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I ABSTRACT

This document describes the functions and operating procedures of the Altair 680b PROM Monitor, a system program which allows the user to examine and change the contents of memory locations, load formatted object tapes into memory, start program execution at a specified address, and debug user programs. A source listing of the PROM Monitor is included so that its I/O and hexadecimal conversion routines may be utilized by user programs.

II NOTES ON THE FORMAT OF THIS MANUAL

1) All numbers used in this document are hexadecimal (base 16) unless otherwise indicated.

2) In the examples provided in this document, underscoring is used to indicate user typed information.

3) The symbol <CR> is used to represent a carriage return.

4) There are two versions of the PROM Monitor, one which supports the use of the ACIA chip, and one for use with a Baudot Teletype. All information in this manual applies to both versions of the Monitor, except where otherwise noted.

5) Symbolic addresses which are referenced but not defined in the examples, such as OUTCH and OUT2H, are entry points in the PROM Monitor. Refer to appropriate source listing (Section IX for the ACIA version and Section X for the Baudot version) for detailed information on these routines.

6) Assembly code examples follow the conventions of the 680B Resident Assembler.

III STARTING UP THE PROM MONITOR

A) Power up sequence

1) Strap the appropriate bits at location FØØ2 to indicate the presence of a terminal, the type of terminal, and the number of stop bits to be used. (See the 68ØB Operator's Manual.)

2) Turn the Altair T.M. computer on.

3) Turn the terminal on.

4) Switch the Halt-Run switch to the Halt position.

5) Actuate the Reset switch.

6) Switch the Halt-Run switch to the Run position.

7) The PROM Monitor will respond by sending a carriage return and line feed to the terminal and printing a ".". The "." is the Monitor's prompt character which indicates that the Monitor is ready to accept a command.

> **NOTE**
>
> Use steps 4 through 7 to start the Monitor if the system is already powered up.

B) Entering the PROM Monitor from a User Program

There are three methods of entering the Monitor from a user program. The first method is to include the following instructions at the appropriate place in the program.

```
        LDX $FFFE  RESTART VECTOR TO X REGISTER
```

JMP X JUMP TO RESTART ADDRESS

This has the same effect as doing a Reset from the front panel. The Monitor is entered at its reset entry point, causing the stack pointer and all system parameters to be initialized.

> NOTE
>
> If the user program is outputting to the terminal just prior to the execution of these instructions, the last character sent to the terminal may be lost when the Monitor initializes the terminal control register.

The second method of entering the Monitor from a user program is to include the following instruction at the appropriate place in the program.

```
JMP CRLF
```

The symbol CRLF must be correctly defined in the user program for the version of the Monitor being used (ACIA or Baudot). The Monitor is entered, the stack pointer is loaded from SAVSTK (ØØF6 and ØØF7), and a carriage return, line feed, and the Monitor's prompt character are sent to the terminal.

The third method of entering the Monitor from a user program is to place a SWI (software interrupt) instruction at the appropriate place in the program. This method is generally used for program debugging and therefore discussion of this feature is delayed until section V.

IV DESCRIPTION OF MONITOR COMMANDS

M - Memory Examine and Deposit Command

Purpose - To examine and optionally modify the contents of a single memory byte.

Usage -

1) Type M in response to the Monitor's ".".

2) A space will be printed.

3) Type the four digit hexadecimal address of the byte to be examined.

4) The two digit hexadecimal contents of the specified byte will be printed, preceded by and followed by a space.

5) To change the contents of the specified byte, enter the new contents by typing two hexadecimal dfgits.

6) To leave the contents of the specified byte unaltered, type a carriage return (or any other non-hexadecimal character).

Examples -

1) To examine and leave unaltered the contents of 00A2, the following command is used:

```
.M 00A2 FF <CR>
```

2) To deposit a 09 in location 0072, the following command is used:

```
.M 0072 E1 09
```

(Note that a carriage return is not used.)

NOTE

The contents of the specified byte are not changed until two valid hexadecimal digits are entered. Therefore, if an invalid digit is typed, the contents of the location will remain unchanged.

N - Memory Deposit and Examine Next Command

Purpose - Used after an M command to examine and optionally modify the contents of the next sequential memory byte.

Usage -

1) Type N in response to the Monitor's ".".

2) The Monitor will type the next sequential memory address, preceded by and followed by a space. The contents of the byte will be printed, followed by a space.

