to decrement to a lower numbered port.

ADVANCED CONTROL

One of the advanced features of PAM-8 is its provisions allowing sophisticated users to augment or replace PAM-8's functions. Augmenting or replacing PAM-8 functions is usually done in conjunction with assembly language programs. Sometimes it is possible to implement these features by using the POKE and PEEK commands in BASIC. The sample exercise in "Appendix B" (Page 1-64) uses several PAM-8 functions, including the clock, I/O, and the audio alarm.

The following discussion refers to symbols and locations defined in the PAM-8 program listing, given in its complete form as "Appendix A." It is recommended that you review the PAM-8 listing in order to become familiar with its various features. This can be done in conjunction with reading the following section, or independently. In either case, a first overview followed by a detailed analysis of the listing is probably necessary for a complete understanding.

16-Bit Tick Counter (TICCNT)

PAM-8 maintains a 16-bit (2 byte) tick counter known as TICCNT. The value of this counter is incremented each time a clock interrupt is processed. As an interrupt occurs once every 2 mS, the counter is incremented once every 2 mS. As long as clock interrupts are not disabled, this value can be used by any program to compute elapsed time. The tick counter may be set to any desired value, but it should not be frequently reset, as this interferes with the front panel refresh cycle. The contents of the tick counter are contained in memory locations 040 033 (the least significant byte) and 040 034 (the most significant byte).

Using the Keypad

When your program is running, PAM-8 does not recognize any single key command. Thus, all single key patterns are available for your program. To read keypad patterns, you can use one of two routines. First, you may take an input from port IP. PAD; or second, your program may use PAM-8's RCK routine. The input port IP. PAD is permanently assigned to port location 360. Inputting a binary number from this port detects which of the 16 keys are depressed. These results are shown in the table on Page 1-57 of "Appendix A."

A far more sophisticated keypad routine is available to you in the RCK (read Console Keypad) routine. This is also described in "Appendix A" (see Page 1-57). RCK provides keypad decoding, keypad debounce routines, auto-repeat routines, and acoustical feedback.

NOTE: If you use two key combinations, each key must reside in a separate bank. The first bank includes keys 0-7 and the second bank includes keys 8-#. RCK cannot decode two key combinations.

Display Usage

When a user program is running, PAM-8 normally displays the contents of the selected register or memory location. However, you may disable this process and display any arbitrary segment pattern, or completely disable the display to provide greater computational through-put. The display usage is primarily controlled by setting various bits in the .MFLAG memory cell. This memory cell is found at location 040 010.

MANUAL UPDATING

By setting the UO.DDU (see "Appendix A," Page 1-25, for an explanation of the user option bits, UO.XXX) bit in the .MFLAG memory location, you can instruct PAM-8 to continue refreshing the front panel displays and to disable updating. When this is done, PAM-8 continues to refresh the LED's from a 9-byte block of RAM cells found at locations 040 013 through 040 023. A description of these front panel LED's (FPLEDS) is found in "Appendix A" (see Page 1-60). When the UO.DDU bit is set in .MFLAG, the contents of these bytes are not altered in any manner by PAM-8.

You can use this technique to display numbers, letters, or arbitrary bar patterns (see Page 1-58) on the front panel displays. For instance, your program may alter the display by inserting any value into FPLEDS. The front panel LED segments will display a decimal integer if you use the octal to 7-segment pattern (DODA) display.

MANUAL DISPLAY REFRESHING

By setting the UO.NFR (User Option.No Front Panel Refresh) bit in the .MFLAG memory cell, you can instruct PAM-8 to stop refreshing the front panel displays. Setting the UO.NFR bit does not disable the clock interrupts; therefore, the tick counter (TICCNT) is still incremented. But PAM-8 does not refresh the displays from the information contained in the FPLEDS bytes.

NOTE: If you desire, you may write a program to refresh the front panel LED displays. Usually this is done using the clock interrupts. If you undertake an independent front panel refresh program, take extreme care to avoid burning the displays due to excessive refreshing. **The total power dissipated in the LEDs is determined by the refresh cycle, and too frequent refreshing will result in excessive display heating.**

Using Interrupts

All H-8 interrupts cause control to be transferred into the low 64 bytes of memory. PAM-8 occupies this memory space so all interrupts are first processed by PAM-8. Except for level zero interrupts, which are used as master clears, you can supply an interrupt processing routine for each of the seven additional interrupts. The following sections explain the use of each of these interrupts.

I/O INTERRUPTS

Interrupts numbered 3 through 7 are I/O interrupts. PAM-8 does not process these interrupts in any way. When a level 3 through level 7 interrupt is received, PAM-8 immediately transfers to the user interrupt vectors contained in memory locations 040 037 through 040 064. These locations are listed in "Appendix A" (see Page 1-60). Each location must contain a jump instruction pointing to the appropriate program location which processes these interrupts.

NOTE: If any of these interrupts occur, you must supply a processing routine for them. This routine must be complete including both entry and exit processing. When you use H8 interrupts, you must use only the available vector which is 6 to insure compatability with future H8 products. You may also use 2 if you will not be using BUG-8.

CLOCK INTERRUPTS

The level one interrupts are generated by the front panel hardware every 2 mS. PAM-8 normally processes these interrupts. However, by setting a processing vector in UIVEC and setting the UO.INT bit in the MFLAG cell, PAM-8 enters the users routine each time a clock interrupt is generated. "Appendix A" (see Page 1-31) gives the required entry and exit conditions for processing clock interrupts.

SINGLE INSTRUCTION AND BREAKPOINT INTERRUPTS

Level two interrupts are generated by the single instruction hardware contained on the CPU card. When a single instruction is requested, the result of the interrupt is processed by PAM-8. If the single instruction interrupt was generated by PAM-8 in response to a Monitor Mode Single Instruction register condition, PAM-8 processes it. Otherwise, PAM-8 jumps to the user level two interrupt vector (UIVEC). Since the level two interrupt does not affect PAM-8, a level two restart instruction can be used as a breakpoint instruction by the user programs.

APPENDIX A

Panel Monitor Listing

This appendix contains a complete listing of the PAM-8 front panel monitor program. PAM-8 resides in the low 1,024 bytes of the H8 computer. It provides all the control for front panel operation, and cassette or paper tape load and dump facilities. It also provides for master clear and front panel interrupt processing. PAM-8 presumes RAM cells are available for its use in locations 040 000 through 040 077 and 80 bytes are available in high memory for a stack. The use of these RAM cells is described on Page 1-60 of this Appendix and in the memory map on Page 0-36.

Pages 1-61, 1-62, and 1-63 of this Appendix are a symbolic reference table. Use this table to find the program locations where each symbolic address is used. Symbolic addresses are listed in alphabetical sequence.

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.1  06/21/77
 INTRODUCTION.                                                15:43:50  01-APR-77  PAGE     1

***     PAM/8 - H8 FRONT PANEL MONITOR.
*
*       JGL, 05/01/76.
*
*       FOR *WINTEK* INC.
*
*       COPYRIGHT  05/1976, WINTEK CORPORATION,
*                               902 N. 9TH ST.
*                               LAFAYETTE, IND.


***     PAM/8 - H8 FRONT PANEL MONITOR.
*
*       THIS PROGRAM RESIDES (IN ROM) IN THE LOW 1024 BYTES OF THE HEATH
*       H8 COMPUTER. IT ACTUALLY CONSISTS OF TWO VIRTUALLY INDEPENDENT
*       ROUTINES: A TASK-TIME PROGRAM WHICH PROVIDES SOPHISTICATED
*       FRONT PANEL MONITOR SERVICE, AND AN INTERRUPT-TIME PROGRAM WHICH
*       PROVIDES BOTH A REAL-TIME CLOCK AND EMULATES AN EFFECTIVE
*       HARDWARE FRONT PANEL.


***     INTERRUPTS.
*
*       PAM/8 IS THE PRIMARY PROCESSOR FOR ALL INTERRUPTS.
*       THEY ARE PROCESSED AS FOLLOWS:
*
*       RST     USE
*
*       0       MASTER CLEAR. (NEVER USED FOR I/O OR RST)
*
*       1       CLOCK INTERRUPT. NORMALLY TAKEN BY PAM/8,
*               SETTING BIT *UO.CLK* IN BYTE *.MFLAG* ALLOWS
*               USER PROCESSING (VIA A JUMP THROUGH *UIVEC*).
*               UPON ENTRY OF THE USER ROUTINE, THE STACK
*               CONTAINS:
*               (STACK+0)  = RETURN ADDRESS (TO PAM/8)
*               (STACK+2)  = (STACKPTR+14)
*               (STACK+4)  = (AF)
*               (STACK+6)  = (BC)
*               (STACK+8)  = (DE)
*               (STACK+10) = (HL)
*               (STACK+12) = (PC)
*               THE USER'S ROUTINE SHOULD RETURN TO PAM/8 VIA
*               A *RET* WITHOUT ENABLING INTERRUPTS.
*
*       2       SINGLE STEP. SINGLE STEP INTERRUPTS GENERATED
*               BY PAM/8 ARE PROCESSED BY PAM/8.
*               ANY SINGLE STEP INTERRUPT 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)
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.1  06/21/77
  INTRODUCTION.                                             15:43:51  01-APR-77  PAGE     2

*                    (STACK+6)  = (DE)
*                    (STACK+8)  = (HL)
*                    (STACK+10) = (PC)
*                    THE USER'S ROUTINE SHOULD HANDLE ITS OWN RETURN
*                    FROM THE INTERRUPT.
*
*
*           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.
*
*           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
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                     HEATH X8ASM V1.1  06/21/77
ASSEMBLY CONSTANTS.                                              15:43:52  01-APR-77  PAGE     3

                         77  **     ASSEMBLY CONSTANTS

                         79  **     I/O PORTS
                         80
     000.360             81  IP.PAD  EQU     360Q              PAD INPUT PORT
     000.360             82  OP.CTL  EQU     360Q              CONTROL OUTPUT PORT
     000.360             83  OP.DIG  EQU     360Q              DIGIT SELECT OUTPUT PORT
     000.361             84  OP.SEG  EQU     361Q              SEGMENT SELECT OUTPUT PORT
     000.371             85  IP.TPC  EQU     371Q              TAPE CONTROL IN
     000.371             86  OP.TPC  EQU     371Q              TAPE CONTROL OUT
     000.370             87  IP.TPD  EQU     370Q              TAPE DATA IN
     000.370             88  OP.TPD  EQU     370Q              TAPE DATA OUT

                         90  **     ASCII CHARACTERS.
                         91
     000.026             92  A.SYN   EQU     026Q              SYNC CHARACTER
     000.002             93  A.STX   EQU     002Q              STX CHARACTER

                         95  **     FRONT PANEL HARDWARE CONTROL BITS.
                         96
     000.020             97  CB.SSI  EQU     00010000B         SINGLE STEP INTERRUPT
     000.040             98  CB.MTL  EQU     00100000B         MONITOR LIGHT
     000.100             99  CB.CLI  EQU     01000000B         CLOCK INTERRUPT ENABLE
     000.200            100  CB.SPK  EQU     10000000B         SPEAKER ENABLE

                        102  **     DISPLAY MODE FLAGS (IN *DSPMOD*)
                        103
     000.000            104  DM.MR   EQU     0                 MEMORY READ
     000.001            105  DM.MW   EQU     1                 MEMORY WRITE
     000.002            106  DM.RR   EQU     2                 REGISTER READ
     000.003            107  DM.RW   EQU     3                 REGISTER WRITE
     000.000            108          XTEXT   TAPE              TAPE DEFINITIONS

                        110X **     TAPE EQUIVALENCES.
                        111X
     000.001            112X RT.MI   EQU     1                 RECORD TYPE - MEMORY DUMP IMAGE
     000.002            113X RT.BP   EQU     2                 RECORD TYPE - BASIC PROGRAM
     000.003            114X RT.CT   EQU     3                 RECORD TYPE - COMPRESSED TEXT
                        115X
                        116X **     BLOCK SIZE FOR INTER-PRODUCT COMMUNICATION.
                        117X
     002.000            118X BLKSIZ  EQU     512
                        119X
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                    HEATH X8ASM V1.1  06/21/77
ASSEMBLY CONSTANTS.                                            15:43:56  01-APR-77  PAGE     4