3) To change the contents of the specified byte, enter the new contents by typing two hexadecimal digits.

4) To leave the contents of the specified byte unaltered, type a carriage return (or any other non-hexadecimal character).

Examples -

1) To load a string of ASCII characters into successive memory bytes starting at location 0050, use the following commands:

```
.M 0050 00 4D

.N 0051 00 49

.N 0052 00 54

.N 0053 00 53
```

2) To check and correct a sequence of instructions located at 0015 through 0018, the following commands are used:

```
.M 0015 4C <CR>

.N 0016 5C <CR>

.N 0017 36 32

.N 0018 37 <CR>
```

J - Jump to Specified Address Command

Purpose - To start program execution at a specified address.

Usage -

1) Type J in response to the Monitor's ".".

2) A space will be printed.

3) Type the four digit hexadecimal address at which execution is to begin.

4) The processor will jump to the specified location and start execution of the program stored there.

Example -

To start execution of a program which starts at Ø2F3, the following command is used:

```
.J Ø2F3
```

L - Load Paper Tape Command

Purpose - To load formatted object tapes into memory. (See Section VI for paper tape format.)

Usage -

1) Type L in response to the Monitor's ".".

2) Place the paper tape in the reader and start the reader.

Loading begins with the first data record (type S1). Any information preceding the first data record, including the header record (type SØ) is ignored.

Normal termination of the load occurs when an end of file record (type S9) is encountered. Control returns to the Monitor's command decoding section and any information following the S9 on the tape is interpreted as Monitor commands. Therefore, the paper tape reader should be turned off as soon as the S9 is printed on the terminal.

If a checksum error occurs while the tape is being read, control is returned to the Monitor's command decoding section and the rest of the information on the tape is interpreted as Monitor commands. If this occurs, the paper tape reader should be turned off and the paper tape should be reloaded from its beginning.

Suppressing Teletype Echo

NOTE

This information applies only to the ACIA version of the PROM Monitor.

While loading a paper tape, Teletype echo can be suppressed by one of two methods. The first method is to use the Monitor's M command to store an FF into the Monitor's echo flag (location 00F3). The command

```
M 00F3 03 FF
```

turns off Teletype echoing. The L command can then be used to load the paper tape. (The L will not be echoed!) When the load is completed, the command

```
M 00F3 FF 00
```

is used to restore Teletype echoing. (Only the FF, which is printed by the Monitor, will appear on the terminal!)

NOTE

Only the most significant bit of the echo flag affects Teletype echoing. Therefore, any number loaded into 00F3 which has bit 7 set will suppress echoing, and any number loaded into 00F3 which has bit 7 clear will restore echoing.

The second method of suppressing Teletype echo is to have the first data block of the paper tape load an FF into location 00F3 and to have the last data block load a 00 into location 00F3. This can be accomplished by including the following mnemonics in an assembly code program.

```
NAM EXAMPL
ORG $00F3
FCB $FF          TURN OFF ECHO FOR LOAD

(PROGRAM STATEMENTS)

ORG $00F3
FCB 0            RESTORE TTY ECHO
END
```

This is the method used on all MITS supplied paper tapes. When using this method, a typical load looks like:

```
.L S00B00004D454D5445535420B5
S10400F3FF08
S9
.
```

If a checksum error occurs, Teletype echoing will remain off. The command

```
.M 00F3  FF 00
```

can be used to restore echoing. (Only the FF will appear on the terminal!)

P - Proceed From Program Breakpoint Command

Purpose - To proceed from a program breakpoint.

Usage -

1) Type P in response to the Monitor's ".".

2) Program execution will be resumed.

> **NOTE**
>
> A discussion of program breakpoints is included in Section V.

V USER PROGRAM DEBUGGING WITH THE PROM MONITOR

Setting Program Breakpoints

When a program is not performing properly, it is often helpful to stop program execution at strategic points for the purpose of displaying and/or modifying the contents of the processor registers and memory locations. This is known as setting program breakpoints.

The PROM Monitor allows a program breakpoint to be set by insertion of a SWI (software interrupt) instruction at the point in the program where the break is to occur. When the SWI instruction is executed, the status of the processor is pushed onto the stack according to the format shown in Table 5-1. The PROM Monitor gains control of the processor and may be used to examine and/or modify the contents of the registers and memory locations.

Stack Pointer	>	
SP+1	>	Condition Codes
SP+2	>	Accumulator B
SP+3	>	Accumulator A
SP+4	>	Index Reg (High Order Byte)
SP+5	>	Index Reg (Low Order Byte)
SP+6	>	Program Counter (High Order Byte)
SP+7	>	Program Counter (Low Order Byte)

TABLE 5-1

When the Monitor is entered at a program breakpoint, the stack pointer is saved in locations 00FA and 00FB. When an N command is executed, the contents of 00FA and 00FB are incremented by one and then used as the address of the next memory byte to be examined. Therefore, if an N command is issued directly after entering the Monitor at a breakpoint, the address displayed will be SP+1 (see Table 5-1) and the contents displayed will be the contents of the condition codes register. Further N commands will display the contents of the remaining processor registers in the order shown in Table 5-1.

Alternatively, the contents of the stack pointer can be determined by using the M and N commands to examine locations 00F6 and 00F7, where the Monitor stores the high and low bytes of the stack pointer, respectively. Once the contents of the stack pointer have been determined, the M and N commands can be used in conjunction with Table 5-1 to examine and/or modify the contents of the processor registers.

The P command is used to continue program execution after a breakpoint. The P command causes the stack pointer to be loaded from locations 00F6 and 00F7 and the other processor registers to be pulled from the stack. Program execution is resumed at the address of the SWI instruction that caused the break, plus one.

> NOTE
>
> The contents of the stack pointer may be changed by modifying the contents of locations 00F6 and 00F7. However, great caution should be exercised when so doing since the P command causes the processor registers to be pulled from the stack.

Any number of breakpoints may be present in a program at one time. It should be clear that insertion of a SWI instruction may make re-assembly of the program necessary. A breakpoint can be removed by replacing the SWI instruction with a NOP or by deleting the SWI instruction and re-assembling the program.

Breakpoint Routines

Whenever the PROM Monitor is entered at a program breakpoint, the flag BRKADR (location F2) is checked. If the most significant bit (bit 7) of BRKADR is clear (=0) then the Monitor assumes processor control. (This is the normal course of events since the Monitor initializes BRKADR to 03 whenever the Reset function is performed.) However, if the most significant bit of BRKADR is set (=1), which can be accomplished by using the command

```
M 00F2 03 FF
```

or including the instruction

```
COM     $F2      SET BRKADR FLAG
```

in a program, then control is transferred to location 0000 when a program breakpoint occurs. This feature can be used to perform special functions when program breakpoints occcur. Two examples of the use of this feature are given below.

1) This example illustrates the use of a breakpoint routine to print the contents of the processor's registers and continue program execution each time a program breakpoint occurs.

```
          ORG     Ø        BREAKPOINT ROUTINE ADDRESS
          LDA B   #@15     SEND CR AND LF
          JSR     OUTCH    TO TERMINAL
          LDA B   #@12
          JSR     OUTCH
          TSX              X POINTS TO PROCESSOR STATUS
          LDA B   #7       INITIALIZE COUNTER
LOOP      LDA A   X        BYTE OF STATUS TO A REG
          PSH B            OUT2H & OUTS CLOBBER B REG
          JSR     OUT2H    PRINT OUT BYTE OF STATUS
          JSR     OUTS     SPACE OVER
          PUL B            RESTORE B REG
          INX              BUMP POINTER
          DEC B            DECREMENT COUNTER
          BNE     LOOP     IF NOT DONE, KEEP PRINTING
          RTI              CONTINUE PROGRAM EXECUTION
```

2) This example illustrates the use of a breakpoint routine to examine the contents of the A register and transfer control to the Monitor if A is clear (contains all zeroes). If A is not clear, program execution continues. This type of routine is used to implement "conditional breakpoints".

```
          ORG     Ø
          JMP     $Ø3ØØ    THIS BREAKPOINT ROUTINE
          ORG     $Ø3ØØ    STARTS AT Ø3ØØ
          TST A            TEST CONTENTS OF A REG
          BNE     CONTIN   A ALL ZEROES?
          JMP     CRLF     YES, JUMP TO MONITOR
CONTIN    RTI              NO, CONTINUE PROG EXEC
```

VI PAPER TAPE FORMAT

The PROM Monitor supports the paper tape format established by Motorola.

The first character of a record is an S. The digit following the S defines the type of record.