                      **       MACHINE INSTRUCTIONS.

      000.166         MI.HLT   EQU      01110110B        HALT
      000.311         MI.RET   EQU      11001001B        RETURN
      000.333         MI.IN    EQU      11011011B        INPUT
      000.323         MI.OUT   EQU      11010011B        OUTPUT
      000.072         MI.LDA   EQU      00111010B        LDA
      000.346         MI.ANI   EQU      11100110B        ANI
      000.021         MI.LXID  EQU      00010001B        LXI D

                      **       USER OPTION BITS.
                      *
                      *        THESE BITS ARE SET IN CELL .MFLAG.

      000.200         UO.HLT   EQU      10000000B        DISABLE HALT PROCESSING
      000.100         UO.NFR   EQU      CB.CLI           NO REFRESH OF FRONT PANEL
      000.002         UO.DDU   EQU      00000010B        DISABLE DISPLAY UPDATE
      000.001         UO.CLK   EQU      00000001B        ALLOW CLOCK INTERRUPT PROCESSING

      000.000                  XTEXT    U8251            DEFINE 8251 USART BITS
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.0  02/18/77
8251 USART BIT DEFINITIONS.                                13:23:23  01-APR-77  PAGE     5

                         143X **       8251 USART BIT DEFINITIONS.
                         144X *
                         145X
                         146X **       MODE INSTRUCTION CONTROL BITS.
                         147X
     000.100             148X UMI.1B   EQU      01000000B        1 STOP BIT
     000.200             149X UMI.HB   EQU      10000000B        1 1/2 STOP BITS
     000.300             150X UMI.2B   EQU      11000000B        2 STOP BITS
     000.040             151X UMI.PE   EQU      00100000B        EVEN PARITY
     000.020             152X UMI.PA   EQU      00010000B        USE PARITY
     000.000             153X UMI.L5   EQU      00000000B        5 BIT CHARACTERS
     000.004             154X UMI.L6   EQU      00000100B        6 BIT CHARACTERS
     000.010             155X UMI.L7   EQU      00001000B        7 BIT CHARACTERS
     000.014             156X UMI.L8   EQU      00001100B        8 BIT CHARACTERS
     000.001             157X UMI.1X   EQU      00000001B        CLOCK X 1
     000.002             158X UMI.16X  EQU      00000010B        CLOCK X 16
     000.003             159X UMI.64X  EQU      00000011B        CLOCK X 64
                         160X
                         161X **       COMMAND INSTRUCTION BITS.
                         162X
     000.100             163X UCI.IR   EQU      01000000B        INTERNAL RESET
     000.040             164X UCI.RO   EQU      00100000B        READER-ON CONTROL FLAG
     000.020             165X UCI.ER   EQU      00010000B        ERROR RESET
     000.004             166X UCI.RE   EQU      00000100B        RECEIVE ENABLE
     000.002             167X UCI.IE   EQU      00000010B        ENABLE INTERRUPTS FLAG
     000.001             168X UCI.TE   EQU      00000001B        TRANSMIT ENABLE
                         169X
                         170X **       STATUS READ COMMAND BITS.
                         171X
     000.040             172X USR.FE   EQU      00100000B        FRAMING ERROR
     000.020             173X USR.OE   EQU      00010000B        OVERRUN ERROR
     000.010             174X USR.PE   EQU      00001000B        PARITY ERROR
     000.004             175X USR.TXE  EQU      00000100B        TRANSMITTER EMPTY
     000.002             176X USR.RXR  EQU      00000010B        RECEIVER READY
     000.001             177X USR.TXR  EQU      00000001B        TRANSMITTER READY
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                     HEATH X8ASM V1.0  02/18/77
HARDWARE INTERRUPT VECTORS                                      13:23:25  01-APR-77  PAGE     6

                         ***     INTERRUPT VECTORS.
                         *

                         **      LEVEL 0 - RESET
                         *
                         *       THIS 'INTERRUPT' MAY NOT BE PROCESSED BY A USER PROGRAM.

000.000                          ORG     00A

000.000  021 371 003     INIT0   LXI     D,PRSROM          (DE) = ROM COPY OF PRS CODE
000.003  041 012 040             LXI     H,PRSRAM+PRSL-1   (HL) = RAM DESTINATION FOR CODE
000.006  303 073 000             JMP     INIT              INITIALIZE
377.073                          ERRPL   INIT-1000A        BYTE IN WORD 10A MUST BE 0

                         **      LEVEL 1 - CLOCK

000.010                  INT1    EQU     10Q               INTERRUPT ENTRY POINT

000.000                          ERRNZ   *-11Q             INT0 TAKES UP ONE BYTE
000.011  315 132 000             CALL    SAVALL            SAVE USER REGISTERS
000.014  026 000                 MVI     D,0
000.016  303 201 000             JMP     CLOCK             PROCESS CLOCK INTERRUPT
377.201                          ERRPL   CLOCK-1000A       EXTRA BYTE MUST BE 0

                         **      LEVEL 2 - SINGLE STEP
                         *
                         *       IF THIS INTERRUPT IS RECEIVED WHEN NOT IN MONITOR MODE,
                         *       THEN IT IS ASSUMED TO BE GENERATED BY A USER PROGRAM
                         *       (SINGLE STEPPING OR BREAKPOINTING). IN SUCH CASE, THE
                         *       USER PROGRAM IS ENTERED THROUGH (UIVEC+3

000.020                  INT2    EQU     20A               LEVEL 2 ENTRY

000.000                          ERRNZ   *-21A             INT1 TAKES EXTRA BYTE
000.021  315 132 000             CALL    SAVALL            SAVE REGISTERS
000.024  032                     LDAX    D                 (A) = (CTLFLG)
040.011                  .       SET     CTLFLG
000.025  303 244 001             JMP     STPRTN            STEP RETURN

                         ***     I/O INTERRUPT VECTORS.
                         *
                         *       INTERRUPTS 3 THROUGH 7 ARE AVAILABLE FOR GENERAL I/O USE.
                         *
                         *       THESE INTERRUPTS ARE NOT SUPPORTED BY PAM/8, AND SHOULD
                         *       NEVER OCCUR UNLESS THE USER HAS SUPPLIED HANDLER ROUTINES
                         *       (THROUGH UIVEC)
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                     HEATH XBASM V1.0  02/18/77
HARDWARE INTERRUPT VECTORS                                       13:23:26  01-APR-77  PAGE     7

000.030                228          ORG     30A
000.030  303 045 040   229  INT3    JMP     UIVEC+6            JUMP TO USER ROUTINE
                       230
000.033  064 064 064   231          DB      '44413'            HEATH PART NUMBER 444-13

000.040                233          ORG     40A
000.040  303 050 040   234  INT4    JMP     UIVEC+9            JUMP TO USER ROUTINE
                       235
000.043  100 112 107   236          DB      100Q,112Q,107Q,114Q,100Q     SUPPORT CODE

000.050                238          ORG     50A
000.050  303 053 040   239  INT5    JMP     UIVEC+12           JUMP TO USER ROUTINE
                       240
                       241
                       242  **      DLY - DELAY TIME INTERVAL.
                       243  *
                       244  *       ENTRY   (A) = MILLISECOND DELAY COUNT/2
                       245  *       EXIT    NONE
                       246  *       USES    A,F
                       247
000.053  365           248  DLY     PUSH    PSW                SAVE COUNT
000.054  257           249          XRA     A                  DONT SOUND HORN
000.055  303 143 002   250          JMP     HRNO               PROCESS AS HORN

000.060                252          ORG     60A
000.060  303 056 040   253  INT6    JMP     UIVEC+15           JUMP TO USER ROUTINE
                       254
                       255
000.063  076 320       256  GO.     MVI     A,CB.SSI+CB.CLI+CB.SPK  OFF MONITOR MODE LIGHT
000.065  303 235 001   257          JMP     SST1               RETURN TO USER PROGRAM

000.070                259          ORG     70A
000.070  303 061 040   260  INT7    JMP     UIVEC+18           JUMP TO USER ROUTINE
```

```
FAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                   HEATH X8ASM V1.0  02/18/77
MASTER CLEAR PROCESSING                                        13:23:28  01-APR-77  PAGE      8

                           263  **      INIT - INITIALIZE SYSTEM
                           264  *
                           265  *       INIT IS CALLED WHENEVER A HARDWARE MASTER-CLEAR IS INITIATED.
                           266  *
                           267  *       SETUP FAM/8 CONTROL CELLS IN RAM.
                           268  *       DECODE HOW MUCH MEMORY EXISTS, SETUP STACKPOINTER, AND
                           269  *       ENTER THE MONITOR LOOP.
                           270  *
                           271  *       ENTRY   FROM MASTER CLEAR
                           272  *       EXIT    INTO FAM/8 MAIN LOOP
                           273
                           274
000.073  032               275  INIT    LDAX    D                COPY *PRSROM* INTO RAM
000.074  167               276          MOV     M,A              MOVE BYTE
000.075  053               277          DCX     H                DECREMENT DESTINATION
000.076  034               278          INR     E                INCREMENT SOURCE
000.077  302 073 000       279          JNZ     INIT             IF NOT DONE
                           280
004.000                    281  SINCR   EQU     4000A            SEARCH INCREMENT
                           282
000.102  026 004           283          MVI     D,SINCR/256      (DE) = SEARCH INCREMENT
000.104  041 000 034       284          LXI     H,START-SINCR    (HL) = FIRST RAM - SEARCH INCREMENT
                           285
                           286  *       DETERMINE MEMORY LIMIT.
                           287
000.107  167               288  INIT1   MOV     M,A              RESTORE VALUE READ
000.110  031               289          DAD     D                INCREMENT TRIAL ADDRESS
000.111  176               290          MOV     A,M              (A) = CURRENT MEMORY VALUE
000.112  065               291          DCR     M                TRY TO CHANGE IT
000.113  276               292          CMP     M
000.114  302 107 000       293          JNE     INIT1            IF MEMORY CHANGED
                           294
000.117  053               295  INIT2   DCX     H
000.120  371               296          SPHL                     SET STACKPOINTER = MEMORY LIMIT -1
000.121  345               297          PUSH    H                SET *PC* VALUE ON STACK
000.122  041 322 000       298          LXI     H,ERROR
000.125  345               299          PUSH    H                SET 'RETURN ADDRESS'
                           300
                           301  *       CONFIGURE LOAD/DUMP UART
                           302
000.126  076 116           303          MVI     A,UMI.1B+UMI.L8+UMI.16X
000.130  323 371           304          OUT     OP.TPC           SET 8 BIT, NO PARITY, 1 STOP, X16
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                 HEATH X8ASM V1.0  02/18/77
INTERRUPT TIME SUBROUTINES                                  13:23:29  01-APR-77  PAGE     9

                    **      SAVALL - SAVE ALL REGISTERS ON STACK.
                    *
                    *       SAVALL IS CALLED WHEN AN INTERRUPT IS ACCEPTED, IN ORDER TO
                    *       SAVE THE CONTENTS OF THE REGISTERS ON THE STACK.
                    *
                    *       ENTRY   CALLED DIRECTLY FROM INTERRUPT ROUTINE.
                    *       EXIT    ALL REGISTERS PUSHED ON STACK.
                    *               IF NOT YET IN MONITOR MODE, REGPTR = ADDRESS OF REGISTERS
                    *               ON STACK.
                    *               (DE) = ADDRESS OF CTLFLG


000.132  343        SAVALL  XTHL                        SET H,L ON STACK TOP
000.133  325                PUSH    D
000.134  305                PUSH    B
000.135  365                PUSH    PSW
000.136  353                XCHG                        (D,E) = RETURN ADDRESS
000.137  041 012 000        LXI     H,10
000.142  071                DAD     SP                  (H,L) = ADDRESS OF USERS SP
000.143  345                PUSH    H                   SET ON STACK AS 'REGISTER'
000.144  325                PUSH    D                   SET RETURN ADDRESS
000.145  021 011 040        LXI     D,CTLFLG
000.150  032                LDAX    D                   (A) = CTLFLG
000.151  057                CMA
000.152  346 060            ANI     CB.MTL+CB.SSI       SAVE REGISTER ADDR IF USER OR SINGLE-STEP
000.154  310                RZ                          RETURN IF WAS INTERRUPT OF MONITOR LOOP
000.155  041 002 000        LXI     H,2
000.160  071                DAD     SP                  (H,L) = ADDRESS OF 'STACKPTR' ON STACK
000.161  042 035 040        SHLD    REGPTR
000.164  311                RET


                    **      CUI - CHECK FOR USER INTERRUPT PROCESSING.
                    *
                    *       CUI IS CALLED TO SEE IF THE USER HAS SPECIFIED PROCESSING
                    *       FOR THE CLOCK INTERRUPT.