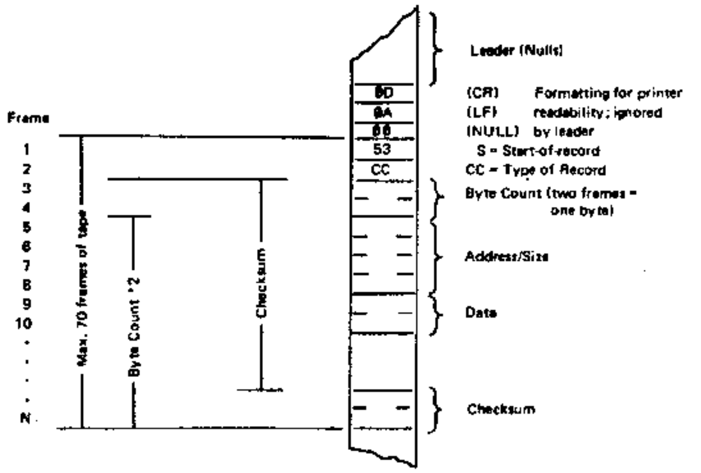
S0 = Header Record
S1 = Data Record
S9 = End of File Record

Header records (type S0) contain the program name, and are ignored by the PROM Monitor. The end of file record (type S9) causes the Monitor to terminate the loading process. Data records (type S1) contain the actual data to be loaded and are of the form:

```
S1NNAAAADDDDDDDDDD........DDCC
```

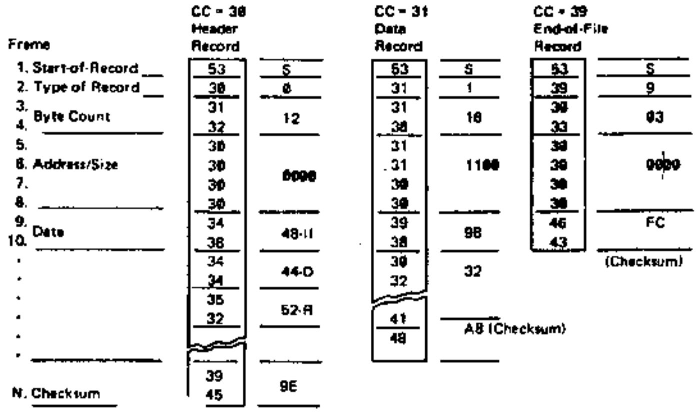
where S1 specifies that the record is a data record, NN is a two digit hexadecimal byte count specifying the number of remaining bytes in the record (1 byte = 2 frames of tape), AAAA is the 4 digit hexadecimal starting address of the data block, each DD pair consists of two hexadecimal digits which are combined to form a byte, and CC is the checksum of all preceding frames (excluding the S and 1). The checksum is the one's complement of the binary sum of the byte count, the address, and the data bytes.

Further information concerning the paper tape format is given in Figure 6-1.



Frames 3 through N are hexadecimal digits (in 7-bit ASCII) which are converted to BCD. Two BCD digits are combined to make one 8-bit byte.

The checksum is the one's complement of the summation of 8-bit bytes.



Frame	CC = 30 Header Record		CC = 31 Data Record		CC = 39 End-of-File Record	
1. Start-of-Record	53	S	53	S	53	S
2. Type of Record	30	0	31	1	39	9
3. Byte Count	31	12	31	10	30	03
4.	32		30		33	
5. Address/Size	30	0000	31	1100	30	0000
6.	30		31		30	
7.	30		30		30	
8.	30		30		30	
9. Data	34	48-H	39	98	46	FC (Checksum)
10.	38		38		43	
.	34	44-D	30	32		
.	34		32			
.	35	52-R	41	A8 (Checksum)		
.	32		48			
N. Checksum	39	9E				
	45					

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FIGURE 6-1. Paper Tape Format

VII PROM MONITOR MEMORY USE INFORMATION

Monitor Memory Location

The ACIA version of the PROM Monitor is 256 bytes long and resides in locations FF00 through FFFF. The Baudot version of the Monitor is 512 bytes long and resides in locations FE00 through FFFF.

Monitor Stack

The stack pointer is initialized to 00F1 whenever the Monitor is entered at its reset entry point. The stack pointer can be changed by using the Monitor's M and N commands to alter the contents of SAVSTK (see Monitor flags below)

> NOTE
>
> The contents of SAVSTK should generally not be changed when the Monitor is entered at a program breakpoint as this will cause the P command to operate improperly.

Monitor Flags

Locations 00F2 through 00FF are reserved for use by the Monitor. These locations are assigned as described below. With the exceptions of BRKADR, ECHO, and SAVSTK, these locations should generally not be tampered with.

BRKADR (00F2) - BREAKPOINT ADDRESS FLAG

If bit 7 of BRKADR is clear (=0) the Monitor gains processor control when a program breakpoint occurs. If bit 7 is set, control is transferred to location 0000 when a breakpoint occurs. See Section V for further information.

ECHO (00F3) - TELETYPE ECHO FLAG

(Applies to ACIA version only)

If bit 7 of ECHO is clear, Teletype input is echoed. If bit 7 is set, Teletype echo is suppressed. See Page 9 for further information.

EXTFLG (00F4) - EXTENDED CHARACTER FLAG

(Applies to Baudot version only)

EXTFLG is set when the Baudot character input routine receives the extend character and cleared after the extended character is received. See Section VIII for information on the Baudot version of the Monitor.

BUFULL (00F5) - BUFFER FULL FLAG

(Applies to Baudot version only)

If BUFULL is clear then the contents of the character buffer are not current. If BUFULL is set (any bits high) then the contents of the character buffer are current.

SAVSTK (00F6-00F7)

SAVSTK is used to save and restore the contents of the stack pointer.

TEMP (00F8)

TEMP is used for temporary storage during computation of paper tape checksums.

BYTECT (00F9) - BYTE COUNT

BYTECT contains the byte count during paper tape loading.

XHI (ØØFA)

XHI stores the high order byte of the index register.

XLO (ØØFB)

XLO stores the low order byte of the index register.

NOTE

XHI and XLO are also used to store the stack pointer when the Monitor is entered at a program breakpoint. This allows the N command to be used to examine the processor status. (See Section V for further information.)

SHIFT (ØØFC)

(Applies to Baudot version only)

SHIFT is set whenever the Baudot Teletype is in the upper case mode. SHIFT is clear whenever the Baudot Teletype is in the lower case mode.

SAVEX (ØØFD-OOFE)

(Applies to Baudot version only)

SAVEX is used by the Baudot output character routine to save and restore the contents of the index register.

BUFFER (ØØFF)

(Applies to Baudot version only)

BUFFER is the character buffer used by the Baudot input character routine.

Interrupt Vectors

The non-maskable interrupt vector points to location 0104.

The maskable interrupt vector points to location 0100 in the ACIA version of the Monitor. See Section VIII for information concerning the maskable interrupt vector in the Baudot version.)

VII BAUDOT TELETYPE OPTION INFORMATION

The Baudot version of the PROM Monitor is a 512 byte, 2 PROM chip version of the Monitor, which contains the necessary software to support a Baudot Teletype (using bit banger I/O) and convert between Baudot (5 level code) and 7 bit ASCII.

> NOTE
>
> The Monitor supports Baudot Teletypes wired for half duplex only.

Baudot Input

Input from the Baudot Teletype is handled by using the maskable interrupt feature of the 68ØØ MPU. Therefore, the interrupt mask (bit 4 in the processor condition codes register) must be clear (=Ø) to enable input from the Baudot Teletype.

The maskable interrupt vector points to location FEØØ. When a maskable interrupt request is acknowledged, the Monitor checks to see if the the interrupt request was originated by the Baudot Teletype. If so, the character code is clocked in. If the request was originated by a device other than the Baudot Teletype, control is transferred to location Ø1Ø4.

The Baudot input routine converts from Baudot to ASCII and then stores the ASCII character into a 1 byte buffer. Therefore, one character type ahead is possible.

> NOTE
>
> The Baudot output character routine masks out interrupts and therefore a character typed while output is occurring is likely to be either misread or lost entirely.

Baudot < > ASCII Conversion

Figure 8-1 shows the Baudot keyboard which the Monitor's Baudot < > ASCII conversion is based on. The Baudot character set contains 55 (decimal) useable codes. For most computer applications this is an insufficient number of character codes, and therefore the PROM Monitor supports an extended Baudot character set. Table 8-2 shows the characters supported by the Baudot version of the Monitor.

The following is a list of conventions used for Baudot < > ASCII conversion.

1) Extended characters are formed by combining an & (the extend character) with another upper case character. For example, an "=" sign is represented by "&;" .

2) On output, if an ASCII code cannot be matched with a Baudot code, the extend character is printed, followed by a blank.