040.010             .       SET     .MFLAG              REFERENCE TO MFLAG
000.165  012        CUI1    LDAX    B                   (A) = .MFLAG
000.000                     ERRNZ   UO.CLK-1            CODE ASSUMED = 01
000.166  017                RRC
000.167  334 037 040        CC      UIVEC               IF SPECIFIED, TRANSFER TO USER

                    *       RETURN TO PROGRAM FROM INTERRUPT.

000.172  361        INTXIT  POP     PSW                 REMOVE FAKE 'STACK REGISTER'
000.173  361                POP     PSW
000.174  301                POP     B
000.175  321                POP     D
000.176  341                POP     H
000.177  373                EI
000.200  311                RET
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.0  02/18/77
PROCESS CLOCK INTERRUPTS                                   13:23:31  01-APR-77  PAGE    10

                         ***     CLOCK - PROCESS CLOCK INTERRUPT
                         *
                         *       CLOCK IS ENTERED WHENEVER A MILLISECOND CLOCK INTERRUPT IS
                         *       PROCESSED.
                         *
                         *       TICCNT IS INCREMENTED EVERY INTERRUPT.


000.201  052 033 040     CLOCK   LHLD    TICCNT
000.204  043                     INX     H
000.205  042 033 040             SHLD    TICCNT              INCREMENT TICCOUNT

                         **      REFRESH FRONT PANEL.
                         *
                         *       THIS CODE DISPLAYS THE APPROPRIATE PATTERN ON THE
                         *       FRONT PANEL LEDS. THE LEDS ARE PAINTED IN REVERSE ORDER,
                         *       ONE PER INTERRUPT. FIRST, NUMBER 9 IS LIT, THEN NUMBER 8,
                         *       ETC.


000.210  041 010 040             LXI     H,.MFLAG
000.213  176                     MOV     A,M
000.214  107                     MOV     B,A                 (B) = CURRENT FLAG
000.215  346 100                 ANI     UO.NFR              SEE IF FRONT PANEL REFRESH WANTED
000.217  043                     INX     H
000.000                          ERRNZ   CTLFLG-.MFLAG-1
000.220  176                     MOV     A,M                 (A) = CTLFLG
000.221  112                     MOV     C,D                 (C) = 0 IN CASE NO PANEL DISPLAY
000.222  302 237 000             JNZ     CLK3                IF NOT
000.225  043                     INX     H                   (H,L) = (REFIND)
000.000                          ERRNZ   REFIND-CTLFLG-1
000.226  065                     DCR     M                   DECREMENT DIGIT INDEX
000.227  302 234 000             JNZ     CLK2                IF NOT WRAP-AROUND
000.232  066 011                 MVI     M,9                 WRAP DISPLAY AROUND
000.234  136             CLK2    MOV     E,M
000.235  031                     DAD     D                   (H,L) = ADDRESS OF PATTERN
000.236  113                     MOV     C,E
000.237                  CLK3    EQU     *                   (A) = CTLNLG
000.237  261                     ORA     C                   (A) = INDEX + FIXED BITS
000.240  323 360                 OUT     OP.DIG              SELECT DIGIT
000.242  176                     MOV     A,M
000.243  323 361                 OUT     OP.SEG              SELECT SEGMENT

                         *       SEE IF TIME TO DECODE DISPLAY VALUES.

000.245  056 033                 MVI     L,#TICCNT
000.247  176                     MOV     A,M
000.250  346 037                 ANI     37Q                 EVERY 32 INTERRUPTS
000.252  314 161 003             CZ      UFD                 UPDATE FRONT PANEL DISPLAYS

                         *       EXIT CLOCK INTERRUPT.

000.255  001 011 040             LXI     B,CTLFLG
000.260  012                     LDAX    B                   (A) = CTLFLG
000.261  346 040                 ANI     CB.MTL
000.263  302 172 000             JNZ     INTXIT              IF IN MONITOR MODE
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.0  02/18/77
PROCESS CLOCK INTERRUPTS                                      13:23:34  01-APR-77  PAGE    11

000.266  013                    DCX     B
000.000                         ERRNZ   CTLFLG-.MFLAG-1
000.267  012                    LDAX    B                (A) = .MFLAG
000.000                         ERRNZ   UO.HLT-200Q      ASSUME HIGH-ORDER
000.270  027                    RAL
000.271  332 313 000            JC      CLK4             SKIP IT

                      *         NOT IN MONITOR MODE. CHECK FOR HALT

000.274  076 012                MVI     A,10             (A) = INDEX OF *P* REG
000.276  315 052 003            CALL    LRA.             LOCATE REGISTER ADDRESS
000.301  136                    MOV     E,M
000.302  043                    INX     H
000.303  126                    MOV     D,M              (D,E) = PC CONTENTS
000.304  033                    DCX     D
000.305  032                    LDAX    D
000.306  376 166                CPI     MI.HLT           CHECK FOR HALT
000.310  312 322 000            JE      ERROR            IF HALT, BE IN MONITOR MODE

                      *         CHECK FOR 'RETURN TO MONITOR' KEY ENTRY.

000.313               CLK4      EQU     *
000.313  333 360                IN      IP.PAD
000.315  376 056                CPI     56Q              SEE IF '0' AND '#'
000.317  302 165 000            JNE     CUI1             IF NOT, ALLOW USER PROCESSING OF CLOCK
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.1  06/21/77
MTR - MAIN EXECUTIVE LOOP.                                   15:44:09  01-APR-77  PAGE    12

                          445  ***    ERROR - COMMAND ERROR.
                          446  *
                          447  *      ERROR IS CALLED AS A 'BAIL-OUT' ROUTINE.
                          448  *
                          449  *      IT RESETS THE OPERATIONAL MODE, AND RESTORES THE STACKPOINTER.
                          450  *
                          451  *      ENTRY   NONE
                          452  *      EXIT    TO MTR LOOP
                          453  *              CTLFLG SET
                          454  *              .MFLAG CLEARED
                          455  *      USES    ALL
                          456
                          457
000.322                   458  ERROR  EQU     *
000.322  041 010 040      459         LXI     H,.MFLAG
000.325  176              460         MOV     A,M                  (A) = .MFLAG
000.326  346 275          461         ANI     377Q-UO.DDU-UO.NFR       RE-ENABLE DISPLAYS
000.330  167              462         MOV     M,A                  REPLACE
000.331  043              463         INX     H
000.332  066 360          464         MVI     M,CB.SSI+CB.MTL+CB.CLI+CB.SPK   RESTORE *CTLFLG*
000.000                   465         ERRNZ   CTLFLG-.MFLAG-1
000.334  373              466         EI
000.335  052 035 040      467         LHLD    REGPTR
000.340  371              468         SPHL                         RESTORE STACK POINTER TO EMPTY STATE
000.341  315 136 002      469         CALL    ALARM                ALARM FOR 200 MS


                          471  **     MTR - MONITOR LOOP.
                          472  *
                          473  *      THIS IS THE MAIN EXECUTIVE LOOP FOR THE FRONT PANEL EMULATOR.
                          474
                          475
000.344                   476  MTR    EQU     *
000.344  373              477         EI
                          478
000.345  041 345 000      479  MTR1   LXI     H,MTR1
000.350  345              480         PUSH    H                    SET 'MTR1' AS RETURN ADDRESS
000.351  001 007 040      481         LXI     B,DSPMOD             (BC) = #DSPMOD
000.354  012              482         LDAX    B
000.355  346 001          483         ANI     1                    (A) = 1 IF ALTER
000.357  057              484         CMA
000.360  062 006 040      485         STA     DSPROT               ROTATE LED PERIODS IF ALTER
                          486
                          487  *      READ KEY
                          488
000.363  315 260 003      489         CALL    RCK                  READ CONSOLE KEYPAD
000.366  052 024 040      490         LHLD    ABUSS
000.371  376 012          491         CPI     10
000.373  322 005 001      492         JNC     MTR4                 IF IN 'ALWAYS VALID' GROUP
000.376  137              493         MOV     E,A                  SAVE VALUE
040.007                   494  .      SET     DSPMOD
000.377  012              495         LDAX    B                    (A) = DSPMOD
001.000  017              496         RRC
001.001  332 051 001      497         JC      MTR5                 IF IN ALTER MODE
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                      HEATH X8ASM V1.0  02/18/77
MTR - MAIN EXECUTIVE LOOP.                                        13:23:37  01-APR-77  PAGE    13

001.004  173                  MOV     A,E             (A) = CODE

               *        HAVE A COMMAND (NOT A VALUE)

001.005  326 004       MTR4   SUI     4               (A) = COMMAND
001.007  332 322 000          JC      ERROR           IF BAD
001.012  137                  MOV     E,A
001.013  345                  PUSH    H               SAVE ABUSS VALUE
001.014  041 035 001          LXI     H,MTRA
001.017  026 000              MVI     D,0
001.021  031                  DAD     D               (H,L) = ADDRESS OF TABLE ENTRY
001.022  136                  MOV     E,M
001.023  031                  DAD     D               (H,L) = ADDRESS OF PROCESSOR
001.024  343                  XTHL                    SET ADDRESS, (H,L) = (ABUSS)
001.025  021 005 040          LXI     D,REGI          (D,E) = ADDRESS OF REG INDEX
040.007                       SET     DSPMOD
001.030  012                  LDAX    B               (A) = DSPMOD
001.031  346 002              ANI     2               SET 'Z' IF MEMORY
001.033  012                  LDAX    B               (A) = DSPMOD
001.034  311                  RET                     JUMP TO PROCESSOR


001.035                MTRA   EQU     *               JUMP TABLE
001.035  165                  DB      GO-*            4 - GO
001.036  141                  DB      IN-*            5 - INPUT
001.037  143                  DB      OUT-*           6 - OUTPUT
001.040  165                  DB      SSTEP-*         7 - SINGLE STEP
001.041  220                  DB      RMEM-*          8 - CASSETTE LOAD
001.042  332                  DB      WMEM-*          9 - CASSETTE DUMP
001.043  067                  DB      NEXT-*          + - NEXT
001.044  104                  DB      LAST-*          - - LAST
001.045  102                  DB      ABORT-*         * - ABORT
001.046  060                  DB      R$W-*           / - DISPLAY/ALTER
001.047  116                  DB      MEMM-*          # - MEMORY MODE
001.050  034                  DB      REGM-*          . - REGISTER MODE


               **       PROCESS MEMORY/REGISTER ALTERATIONS.
               *
               *        THIS CODE IS ENTERED IF
               *
               *        1) AM IN ALTER MODE, AND
               *        2) A KEY FROM 0-7 WAS ENTERED.

001.051  017           MTR5   RRC
001.052  173                  MOV     A,E             (A) = VALUE
001.053  332 067 001          JC      MTR6            IS REGISTER
001.056  067                  STC                     INDICATE 1ST DIGIT IS IN (A)
001.057  315 066 003          CALL    IOB             INPUT OCTAL BYTE
001.062  043                  INX     H               DISPLAY NEXT LOCATION
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH XBASM V1.0  02/18/77
MTR - MAIN EXECUTIVE LOOP.                                  13:23:39  01-APR-77  PAGE    14

                           **      SAE - STORE ABUSS AND EXIT.
                           *
                           *       ENTRY   (HL) = ABUSS VALUE
                           *       EXIT    TO (RET)
                           *       USES    NONE

001.063  042 024 040       SAE     SHLD    ABUSS
001.066  311                       RET

                           *       ALTER REGISTER

001.067  365               MTR6    PUSH    PSW             SAVE CODE
001.070  315 047 003               CALL    LRA             LOCATE REGISTER ADDRESS
001.073  247                       ANA     A
001.074  312 322 000               JZ      ERROR           NOT ALLOWED TO ALTER STACKPOINTER
001.077  043                       INX     H
001.100  361                       POP     PSW             RESTORE VALUE AND CARRY FLAG
001.101  303 062 003               JMP     IOA             INPUT OCTAL ADDRESS
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                    HEATH X8ASM V1.1  06/21/77
MONITOR TASK SUBROUTINES.                                        15:44:14  01-APR-77  PAGE    15

                          569  **      REGM - ENTER REGISTER DISPLAY MODE.
                          570  *
                          571  *       ENTRY   (A) = DSPMOD
                          572  *               (BC) = #DSPMOD
                          573
001.104  076 002          574  REGM    MVI     A,2                    SET DISPLAY REGISTER MODE
040.007                   575          SET     DSPMOD
001.106  002              576          STAX    B                      SET DISPLAY REGISTER MODE
000.000                   577          ERRNZ   DSPMOD-DSPROT-1
001.107  013              578          DCX     B                      (BC) = #DSPROT
001.110  257              579          XRA     A
001.111  002              580          STAX    B                      SET ALL PERIODS ON
001.112  315 260 003      581          CALL    RCK                    READ KEY ENTRY
001.115  075              582          DCR     A                      DISPLACE
001.116  376 006          583          CPI     6
001.120  322 322 000      584          JNC     ERROR                  NOT 1-6
001.123  007              585          RLC
001.124  022              586          STAX    D                      SET NEW REG IND
040.005                   587          SET     REGI
001.125  311              588          RET


                          590  **      R$W - TOGGLE DISPLAY/ALTER MODE.
                          591  *
                          592  *       ENTRY   (A) = DSPMOD
                          593  *               (BC) = ADDRESS OF DSPMOD
                          594
040.007                   595  .       SET     DSPMOD
001.126  356 001          596  R$W     XRI     1
001.130  002              597          STAX    B
001.131  311              598          RET


                          600  **      NEXT - INCREMENT DISPLAY ELEMENT.
                          601  *
                          602  *       ENTRY   (HL) = (ABUSS)
                          603  *               (DE) = ADDRESS OF REGIND
                          604
001.132  043              605  NEXT    INX     H
001.133  312 063 001      606          JZ      SAE                    IF MEMORY, STORE ABUSS AND EXIT
                          607
                          608  *       IS REGISTER MODE.
                          609
040.005                   610  .       SET     REGI
001.136  032              611          LDAX    D                      (A) = REGI
001.137  306 002          612          ADI     2                      INCREMENT REG INNEX
001.141  022              613          STAX    D                      WRAP TO *SP*
001.142  376 014          614          CPI     12
001.144  330              615          RC                             IF NOT TOO LARGE, EXIT
001.145  257              616          XRA     A                      OVERFLOW
001.146  022              617          STAX    D
001.147  311              618  ABORT   RET
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.1  06/21/77
MONITOR TASK SUBROUTINES.                                   15:44:16  01-APR-77  PAGE    16

                            **      LAST - DECREMENT DISPLAY ELEMENT.
                            *
                            *       ENTRY   (HL) = (ABUSS)
                            *               (DE) = ADDRESS OF REGIND

001.150  053                LAST    DCX     H
001.151  312 063 001                JZ      SAE                 IF MEMORY, STORE AND EXIT

                            *       IS REGISTER MODE.

040.005                     .       SET     REGI
001.154  032                LST2    LDAX    D                   (A) = REGI
001.155  326 002                    SUI     2
001.157  022                        STAX    D
001.160  320                        RNC                         IF OK
001.161  076 012                    MVI     A,10                UNDERFLOW TO *PC*
001.163  022                        STAX    D
001.164  311                        RET


                            **      MEMM - ENTER DISPLAY MEMORY MODE.
                            *
                            *       ENTRY   (BC) = ADDRESS OF DSPMOD

001.165  257                MEMM    XRA     A                   (A) = 0
040.007                     .       SET     DSPMOD
001.166  002                        STAX    B                   SET DISPLAY MEMORY MODE
000.000                             ERRNZ   DSPMOD-DSPROT-1
001.167  013                        DCX     B                   (BC) = #DSPROT
001.170  002                        STAX    B                   SET ALL PERIODS ON
001.171  041 025 040                LXI     H,ABUSS+1
001.174  303 062 003                JMP     IOA                 INPUT OCTAL ADDRESS


                            **      IN - INPUT DATA BYTE.
                            *

                            **      OUT - OUTPUT DATA BYTE.
                            *
                            *       ENTRY   (HL) = (ABUSS)

001.177  006 333            IN      MVI     B,MI.IN
001.201  021                        DB      MI.LXID             SKIP NEXT INSTRUCTION
001.202  006 323            OUT     MVI     B,MI.OUT
001.204  174                        MOV     A,H                 (A) = VALUE
001.205  145                        MOV     H,L                 (H) = PORT
001.206  150                        MOV     L,B                 (L) = IN/OUT INSTRUCTION
001.207  042 002 040                SHLD    IOWRK
001.212  315 002 040                CALL    IOWRK               PERFORM IO
001.215  154                        MOV     L,H                 (L) = PORT
001.216  147                        MOV     H,A                 (H) = VALUE
001.217  303 063 001                JMP     SAE                 STORE ABUSS AND EXIT
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.0  02/18/77
*GO* AND *STEP* FUNCTIONS                                   13:23:43  01-APR-77  PAGE    18

                         **      GO - RETURN TO USER MODE
                         *
                         *       ENTRY   NONE

 001.222  303 063 000    GO      JMP     GO.             ROUTINE IS IN WASTE SPACE


                         **      SSTEP - SINGLE STEP INSTRUCTION.
                         *
                         *       ENTRY   NONE

 001.225                 SSTEP   EQU     *               SINGLE STEP
 001.225  363                    DI                      DISABLE INTERRUPTS UNTIL THE RIGHT TIME
 001.226  072 011 040            LDA     CTLFLG
 001.231  356 020                XRI     CB.SSI          CLEAR SINGLE STEP INHIBIT
 001.233  323 360                OUT     OP.CTL          PRIME SINGLE STEP INTERRUPT
 001.235  062 011 040    SST1    STA     CTLFLG          SET NEW FLAG VALUES
 001.240  341                    POP     H               CLEAN STACK
 001.241  303 172 000            JMP     INTXIT          RETURN TO USER ROUTINE FOR STEP


                         **      STPRTN - SINGLE STEP RETURN

 001.244                 STPRTN  EQU     *
 001.244  366 020                ORI     CB.SSI          DISABLE SINGLE STEP INTERRUPTION
 001.246  323 360                OUT     OP.CTL          TURN OFF SINGLE STEP ENABLE
 040.011                         SET     CTLFLG
 001.250  022                    STAX    D
 001.251  346 040                ANI     CB.MTL          SEE IF IN MONITOR MODE
 001.253  302 344 000            JNZ     MTR
 001.256  303 042 040            JMP     UIVEC+3         TRANSFER TO USER'S ROUTINE


                         **      RMEM - LOAD MEMORY FROM TAPE.
                         *

 001.261  041 244 002    RMEM    LXI     H,TPABT
 001.264  042 031 040            SHLD    TPERRX          SETUP ERROR EXIT ADDRESS
                         *       JMP     LOAD
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.1  06/21/77
LOAD - LOAD MEMORY FROM TAPE                                15:44:19  01-APR-77  PAGE    19

                          ***     LOAD - LOAD MEMORY FROM TAPE.
                          *
                          *       READ THE NEXT RECORD FROM THE CASSETTE TAPE.
                          *
                          *       USE THE LOAD ADDRESS IN THE TAPE RECORD.
                          *
                          *       ENTRY   (HL) = ERROR EXIT ADDRESS
                          *       EXIT    USER P-REG (IN STACK) SET TO ENTRY ADDRESS
                          *               TO CALLER IF ALL OK
                          *               TO ERROR EXIT IF TAPE ERRORS DETECTED.


001.267                   LOAD    EQU     *
001.267  001 000 376              LXI     B,1000A-RT.MI*256-256   (BC) = - REQUIRED TYPE AND #
001.272  315 265 002      LOA0    CALL    SRS                     SCAN FOR RECORD START
001.275  157                      MOV     L,A                     (HL) = COUNT
001.276  353                      XCHG                            (DE) = COUNT, (HL) = TYPE AND #
001.277  015                      DCR     C                       (C) = - NEXT #
001.300  011                      DAD     B
001.301  174                      MOV     A,H
001.302  305                      PUSH    B                       SAVE TYPE AND #
001.303  365                      PUSH    PSW                     SAVE TYPE CODE
001.304  346 177                  ANI     177Q                    CLEAR END FLAG BIT
001.306  265                      ORA     L
001.307  076 002                  MVI     A,2                     SEQUENCE ERROR
001.311  302 205 002              JNE     TPERR                   IF NOT RIGHT TYPE OR SEQUENCE
001.314  315 325 002              CALL    RNP                     READ ADDR
001.317  104                      MOV     B,H
001.320  117                      MOV     C,A                     (BC) = P-REG ADDRESS
001.321  076 012                  MVI     A,10
001.323  325                      PUSH    D                       SAVE (DE)
001.324  315 052 003              CALL    LRA.                    LOCATE REG ADDRESS
001.327  321                      POP     D                       RESTORE (DE)
001.330  161                      MOV     M,C                     SET P-REG IN MEM
001.331  043                      INX     H
001.332  160                      MOV     M,B
001.333  315 325 002              CALL    RNP                     READ ADDRESS
001.336  157                      MOV     L,A                     (HL) = ADDRESS, (DE) = COUNT
001.337  042 000 040              SHLD    START

001.342  315 331 002      LOA1    CALL    RNB                     READ BYTE
001.343  167                      MOV     M,A
001.346  042 024 040              SHLD    ABUSS                   SET ABUSS FOR DISPLAY
001.351  043                      INX     H
001.352  033                      DCX     D
001.353  172                      MOV     A,D
001.354  263                      ORA     E
001.355  302 342 001              JNZ     LOA1                    IF MORE TO GO

001.360  315 172 002              CALL    CTC                     CHECK  TAPE CHECKSUM

                          *       READ NEXT BLOCK

001.363  361                      POP     PSW                     (A) = FILE TYPE BYTE
001.364  301                      POP     B                       (BC) = -(LAST TYPE, LAST #)
001.365  007                      RLC
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                 HEATH X8ASM V1.1  06/21/77
LOAD - LOAD MEMORY FROM TAPE                                  15:44:21  01-APR-77  PAGE    20

     001.366  332 133 002   768          JC      TFT          ALL DONE - TURN OFF TAPE
     001.371  303 272 001   769          JMP     LOAD         READ ANOTHER RECORD
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.0  02/18/77
DUMP - DUMP MEMORY TO MAG/PAPER TAPE                          13:23:47  01-APR-77  PAGE    21

                              772  ***     DUMP - DUMP MEMORY TO MAG TAPE.
                              773  *
                              774  *       DUMP SPECIFIED MEMORY RANGE TO MAG TAPE.
                              775  *
                              776  *       ENTRY    (START) = START ADDRESS
                              777  *                (ABUSS) = END ADDRESS
                              778  *                USER PC = ENTRY POINT ADDRESS
                              779  *       EXIT     TO CALLER.
                              780
                              781
 001.374                      782  WMEM    EQU      *
 001.374  041 244 002         783          LXI      H,IPABT
 001.377  042 031 040         784          SHLD     IPERRX           SETUP ERROR EXIT
                              785
 002.002  076 001             786  DUMP    MVI      A,UCI.TE
 002.004  323 371             787          OUT      OP.TPC           SETUP TAPE CONTROL
 002.006  076 026             788          MVI      A,A.SYN
 002.010  046 040             789          MVI      H,32             (H) = # OF SYNC CHARACTERS
 002.012  315 024 003         790  WME1    CALL     WNB
 002.015  045                 791          DCR      H
 002.016  302 012 002         792          JNZ      WME1             WRITE SYN HEADER
 002.021  076 002             793          MVI      A,A.STX
 002.023  315 024 003         794          CALL     WNB              WRITE STX
 002.026  154                 795          MOV      L,H              (HL) = 00
 002.027  042 027 040         796          SHLD     CRCSUM           CLEAR CRC 16
 002.032  041 001 201         797          LXI      H,RT.MI+80H*256+1       FIRST AND LAST MI RECORD
 002.035  315 017 003         798          CALL     WNP              WRITE HEADER
 002.040  052 000 040         799          LHLD     START
 002.043  353                 800          XCHG                      (D,E) = START ADDRESS
 002.044  052 024 040         801          LHLD     ABUSS            (H,L) = STOP ADDR
 002.047  043                 802          INX      H                COMPUTE WITH STOP+1
 002.050  175                 803          MOV      A,L
 002.051  223                 804          SUB      E
 002.052  157                 805          MOV      L,A
 002.053  174                 806          MOV      A,H
 002.054  232                 807          SBB      D
 002.055  147                 808          MOV      H,A              (HL) = COUNT
 002.056  315 017 003         809          CALL     WNP              WRITE COUNT
 002.061  345                 810          PUSH     H
 002.062  076 012             811          MVI      A,10
 002.064  325                 812          PUSH     D                SAVE (DE)
 002.065  315 052 003         813          CALL     LRA.             LOCATE P-REG ADDRESS
 002.070  176                 814          MOV      A,M
 002.071  043                 815          INX      H
 002.072  146                 816          MOV      H,M
 002.073  157                 817          MOV      L,A              (HL) = CONTENTS OF PC
 002.074  315 017 003         818          CALL     WNP              WRITE HEADER
 002.077  341                 819          POP      H                (HL) = ADDRESS
 002.100  321                 820          POP      D                (DE) = COUNT
 002.101  315 017 003         821          CALL     WNP
                              822
 002.104  176                 823  WME2    MOV      A,M
 002.105  315 024 003         824          CALL     WNB              WRITE BYTE
 002.110  042 024 040         825          SHLD     ABUSS            SET ADDRESS FOR DISPLAY
 002.113  043                 826          INX      H
 002.114  033                 827          DCX      D
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.0  02/18/77
DUMP - DUMP MEMORY TO MAG/PAPER TAPE                         13:23:49  01-APR-77  PAGE     22