3) On input, control characters are formed by combining an & (the extend character) with the appropriate lower case character. For example, to send a control-A, the extend character must be typed, followed by a letters shift, followed by an A.

4) On input, any upper case extended character which is not explicitly defined in Table 8-2 is matched to the ASCII control character of its associated lower case. For example, an extended ":" (&:) is matched to a control-C.

5) On input, the codes for null, line feed, and carriage return are unaffected by case. For example, a lower case line feed, an upper case line feed, and an extended line feed are all matched to an ASCII 12 (octal).

6) The letters and figures shift codes are not matched to ASCII codes. They serve only to change the character case.

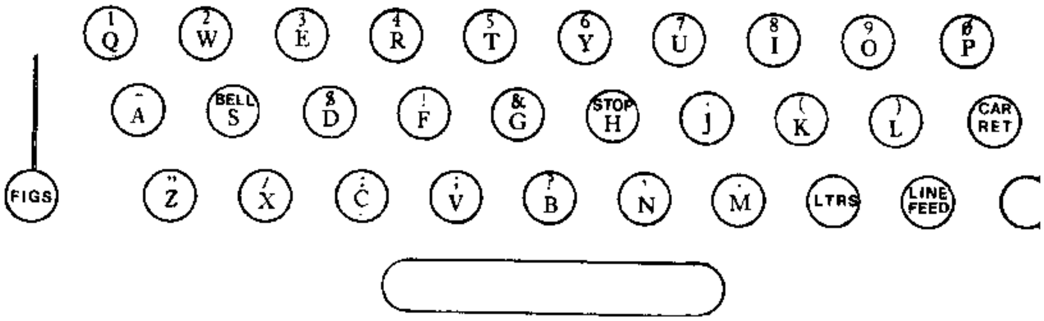

Figure 8-1. Baudot Keyboard

BAUDOT (OCTAL)	LOWER CASE	UPPER CASE	EXTENDED CASE
0	NULL	NULL	
1	E	3	
2	LINE FEED	LINE FEED	
3	A	-	_ SEE *2 BELOW
4	BLANK	BLANK	
5	S	CONTROL-G	
6	I	8	
7	U	7	
10	CAR RETURN	CAR RETURN	
11	D	$	ESCAPE
12	R	4	
13	J	'	
14	N	,	@
15	F	!	^
16	C	:	
17	K	(	<
20	T	5	
21	Z	"	#
22	L	)	>
23	W	2	
24	H	SEE *1 BELOW	
25	Y	6	
26	P	0	
27	Q	1	
30	O	9	
31	B	?	%
32	G	& (EXT CHAR)	+
33	FIG SHIFT	FIG SHIFT	
34	M	.	*
35	X	/	
36	V	;	=
37	LTR SHIFT	LTR SHIFT	

*1 ON INPUT A STOP IS MATCHED TO A NULL. THERE IS NO ASCII CODE WHICH WILL OUTPUT A STOP.

*2 THIS CHARACTER IS PRINTED AS A BACK ARROW ON TELETYPE MODEL 33.