002.115  172                       MOV     A,D
002.116  263                       ORA     E
002.117  302 104 002               JNZ     WME2            IF MORE TO GO

                           *       WRITE CHECKSUM

002.122  052 027 040               LHLD    CRCSUM
002.125  315 017 003               CALL    WNP             WRITE IT
002.130  315 017 003               CALL    WNP             FLUSH CHECKSUM
                           *       JMP     TFT


                           **      TFT - TURN OFF TAPE.
                           *
                           *       STOP THE TAPE TRANSPORT.
                           *

002.133  257               TFT     XRA     A
002.134  323 371                   OUT     OP.TPC          TURN OFF TAPE


                           **      HORN - MAKE NOISE.
                           *
                           *       ENTRY   (A) = (MILLISECOND COUNT)/2
                           *       EXIT    NONE
                           *       USES    A,F


002.136  076 144           ALARM   MVI     A,200/2         200 MS BEEP
002.140  365               HORN    PUSH    PSW
002.141  076 200                   MVI     A,CB.SPK        TURN ON SPEAKER

002.143  343               HRNO    XTHL                    SAVE (HL), (H)  = COUNT
002.144  325                       PUSH    D               SAVE (DE)
002.145  353                       XCHG                    (D) = LOOP COUNT
002.146  041 011 040               LXI     H,CTLFLG
002.151  256                       XRA     M
002.152  136                       MOV     E,M             (E) = OLD CTLFLG VALUE
002.153  167                       MOV     M,A             TURN ON HORN
002.154  056 033                   MVI     L,#TICCNT

002.156  172                       MOV     A,D             (A) = CYCLE COUNT
002.157  206                       ADD     M
002.160  276               HRN2    CMP     M               WAIT REQUIRED TICCOUNTS
002.161  302 160 002               JNE     HRN2
002.164  056 011                   MVI     L,#CTLFLG
002.166  163                       MOV     M,E             TURN HORN OFF
002.167  321                       POP     D
002.170  341                       POP     H
002.171  311                       RET
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.1  06/21/77
TAPE PROCESSING SUBROUTINES                                  15:44:25  01-APR-77  PAGE    23

                               880  **      CTC - VERIFY CHECKSUM.
                               881  *
                               882  *       ENTRY   TAPE JUST BEFORE CRC
                               883  *       EXIT    TO CALLER IF OK
                               884  *               TO *TPERR* IF BAD
                               885  *       USES    A,F,H,L
                               886
                               887
002.172  315 325 002           888  CTC     CALL    RNP                 READ NEXT PAIR
002.175  052 027 040           889          LHLD    CRCSUM
002.200  174                   890          MOV     A,H
002.201  265                   891          ORA     L
002.202  310                   892          RZ                          RETURN OF OK
002.203  076 001               893          MVI     A,1                 CHECKSUM ERROR
                               894  *       JMP     TPERR               (B) = CODE


                               896  **      TPERR - PROCESS TAPE ERROR.
                               897  *
                               898  *       DISPLAY ERR NUMBER IN LOW BYTE OF ABUSS
                               899  *
                               900  *       IF ERROR NUMBER EVEN, DONT ALLOW #
                               901  *       IF ERROR NUMBER ODD, ALLOW #
                               902  *
                               903  *       ENTRY   (A) = NUMBER
                               904
                               905
002.205  062 024 040           906  TPERR   STA     ABUSS
002.210  107                   907          MOV     B,A                 (B) = CODE
002.211  315 133 002           908          CALL    TFT                 TURN OFF TAPE
                               909
                               910  *       IS #, RETURN (IF PARITY ERROR)
                               911
002.214  346                   912          DB      MI.ANI              FALL THROUGH WITH CARRY CLEAR
002.215  170                   913  TER3    MOV     A,B
                               914
002.216  017                   915          RRC
002.217  330                   916          RC                          RETURN IF OK
                               917
                               918  *       BEEP AND FLASH ERROR NUMBER
                               919
002.220  334 136 002           920  TER1    CC      ALARM               ALARM IF PROPER TIME
002.223  315 252 002           921          CALL    TPXIT               SEE IF *
002.226  333 360               922          IN      IP.PAD
002.230  376 057               923          CPI     00101111B           CHECK FOR #
002.232  312 215 002           924          JE      TER3                IF #
002.235  072 034 040           925          LDA     TICCNT+1
002.240  037                   926          RAR                         'C' SET IF 1/2 SECOND
002.241  303 220 002           927          JMP     TER1
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                HEATH X8ASM V1.0  02/18/77
TAPE PROCESSING SUBROUTINES                                  13:23:52  01-APR-77  PAGE     24

                        929  **       TPABT - ABORT TAPE LOAD OR DUMP.
                        930  *
                        931  *        ENTERED WHEN LOADING OR DUMPING, AND THE '*' KEY
                        932  *        IS STRUCK.
                        933
                        934
002.244  257            935  TPABT   XRA     A
002.245  323 371        936          OUT     OP.TPC           OFF TAPE
002.247  303 322 000    937          JMP     ERROR



                        939  **       TPXIT - CHECK FOR USER FORCED EXIT.
                        940  *
                        941  *        TPXIT CHECKS FOR AN '*' KEYPAD ENTRY. IF SO, TAKE
                        942  *        THE TAPE DRIVER ABNORMAL EXIT.
                        943  *
                        944  *        ENTRY   NONE
                        945  *        EXIT    TO *RET* IF NOT '*'
                        946  *                 (A) = PORT STATUS
                        947  *                TO (TPERRX) IF '*' DOWN
                        948  *        USES    A,F
                        949
                        950
002.252  333 360        951  TPXIT   IN      IP.PAD
002.254  376 157        952          CPI     01101111B        *
002.256  333 371        953          IN      IP.TPC           READ TAPE STATUS
002.260  300            954          RNE                      NOT '*', RETURN WITH STATUS
002.261  052 031 040    955          LHLD    TPERRX
002.264  351            956          PCHL                     ENTER (TPERRX)



                        958  **       SRS - SCAN RECORD START
                        959  *
                        960  *        SRS READS BYTES UNTIL IT RECOGNIZES THE START OF A RECORD.
                        961  *
                        962  *        THIS REQUIRES
                        963  *        AT LEAST 10 SYNC CHARACTERS
                        964  *        1 STX CHARACTER.
                        965  *
                        966  *        THE CRC-16 IS THEN INITIALIZED.
                        967  *
                        968  *        ENTRY   NONE
                        969  *        EXIT    TAPE POSITIONED (AND MOVING), CRCSUM =0
                        970  *                (DE) = HEADER BYTES
                        971  *                (HA) = RECORD COUNT
                        972  *        USES    A,F,D,E,H,L
                        973
                        974
002.265                 975  SRS     EQU     *
002.265  026 000        976  SRS1    MVI     D,0
002.267  142            977          MOV     H,D
002.270  152            978          MOV     L,D              (HL) = 0
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                    HEATH X8ASM V1.0  02/18/77
TAPE PROCESSING SUBROUTINES                                     13:23:54  01-APR-77  PAGE    25

002.271  315 331 002   979  SRS2    CALL    RNB               READ NEXT BYTE
002.274  024           980          INR     D
002.275  376 026       981          CPI     A,SYN
002.277  312 271 002   982          JE      SRS2              HAVE SYN
002.302  376 002       983          CPI     A,STX
002.304  302 265 002   984          JNE     SRS1              NOT STX - START OVER
                       985
002.307  076 012       986          MVI     A,10
002.311  272           987          CMP     D                 SEE IF ENOUGH SYN CHARACTERS
002.312  322 265 002   988          JNC     SRS1              NOT ENOUGH
002.315  042 027 040   989          SHLD    CRCSUM            CLEAR CRC-16
002.320  315 325 002   990          CALL    RNP               READ LEADER
002.323  124           991          MOV     D,H
002.324  137           992          MOV     E,A
                       993  *       JMP     RNP               READ COUNT


                       995  **      RNP - READ NEXT PAIR.
                       996  *
                       997  *       RNP READS THE NEXT TWO BYTES FROM THE INPUT DEVICE.
                       998  *
                       999  *       ENTRY   NONE
                      1000  *       EXIT    (H,A) = BYTE PAIR
                      1001  *       USES    A,F,H
                      1002
                      1003
002.325  315 331 002  1004  RNP     CALL    RNB               READ NEXT BYTE
002.330  147          1005          MOV     H,A
                      1006  *       JMP     RNB               READ NEXT BYTE


                      1008  **      RNB - READ NEXT BYTE
                      1009  *
                      1010  *       RNB READS THE NEXT SINGLE BYTE FROM THE INPUT DEVICE.
                      1011  *       THE CHECKSUM IS TAKEN FOR THE CHARACTER.
                      1012  *
                      1013  *       ENTRY   NONE
                      1014  *       EXIT    (A) = CHARACTER
                      1015  *       USES    A,F
                      1016
                      1017
002.331  076 064      1018  RNB     MVI     A,UCI.RO+UCI.ER+UCI.RE  TURN ON READER FOR NEXT BYTE
002.333  323 371      1019          OUT     OP.TPC
002.335  315 252 002  1020  RNB1    CALL    TPXIT             CHECK FOR *. READ STATUS
002.340  346 002      1021          ANI     USR.RXR
002.342  312 335 002  1022          JZ      RNB1              IF NOT READY
002.345  333 370      1023          IN      IP.TPD            INPUT DATA
                      1024  *       JMP     CRC               CHECKSUM
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                    HEATH X8ASM V1.0  02/18/77
TAPE PROCESSING SUBROUTINES                                     13:23:56  01-APR-77  PAGE    26

                         **      CRC - COMPUTE CRC-16
                         *
                         *       CRC COMPUTES A CRC-16 CHECKSUM FROM THE POLYNOMIAL
                         *
                         *       (X + 1) * (X^15 + X + 1)
                         *
                         *       SINCE THE CHECKSUM GENERATED IS A DIVISION REMAINDER,
                         *       A CHECKSUMED DATA SEQUENCE CAN BE VERIFIED BY RUNNING
                         *       THE DATA THROUGH CRC, AND THEN RUNNING THE PREVIOUSLY OBTAINED
                         *       CHECKSUM THROUGH CRC. THE RESULTANT CHECKSUM SHOULD BE 0.
                         *
                         *       ENTRY   (CRCSUM) = CURRENT CHECKSUM
                         *               (A) = BYTE
                         *       EXIT    (CRCSUM) UPDATED
                         *               (A) UNCHANGED.
                         *       USES    F


002.347  305                   CRC     PUSH    B                 SAVE (BC)
002.350  006 010                       MVI     B,8               (B) = BIT COUNT
002.352  345                           PUSH    H
002.353  052 027 040                   LHLD    CRCSUM
002.356  007                   CRC1    RLC
002.357  117                           MOV     C,A               (C) = BIT
002.360  175                           MOV     A,L
002.361  207                           ADD     A
002.362  157                           MOV     L,A
002.363  174                           MOV     A,H
002.364  027                           RAL
002.365  147                           MOV     H,A
002.366  027                           RAL
002.367  251                           XRA     C
002.370  017                           RRC
002.371  322 004 003                   JNC     CRC2              IF NOT TO XOR
002.374  174                           MOV     A,H
002.375  356 200                       XRI     200Q
002.377  147                           MOV     H,A
003.000  175                           MOV     A,L
003.001  356 005                       XRI     5Q
003.003  157                           MOV     L,A
003.004  171                   CRC2    MOV     A,C
003.005  005                           DCR     B
003.006  302 356 002                   JNZ     CRC1              IF MORE TO GO
003.011  042 027 040                   SHLD    CRCSUM
003.014  341                           POP     H                 RESTORE (HL)
003.015  301                           POP     B                 RESTORE (BC)
003.016  311                           RET                       EXIT
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                    HEATH X8ASM V1.0  02/18/77
TAPE PROCESSING SUBROUTINES                                     13:23:58  01-APR-77  PAGE     27

                          1074  **       WNP - WRITE NEXT PAIR.
                          1075  *
                          1076  *        WPT WRITES THE NEXT TWO BYTES TO THE CASSETTE DRIVE.
                          1077  *
                          1078  *        ENTRY    (H,L) = BYTES
                          1079  *        EXIT     WRITTEN.
                          1080  *        USES     A,F
                          1081
                          1082
003.017  174              1083  WNP      MOV      A,H
003.020  315 024 003      1084           CALL     WNB
003.023  175              1085           MOV      A,L
                          1086  *        JMP      WNB               WRITE NEXT BYTE


                          1088  **       WNB - WRITE BYTE
                          1089  *
                          1090  *        WNB WRITES THE NEXT BYTE TO THE CASSETTE TAPE.
                          1091  *
                          1092  *        ENTRY    (A) = BYTE
                          1093  *        EXIT     NONE.
                          1094  *        USES     F
                          1095
                          1096
003.024  365              1097  WNB      PUSH     PSW
003.025  315 252 002      1098  WNB1     CALL     TPXIT             CHECK FOR *, READ STATUS
003.030  346 001          1099           ANI      USR.TXR
003.032  312 025 003      1100           JZ       WNB1              IF MORE TO GO
003.035  076 021          1101           MVI      A,UCI.ER+UCI.TE   ENABLE TRANSMITTER
003.037  323 371          1102           OUT      OP.TPC            TURN ON TAPE
003.041  361              1103           POP      PSW
003.042  323 370          1104           OUT      OP.TPD            OUTPUT DATA
003.044  303 347 002      1105           JMP      CRC               COMPUTE CRC
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.0  02/18/77
SUBROUTINES                                                   13:23:59  01-APR-77  PAGE    28

                        1109  **      LRA - LOCATE REGISTER ADDRESS.
                        1110  *
                        1111  *       ENTRY   NONE.
                        1112  *       EXIT    (A) = REGISTER INDEX
                        1113  *               (H,L) = STORAGE ADDRESS
                        1114  *               (D,E) = (0,A)
                        1115  *       USES    A,D,E,H,L,F
                        1116
                        1117
                        1118
003.047  072 005 040    1119  LRA     LDA     REGI
003.052  137            1120  LRA.    MOV     E,A
003.053  026 000        1121          MVI     D,0
003.055  052 035 040    1122          LHLD    REGPTR
003.060  031            1123          DAD     D               (DE) = (REGPTR)+(REGI)
003.061  311            1124          RET


                        1126  **      IOA - INPUT OCTAL ADDRESS.
                        1127  *
                        1128  *       ENTRY   (H,L) = ADDRESS OF RECEPTION DOUBLE BYTE.
                        1129  *       EXIT    TO *RET* IF ERROR.
                        1130  *               TO *RET*+1 IF OK, VALUE IN MEMORY.
                        1131  *       USES    A,D,E,H,L,F
                        1132
                        1133
003.062  315 066 003    1134  IOA     CALL    IOB             INPUT BYTE
003.065  053            1135          DCX     H


                        1137  **      IOB - INPUT OCTAL BYTE.
                        1138  *
                        1139  *       READ ONE OCTAL BYTE FROM THE KEYSET.
                        1140  *
                        1141  *       ENTRY   (H,L) = ADDRESS OF BYTE TO HOLD VALUE
                        1142  *               'C' SET IF FIRST DIGIT IN (A)
                        1143  *       EXIT    TO *RET* IF ALL OK
                        1144  *               TO *ERROR* IF ERROR
                        1145  *       USES    A,D,E,H,L,F
                        1146
                        1147
                        1148
003.066  026 003        1149  IOB     MVI     D,3             (D) = DIGIT COUNT
003.070  324 260 003    1150  IOB1    CNC     RCK             READ CONSOLE KEYSET
                        1151
003.073  376 010        1152          CPI     8
003.075  322 322 000    1153          JNC     ERROR           IF ILLEGAL DIGIT
                        1154
003.100  137            1155          MOV     E,A             (E) = VALUE
003.101  176            1156          MOV     A,M
003.102  007            1157          RLC                     SHIFT 3
003.103  007            1158          RLC
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                    HEATH X8ASM V1.0  02/18/77
SUBROUTINES                                                    13:24:01  01-APR-77  PAGE    29

003.104  007           1159          RLC
003.105  346 370       1160          ANI     370Q
003.107  263           1161          ORA     E
003.110  167           1162          MOV     M,A               REPLACE
003.111  025           1163          DCR     D
003.112  302 070 003   1164          JNZ     IOB1              IF NOT DONE
003.115  076 017       1165          MVI     A,30/2            BEEP FOR 30 MS
003.117  303 140 002   1166          JMP     HORN

                       1168  **      DOD - DECODE FOR OCTAL DISPLAY.
                       1169  *
                       1170  *       ENTRY   (H,L) = ADDRESS OF LED REFRESH AREA
                       1171  *               (B) = *OR* PATTERN TO FORCE ON BARS OR PERIODS
                       1172  *               (A) = OCTAL VALUE
                       1173  *       EXIT    (H,L) = NEX DIGIT ADDRESS
                       1174  *       USES    A,B,C,D,H,L
                       1175
                       1176
003.122  325           1177  DOD     PUSH    D
003.123  026 003       1178          MVI     D,DODA/256
003.125  016 003       1179          MVI     C,3
003.127  027           1180  DOD1    RAL                       LEFT 3 PLACES
003.130  027           1181          RAL
003.131  027           1182          RAL
003.132  365           1183          PUSH    PSW               SAVE FOR NEXT DIGIT
003.133  346 007       1184          ANI     7
003.135  306 356       1185          ADI     #DODA
003.137  137           1186          MOV     E,A               (D) = INDEX
003.140  032           1187          LDAX    D                 (A) = PATTERN
003.141  250           1188          XRA     B
003.142  346 177       1189          ANI     177Q
003.144  250           1190          XRA     B
003.145  167           1191          MOV     M,A               SET IN MEMORY
003.146  043           1192          INX     H
003.147  170           1193          MOV     A,B
003.150  007           1194          RLC
003.151  107           1195          MOV     B,A
003.152  361           1196          POP     PSW               (A) = VALUE
003.153  015           1197          DCR     C
003.154  302 127 003   1198          JNZ     DOD1              IF MORE TO GO
003.157  321           1199          POP     D
003.160  311           1200          RET                       RETURN
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                     HEATH X8ASM V1.0  02/18/77
UFD - UPDATE FRONT PANEL DISPLAYS.                                13:24:02  01-APR-77  PAGE    30

                           1203  **      UFD - UPDATE FRONT PANEL DISPLAYS.
                           1204  *
                           1205  *
                           1206  *       UFD IS CALLED BY THE CLOCK INTERRUPT PROCESSOR WHEN IT IS
                           1207  *       TIME TO UPDATE THE DISPLAY CONTENTS. CURRENTLY, THIS IS DONE
                           1208  *       EVERY 32 INTERRUPTS, OR ABOUT 32 TIMES A SECOND.
                           1209  *
                           1210  *       ENTRY   (H,L) = ADDRESS OF REFCNT
                           1211  *       EXIT    NONE
                           1212  *       USES    ALL
                           1213
                           1214
  003.161                  1215  UFD     EQU     *
  003.161  076 002         1216          MVI     A,UO.DDU
  003.163  240             1217          ANA     B
  003.164  300             1218          RNZ                     IF NOT TO HANDLE UPDATE
                           1219
  003.165  056 006         1220          MVI     L,#DSPROT
  003.167  176             1221          MOV     A,M
  003.170  007             1222          RLC
  003.171  167             1223          MOV     M,A             ROTATE PATTERN
  003.172  107             1224          MOV     B,A
  003.173  043             1225          INX     H
  000.000                  1226          ERRNZ   DSPMOD-DSPROT-1
  003.174  176             1227          MOV     A,M             (A) = DSPMOD
  003.175  346 002         1228          ANI     2
  003.177  052 024 040     1229          LHLD    ABUSS
  003.202  312 227 003     1230          JZ      UFD1            IF MEMORY
                           1231
                           1232  *       AM DISPLAYING REGISTERS.
                           1233
  003.205  315 047 003     1234          CALL    LRA             LOCATE REGISTER ADDRESS
  003.210  345             1235          PUSH    H
  003.211  041 342 003     1236          LXI     H,DSPA
  003.214  031             1237          DAD     D               (H,L) = ADDRESS OF REG NAME PATTERNS
  003.215  176             1238          MOV     A,M
  003.216  043             1239          INX     H
  003.217  146             1240          MOV     H,M
  003.220  157             1241          MOV     L,A             (H,L) = REG NAME PATTERN
  003.221  343             1242          XTHL
  003.222  264             1243          ORA     H               CLEAR 'Z'
  003.223  176             1244          MOV     A,M
  003.224  043             1245          INX     H
  003.225  146             1246          MOV     H,M
  003.226  157             1247          MOV     L,A             (HL) = ADDRESS OF REGISTER PAIR CONTENTS
                           1248
                           1249  *       SETUP DISPLAY
                           1250
  003.227  365             1251  UFD1    PUSH    PSW
  003.230  353             1252          XCHG
  003.231  041 013 040     1253          LXI     H,ALEDS
  003.234  172             1254          MOV     A,D
  003.235  315 122 003     1255          CALL    DOD             FORMAT ABANK HIGH HALF
  003.240  173             1256          MOV     A,E
  003.241  315 122 003     1257          CALL    DOD             FORMAT ABANK LOW HALF
  003.244  361             1258          POP     PSW
```

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PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                     HEATH X8ASM V1.0  02/18/77
UFD - UPDATE FRONT PANEL DISPLAYS.                               13:24:04  01-APR-77  PAGE    31

        003.245  032           1259         LDAX    D
        003.246  312 122 003   1260         JZ      DOD             IF MEMORY, DECODE BYTE VALUE
                               1261
                               1262  *      IS REGISTER. SET REGISTER NAME.
                               1263
        003.251  066 377       1264         MVI     M,377Q          CLEAR DIGIT
        003.253  341           1265         POP     H
        003.254  042 022 040   1266         SHLD    DLEDS+1
        003.257  311           1267         RET
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.1  06/21/77
RCK - READ CONSOLE KEYPAD.                                   15:44:39  01-APR-77  PAGE    32

                          **      RCK - READ CONSOLE KEYPAD.
                          *
                          *       RCK IS CALLED TO READ A KEYSTROKE FROM THE CONSOLE KEYPAD.
                          *       WHENEVER A KEY IS ACCEPTED.
                          *       RCK PERFORMS DEBOUNCING, AND AUTO-REPEAT. A *BIP* IS SOUNDED
                          *       WHEN A VALUE IS ACCEPTED.
                          *
                          *       KEY PAD VALUES:
                          *
                          *       1111 1110  -  0
                          *       1111 1100  -  1
                          *       1111 1010  -  2
                          *       1111 1000  -  3
                          *       1111 0110  -  4
                          *       1111 0100  -  5
                          *       1111 0010  -  6
                          *       1111 0000  -  7
                          *       1110 1111  -  8
                          *       1100 1111  -  9
                          *       1010 1111  -  +
                          *       1000 1111  -  -
                          *       0110 1111  -  *
                          *       0100 1111  -  /
                          *       0010 1111  -  #
                          *       0000 1111  -  .
                          *
                          *
                          *       ENTRY   NONE
                          *       EXIT    TO CALLER WHEN A KEY IS HIT
                          *               (A) =  0 - '0'
                          *                      1 - '1'
                          *                      2 - '2'
                          *                      3 - '3'
                          *                      4 - '4'
                          *                      5 - '5'
                          *                      6 - '6'
                          *                      7 - '7'
                          *                      8 - '8'
                          *                      9 - '9'
                          *                     10 - '+'
                          *                     11 - '-'
                          *                     12 - '*'
                          *                     13 - '/'
                          *                     14 - '#'
                          *                     15 - '.'
                          *       USES    A,F


003.260                   RCK     EQU     *
003.260  345                      PUSH    H
003.261  305                      PUSH    B
003.262  016 024                  MVI     C,400/20        WAIT 400 MS
003.264  041 026 040              LXI     H,RCKA

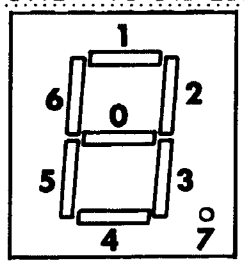
003.267  333 360          RCK1    IN      IP.PAD          INPUT PAD VALUE
003.271  107                      MOV     B,A             (B) = VALUE
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.1  06/21/77
RCK - READ CONSOLE KEYPAD.                                    15:44:41  01-APR-77  PAGE    33

   003.272  076 012       1327          MVI     A,20/2
   003.274  315 053 000   1328          CALL    DLY                 WAIT 20 MS
   003.277  170           1329          MOV     A,B
   003.300  276           1330          CMP     M
   003.301  302 310 003   1331          JNE     RCK2                HAVE A CHANGE
   003.304  015           1332          DCR     C
   003.305  302 267 003   1333          JNZ     RCK1                WAIT N CYCLES
                          1334
                          1335  *       HAVE KEY VALUE
                          1336
   003.310  167           1337  RCK2    MOV     M,A                 UPDATE RCKA
   003.311  356 376       1338          XRI     376Q                INVERT ALL BUT GROUP 0 FLAG
   003.313  017           1339          RRC
   003.314  322 326 003   1340          JNC     RCK3                HIT BANK 0
   003.317  017           1341          RRC
   003.320  017           1342          RRC
   003.321  017           1343          RRC
   003.322  017           1344          RRC
   003.323  322 267 003   1345          JNC     RCK1                NO HIT AT ALL
   003.326  107           1346  RCK3    MOV     B,A                 (B) = CODE
   003.327  076 002       1347          MVI     A,4/2
   003.331  315 140 002   1348          CALL    HORN                MAKE BIP
   003.334  170           1349          MOV     A,B
   003.335  346 017       1350          ANI     17Q
   003.337  301           1351          POP     B
   003.340  341           1352          POP     H
   003.341  311           1353          RET                         RETURN
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                  HEATH X8ASM V1.1  06/21/77
SEGMENT PATTERNS AND CONSTANTS.                               15:44:42  01-APR-77  PAGE    34

                        1357  **      DISPLAY SEGMENT CODING:
                        1358  *
                        1359  *       BYTE = 76 543 210
                        1360  *
                        1361  *
                        1362  *
                        1363  *
                        1364  *
                        1365  *
                        1366  *
```




```
                        1370  **      REGISTER INDEX TO 7-SEGMENT PATTERN
                        1371
003.342                 1372  DSPA    DS      0
003.342  244 230        1373          DW      1001100010100100B   SP
003.344  220 234        1374          DW      1001110010010000B   AF
003.346  206 215        1375          DW      1000110110000110B   BC
003.350  302 214        1376          DW      1000110011000010B   DE
003.352  222 217        1377          DW      1000111110010010B   HL
003.354  230 316        1378          DW      1100111010011000B   PC

                        1380  **      OCTAL TO 7-SEGMENT PATTERN
                        1381
003.356                 1382  DODA    DS      0
003.356  001            1383          DB      00000001B       0
003.357  163            1384          DB      01110011B       1
003.360  110            1385          DB      01001000B       2
003.361  140            1386          DB      01100000B       3
003.362  062            1387          DB      00110010B       4
003.363  044            1388          DB      00100100B       5
003.364  004            1389          DB      00000100B       6
003.365  161            1390          DB      01110001B       7
003.366  000            1391          DB      00000000B       8
003.367  040            1392          DB      00100000B       9

                        1394  **      I/O ROUTINES TO BE COPIED INTO AND USED IN RAM.
                        1395  *
                        1396  *       MUST CONTINUE TO 3777A FOR PROPER COPY.
                        1397  *       THE TABLE MUST ALSO BE BACKWARDS TO THE FINAL RAM
                        1398
003.371                 1399          ORG     4000A-7
                        1400
003.371                 1401  PRSROM  EQU     *
003.371  001            1402          DB      1               REFIND
003.372  000            1403          DB      0               CTLFLG
003.373  000            1404          DB      0               .MFLAG
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.                      HEATH X8ASM V1.1  06/21/77
CONSTANTS AND TABLES.                                             15:44:44  01-APR-77  PAGE    35

     003.374  000              DB      0                 DSPMOD
     003.375  000              DB      0                 DSPROT
     003.376  012              DB      10                REGI
     003.377  311              DB      MI.RET

     000.000                   ERRNZ *-4000A
```

```
PAM/8 - H8 FRONT PANEL MONITOR  #01.00.00.             HEATH X8ASM V1.1  06/21/77
RAM CELLS                                                15:44:44  01-APR-77  PAGE    36

                        1413
                        1414 **       THE FOLLOWING ARE CONTROL CELLS AND FLAGS USED BY THE KEYPAD
                        1415 *        MONITOR.
                        1416
    040.000             1417          ORG     40000A          8192
    040.000             1418 START    DS      2               DUMP STARTING ADDRESS
    040.002             1419 IOWRK    DS      2               IN OR OUT INSTRUCTION
    040.004             1420 PRSRAM   EQU     *               FOLLOWING CELLS INITIALIZED FROM ROM
    040.004             1421          DS      1               RET
                        1422
    040.005             1423 REGI     DS      1               INDEX OF REGISTER UNDER DISPLAY
    040.006             1424 DSPROT   DS      1               PERIOD FLAG BYTE
    040.007             1425 DSPMOD   DS      1               DISPLAY MODE
                        1426
    040.010             1427 .MFLAG   DS      1               USER FLAG OPTIONS
                        1428 *                                SEE *UO.XXX* BITS DESCRIBED AT FRONT
                        1429
    040.011             1430 CTLFLG   DS      1               FRONT PANEL CONTROL BITS
    040.012             1431 REFIND   DS      1               REFRESH INDEX (0 TO 7)
    000.007             1432 PRSL     EQU     *-PRSRAM        END OF AREA INITIALIZED FROM ROM
                        1433
    040.013             1434 FPLEDS   EQU     *               FRONT PANEL LED PATTERNS
    040.013             1435 ALEDS    DS      1               ADDR 0
    040.014             1436          DS      1               ADDR 1
    040.015             1437          DS      1               ADDR 2
                        1438
    040.016             1439          DS      1               ADDR 3
    040.017             1440          DS      1               ADDR 4
    040.020             1441          DS      1               ADDR 5
                        1442
    040.021             1443 DLEDS    DS      1               DATA 0
    040.022             1444          DS      1               DATA 1
    040.023             1445          DS      1               DATA 2
                        1446
    040.024             1447 ABUSS    DS      2               ADDRESS BUS
    040.026             1448 RCKA     DS      1               RCK SAVE AREA
    040.027             1449 CRCSUM   DS      2               CRC-16 CHECKSUM
    040.031             1450 TPERRX   DS      2               TAPE ERROR EXIT ADDRESS
    040.033             1451 TICCNT   DS      2               CLOCK TIC COUNTER
                        1452
    040.035             1453 REGPTR   DS      2               REGISETR CONTENTS POINTER
                        1454
    040.037             1455 UIVEC    DS      0               USER INTERRUPT VECTORS
    040.037             1456          DS      3               JUMP TO CLOCK PROCESSOR
    040.042             1457          DS      3               JUMP TO SINGLE STEP PROCESSOR
    040.045             1458          DS      3               JUMP TO I/O 3
    040.050             1459          DS      3               JUMP TO I/O 4
    040.053             1460          DS      3               JUMP TO I/O 5
    040.056             1461          DS      3               JUMP TO I/O 6
    040.061             1462          DS      3               JUMP TO I/O 7
                        1463
    040.064             1464          END
ASSEMBLY COMPLETE
 1464 STATEMENTS
    0 ERRORS DETECTED
22310 BYTES FREE
```

CROSS REFERENCE TABLE. XREF V1.0 PAGE 37

CTLFLG	040011	217S	344S	494S	513S	574S	586S	594S	609S	630S	645S	699S	
.MFLAG	040010	344	381	386	418	459	465	1427L					
A.STX	000002	93E	793	983									
A.SYN	000026	92E	788	981									
ABORT	001147	529	617L										
ABUSS	040024	490	554	650	754	801	825	906	1229	1147L			
ALARM	002136	469	854L	920									
ALEDS	040013	1253	1435L										
BLKSIZ	002000	118E											
CB.CLI	000100	99E	136	256	464								
CB.MTL	000040	98E	331	415	464	701							
CB.SPK	000200	100E	256	464	856								
CB.SSI	000020	97E	256	331	464	688	697						
CLK2	000234	393	395L										
CLK3	000237	389	398E										
CLK4	000313	422	438E										
CLOCK	000201	202	203	369L									
CRC	002347	1044L	1105										
CRC1	002356	1048L	1068										
CRC2	003004	1059	1066L										
CRCSUM	040027	796	834	889	989	1047	1069	1449L					
CTC	002172	761	888L										
CTLFLG	040011	217	328	386	391	413	418	465	687	690	699	861	871
		1430L											
CUI1	000165	345L	441										
DLEDS	040021	1266	1443L										
DLY	000053	248L	1328										
DM.MR	000000	104E											
DM.MW	000001	105E											
DM.RR	000002	106E											
DM.RW	000003	107E											
DOD	003122	1177L	1255	1257	1260								
DOD1	003127	1180L	1198										
DODA	003356	1178	1185	1382L									
DSPA	003342	1236	1372L										
DSPMOD	040007	481	494	513	574	576	594	645	647	1226	1425L		
DSPROT	040006	485	576	647	1220	1226	1424L						
DUMP	002002	786L											
ERROR	000322	298	434	458E	503	562	583	937	1153				
FFLEDS	040013	1434E											
GO	001222	521	679L										
GO.	000063	256L	679										
HORN	002140	855L	1166	1348									
HRNO	002143	250	858L										
HRN2	002160	869L	870										
IN	001177	522	660L										
INIT	000073	192	193	275L	279								
INIT0	000000	190L											
INIT1	000107	288L	293										
INIT2	000117	295L											
INT1	000010	197E											
INT2	000020	212E											
INT3	000030	229L											
INT4	000040	234L											
INT5	000050	239L											
INT6	000060	253L											
INT7	000070	260L											
INTXIT	000172	352L	416	692									

CROSS REFERENCE TABLE. XREF V1.0 PAGE 38

IOA	003062	565	651	1134L				
IOB	003066	545	1134	1149L				
IOB1	003070	1150L	1164					
IOWRK	040002	666	667	1419L				
IP.PAD	000360	81E	439	922	951	1325		
IP.TPC	000371	85E	953					
IP.TPD	000370	87E	1023					
LAST	001150	528	625L					
LOA0	001272	726L	769					
LOA1	001342	752L	759					
LOAD	001267	724E						
LRA	003047	560	1119L	1234				
LRA.	003052	427	743	813	1120L			
LST2	001154	631L						
MEMM	001165	531	644L					
MI.ANI	000346	128E	912					
MI.HLT	000166	123E	433					
MI.IN	000333	125E	660					
MI.LDA	000072	127E						
MI.LXID	000021	129E	661					
MI.OUT	000323	126E	662					
MI.RET	000311	124E	1408					
MTR	000344	476E	702					
MTR1	000345	479	479L					
MTR4	001005	492	502L					
MTR5	001051	497	541L					
MTR6	001067	543	559L					
MTRA	001035	506	520E					
NEXT	001132	527	604L					
OP.CTL	000360	82E	689	698				
OP.DIG	000360	83E	400					
OP.SEG	000361	84E	402					
OP.TPC	000371	86E	304	787	845	936	1019	1102
OP.TPD	000370	88E	1104					
OUT	001202	523	662L					
PRSL	000007	191	1432E					
PRSRAM	040004	191	1420E	1432				
PRSROM	003371	190	1401E					
R$W	001126	530	595L					
RCK	003260	489	580	1150	1319E			
RCK1	003267	1325L	1333	1345				
RCK2	003310	1331	1337L					
RCK3	003326	1340	1346L					
RCKA	040026	1323	1448L					
REFIND	040012	391	1431L					
REGI	040005	512	586	609	630	1119	1423L	
REGM	001104	532	573L					
REGPTR	040035	335	467	1122	1453L			
RMEM	001261	525	708L					
RNB	002331	752	979	1004	1018L			
RNB1	002335	1020L	1022					
RNP	002325	738	748	888	990	1004L		
RT.BP	000002	113E						
RT.CT	000003	114E						
RT.MI	000001	112E	725	797				
SAE	001063	554L	605	626	670			
SAVALL	000132	200	215	319L				
SINCR	004000	281E	283	284				

```
CROSS REFERENCE TABLE.                 XREF V1.0  PAGE   39

  SRS      002265     726      975E
  SRS1     002265     976L     984     988
  SRS2     002271     979L     982
  SST1     001235     257      690L
  SSTEP    001225     524      685E
  START    040000     284      750     799     1418L
  STPRTN   001244     218      696E
  TER1     002220     920L     927
  TER3     002215     913L     924
  TFT      002133     768      844L    908
  TICCNT   040033     369      371     406     865     925     1451L
  TPABT    002244     708      783     935L
  TPERR    002205     737      906L
  TPERRX   040031     709      784     955     1450L
  TPXIT    002252     921      951L    1020    1098
  UCI.ER   000020     165E     1018    1101
  UCI.IE   000002     167E
  UCI.IR   000100     163E
  UCI.RE   000004     166E     1018
  UCI.RO   000040     164E     1018
  UCI.TE   000001     168E     786     1101
  UFD      003161     409      1215E
  UFD1     003227     1230     1251L
  UIVEC    040037     229      234     239     253     260     348     703     1455L
  UMI.16X  000002     158E     303
  UMI.1B   000100     148E     303
  UMI.1X   000001     157E
  UMI.2B   000300     150E
  UMI.64X  000003     159E
  UMI.HB   000200     149E
  UMI.L5   000000     153E
  UMI.L6   000004     154E
  UMI.L7   000010     155E
  UMI.L8   000014     156E     303
  UMI.PA   000020     152E
  UMI.PE   000040     151E
  UO.CLK   000001     138E     346
  UO.DDU   000002     137E     461     1216
  UO.HLT   000200     135E     420
  UO.NFR   000100     136E     384     461
  USR.FE   000040     172E
  USR.OE   000020     173E
  USR.PE   000010     174E
  USR.RXR  000002     176E     1021
  USR.TXE  000004     175E
  USR.TXR  000001     177E     1099
  WME1     002012     790L     792
  WME2     002104     823L     830
  WMEM     001374     526      782E
  WNB      003024     790      794     824     1084    1097L
  WNB1     003025     1098L    1100
  WNP      003017     798      809     818     821     835     836     1083L

25434 BYTES FREE
```

APPENDIX B

Demo: PAM-8

This program shows the advanced features of PAM-8 and, as such, should not be evaluated as either an efficient or useful routine. The program uses the H8 clock, keyboard, display and interrupt capabilities to create an accurate interval timer that lets you enter an integer value from zero through nine seconds. When the program has counted down to zero, an audio alert is sounded, ending the program and returning control to PAM-8.

Use the H8 keypad to enter the machine code, set the program counter, and execute the program. While the program is being executed, the front panel display will be turned off and the computer will wait for you to enter a digit from the keypad. A single digit corresponding to the integer you selected is displayed and decremented until control is returned to PAM-8.

The timer is typical of a program you might create. An interval timer, a clock, or even a game requires that you communicate with the H8. The keypad lets you communicate with the CPU, and the CPU uses the LED display to communicate with you. The computer understands the selected time interval when you press a decimal key on the front panel. The job status, or decremented time interval, is relayed to you by the front panel displays. This interaction between you and the machine is characteristic of most software applications.

The program uses the PAM-8 firmware. Although it appears simple enough, you must study both the program and the PAM-8 listing ("Appendix A") in order to understand what happens when the program is operating. We suggest that you take a course in assembly language programming, such as the Heath EC-1108, if you have difficulty understanding the program.

The program source listing was prepared on an H8 computer system using the text editor (TED-8) and the assembler (HASL-8). NOTE: Your programs can be handwritten and assembled if you have only an H8.

The Sample Program

This program initially blanks the LED display and waits for you to enter an integer value. The computer verifies that the value you selected is permissible and then increments and stores the integer. The value was incremented because the display routine always decrements the count by one when it is called.

The most subtle part of this program is the interrupt service routine.* The H8 requires that you initialize the interrupt service routine by loading an instruction and address into the user interrupt vector (UIVEC) before executing the interrupt. After UIVEC is initialized, the program will jump to the service routine after the next interrupt signal is generated.

The main body of the program is a "do-nothing" loop that holds the program in a wait status until the interval timer has reached zero. You could replace the loop with another program which would execute simultaneously with the clock counter. When the countdown is complete, the program returns the H8 computer to its original status before halting.

*NOTE: Basically, an interrupt is a CPU response to a control signal. This signal directs the software to automatically save the current CPU status and transfers program control to a specified routine, called an interrupt handler. When the interrupt handler completes the routine, program control returns to its original status and normal program execution continues.

```
                                              HEATH ASM #104.01.00.
                                              PAGE  1

                         ***  *****************************************************
                         *
                         *       DEMO: PAM8
                         *
                         *       SYSTEM DEFINITIONS
                         *
040.100                          ORG     40100A
000.322                  ERROR   EQU     322A     RESET PAM8
002.140                  HORN    EQU     2140A    MAKE NOISE
003.260                  RCK     EQU     3260A    READ CONSOLE KEYPAD
003.356                  DODA    EQU     3356A    OCTAL TO 7-SEGMENT PATTERN
040.010                  .MFLAG  EQU     40010A   USER FLAG OPTIONS
040.013                  FPLEDS  EQU     40013A   FRONT PANEL L.E.D. PATTERNS
040.037                  UIVEC   EQU     40037A   USER INTERRUPT VECTOR
000.001                  UO.CLK  EQU     1A       ALLOW CLOCK INTERRUPT PROCESSING
000.002                  UO.DDU  EQU     2A       DISABLE DISPLAY UPDATE
000.303                  MI.JMP  EQU     303A     MACHINE INSTRUCTION (8080) JUMP
000.377                  LEDOFF  EQU     377A     BLANK L.E.D. DISPLAY
                         ***  *****************************************************
                         *
                         *       DISABLE UPDATING OF L.E.D. DISPLAY
                         *       AND TURN OFF L.E.D.'S
                         *
040.100  076 002         PAM8    MVI     A,UO.DDU          DISABLE NORMAL UPDATING
040.102  062 010 040             STA     .MFLAG               DONE
040.105  041 013 040             LXI     H,FPLEDS          L.E.D. DISPLAY ADDRESS
040.110  006 011                 MVI     B,9               COUNT L.E.D.'S
040.112  076 377                 MVI     A,LEDOFF          TURN OFF L.E.D.
040.114  167             BLANK   MOV     M,A                  O.K. - GO
040.115  043                     INX     H                 NEXT L.E.D. ADDRESS
040.116  005                     DCR     B                 ALL DONE - ??
040.117  302 114 040             JNZ     BLANK                NO - DO AGAIN!
                         ***  *****************************************************
                         *
                         *       READ A DECIMAL INTEGER FROM H8 FRONT PANEL
                         *          IF NOT DECIMAL -- RETURN TO PAM-8.
                         *          INCREMENT THE INTEGER (A PROGRAM REQUIREMENT)
                         *          STORE THE DIGIT.
                         *
040.122  315 260 003             CALL    RCK               READ CONSOLE KEYPAD
040.125  376 012                 CPI     10D               TEST IF ZERO THRU NINE
040.127  322 322 000             JNC     ERROR             ABORT TO PAM-8
040.132  074                     INR     A                 <A>=<A>+1
040.133  062 254 040             STA     DIGIT             STORE INTEGER
                         ***  *****************************************************
                         *
                         *       INITIALIZE CLOCK COUNTER.
                         *          PROGRAM REQUIRES ONE INTERRUPT BEFORE DISPLAY
                         *
040.136  041 001 000             LXI     H,1               H=0 & L=1
040.141  042 252 040             SHLD    TICK              INITIALIZE COUNT
                         ***  *****************************************************
                         *
                         *       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!
```

```
                                   HEATH ASM #104.01.00.
                                   PAGE  2

                              *
040.144  076 303                    MVI    A,MI.JMP             SET-UP JUMP INSTRUCTION
040.146  062 037 040                STA    UIVEC          STORE 'JMP' INSTRUCTION
040.151  041 207 040                LXI    H,INTRP          USER INTERRUPT ADDRESS
040.154  042 040 040                SHLD   UIVEC+1            POSITIONED
040.157  076 003                    MVI    A,UO.DDU+UO.CLK
040.161  062 010 040                STA    .MFLAG         DISABLE UPDATE & ENABLE CLOCK INT.
                              ***   ************************************************************
                              *
                              *     WAIT FOR CLOCK TO REACH ZERO
                              *
040.164  072 254 040 LOOP           LDA    DIGIT          DO NOTHING LOOP.
040.167  376 000                    CPI    0                WAIT FOR END
040.171  302 164 040                JNZ    LOOP             OF COUNT DOWN.
                              ***   ***********************************************************
                              *
                              *     RETURN TO NORMAL INTERRUPT STATUS & HALT.
                              *        DISABLE INTERRUPT & TURN ON SPEAKER
                              *
040.174  076 002                    MVI    A,UO.DDU
040.176  062 010 040                STA    .MFLAG         DISABLE UPDATE & CLOCK INTERRUPT
040.201  076 372                    MVI    A,500/2        250 MS BEEP
040.203  315 140 002                CALL   HORN
040.206  166                        HLT
                              ***   ******************************************************
                              *
                              *     INTERRUPT ROUTINE
                              *        CLOCK AND DISPLAY INTERRUPT
                              *
040.207  052 252 040 INTRP          LHLD   TICK           GET COUNT (BETWEEN 0 & 500)
040.212  053                        DCX    H              TICK=TICK-1
040.213  042 252 040                SHLD   TICK           STORE COUNT
040.216  175                        MOV    A,L            TEST FOR ZERO
040.217  264                        ORA    H                COMPARE WITH 'H'
040.220  300                        RNE                     EXIT IF .NE. 0
                              ***   ******************************************************
                              *
                              *     UPDATE L.E.D. DISPLAY FOR 'NEW' DIGIT.
                              *
040.221  072 254 040                LDA    DIGIT          GET INTEGER
040.224  075                        DCR    A              DIGIT=DIGIT-1
040.225  062 254 040                STA    DIGIT          SAVE INTEGER
040.230  041 356 003                LXI    H,DODA         DECODE DISPLAY ADDRESS
040.233  205                        ADD    L              POSITION DISPLAY
040.234  157                        MOV    L,A            ALL SET -- GO
040.235  176                        MOV    A,M              DISPLAY SET
040.236  366 200                    ORI    200Q             MASK - TURN OFF D.P.
040.240  062 017 040                STA    FPLEDS+4         TURN-ON-THE-LIGHTS
040.243  041 364 001                LXI    H,500          RESTORE COUNT
040.246  042 252 040                SHLD   TICK             WITH 500
040.251  311                        RET
                              *            STORAGE AREA & END ASSEMBLY
040.252                       TICK  DS     2
040.254  001                  DIGIT DB     1
040.255  000                        END    PAM8

 00130 STATEMENTS ASSEMBLED
 12275 BYTES FREE
 NO ERRORS DETECTED
```

INDEX