TABLE 8-2 Baudot <>ASCII Conversion

PAGE ØØ1   PROM MON

IX PROM MONITOR SOURCE LISTING (ACIA VERSION)

```
                        NAM      PROM     MONITOR
                  **
                  ** ALTAIR 68ØB PROM MONITOR
                  ** ACIA VERSION 1.Ø
                  **
                        OPT      S        PRINT SYMBOL TABLE
                        OPT      PAGE     PAGINATED LISTING
          Ø1ØØ    MIVEC  EQU     $1ØØ
          Ø1Ø4    NMIVEC EQU     $1Ø4
          FØØ2    STRAPS EQU     $FØØ2
          ØØØØ    NOTERM EQU     Ø
          FØØØ    ACIACS EQU     $FØØØ
          FØØ1    ACIADA EQU     $FØØ1
                  **
                  * MONITOR STACK AND FLAGS
                  **
ØØF1                    ORG      $F1
ØØF1 ØØØ1         STACK  RMB     1        BOTTOM OF MONITOR'S STACK
ØØF2 ØØØ1         BRKADR RMB     1        BREAKPOINT ADDRESS FLAG
ØØF3 ØØØ1         ECHO   RMB     1        TTY ECHO FLAG
ØØF4 ØØØ1         EXTFLG RMB     1        EXTENDED CHARACTER FLAG
ØØF5 ØØØ1         BUFULL RMB     1        BUFFER FULL FLAG
ØØF6 ØØØ2         SAVSTK RMB     2        TEMP FOR STACK POINTER
ØØF8 ØØØ1         TEMP   RMB     1        TEMPORARY STORAGE
ØØF9 ØØØ1         BYTECT RMB     1        BYTE CGUNT
ØØFA ØØØ1         XHI    RMB     1        XREG HIGH
ØØFB ØØØ1         XLOW   RMB     1        XREG LOW
ØØFC ØØØ1         SHIFT  RMB     1        BAUDOT SHIFT FLAG
ØØFD ØØØ2         SAVEX  RMB     2        TEMP FOR INDEX RG
ØØFF ØØØ1         BUFFER RMB     1        BAUDOT CHARACTER BUFFER
                  **
                  * START OF PROM
                  *
FFØØ                    ORG      $FFØØ
                  **
                  * INPUT ONE CHAR INTO A-REGISTER
                  * ECHO CHAR IF BIT 7 OF ECHO FLAG IS CLEAR
                  **
FFØØ 8D 22        INCH  BSR      POLCAT   ACIA STATUS TO A REG
FFØ2 24 FC              BCC      INCH     RECEIVE NOT READY
FFØ4 C6 7F              LDA B    #$7F     MASK FOR PARITY REMOVAL
FFØ6 D1 F3              CMP B    ECHO     CHECK ECHO FLAG
FFØ8 F4 FØØ1            AND B    ACIADA   GET CHARACTER
FFØB 24 74              BCC      OUTCH    ECHO
FFØD 39                 RTS               NO ECHO
                  **
                  * THE FOLLOWING NOP LINES UP THE ENTRY
                  * POINTS TO POLCAT IN THE TWO VERSIONS
                  * OF THE MONITOR
                  **
FFØE Ø1                 NOP
```

```
---
PAGE  ØØ2   PROM MON


ØØØ59                   **
ØØØ6Ø                   * INPUT ONE HEX DIGIT INTO B REG
ØØØ61                   * RETURN TO CALLING PROGRAM IF
ØØØ62                   * CHARACTER RECEIVED IS A HEX
ØØØ63                   * DIGIT.  IF NOT HEX, GO TO CRLF
ØØØ64                   **
ØØØ65 FFØF 8D EF        INHEX  BSR        INCH      GET A CHARACTER
ØØØ66 FF11 CØ 3Ø               SUB B      #'Ø
ØØØ67 FF13 2B 3C               BMI        C1        NOT HEX
ØØØ68 FF15 C1 Ø9               CMP B      #$9
ØØØ69 FF17 2F ØA               BLE        IN1HG     NOT HEX
ØØØ7Ø FF19 C1 11               CMP B      #$11
ØØØ71 FF1B 2B 34               BMI        C1        NOT HEX
ØØØ72 FF1D C1 16               CMP B      #$16
ØØØ73 FF1F 2E 3Ø               BGT        C1        NOT HEX
ØØØ74 FF21 CØ Ø7               SUB B      #7        IT'S A LETTER-GET BCD
ØØØ75 FF23 39           IN1HG  RTS                  RETURN
ØØØ77                   * *
ØØØ78                   * POLE FOR CHARACTER
ØØØ79                   * SETS CARRY IF CHARACTER IS IN BUFFER
ØØØ8Ø                   * CLOBBERS B REG
ØØØ81                   **
ØØØ82 FF24 F6 FØØØ      POLCAT LDA B      ACIACS    ACIA STATUS TO B
ØØØ83 FF27 57                  ASR B                ROTATE RDRF BIT INTO CARRY
ØØØ84 FF28 39                  RTS                  RETURN
ØØØ88                   **
ØØØ89                   * LOAD PAPER TAPE
ØØØ9Ø                   * LOAD ONLY S1 TYPE RECORDS
ØØØ91                   * TERMINATE ON S9 OR CHECKSUM ERROR
ØØØ92                   **
ØØØ93 FF29 8D D5        LOAD   BSR        INCH      READ FRAME
ØØØ94 FF2B CØ 53               SUB B      #'S
ØØØ95 FF2D 26 FA               BNE        LOAD      FIRST CHAR NOT (S)
ØØØ96 FF2F 8D CF               BSR        INCH      READ FRAME
ØØØ97 FF31 C1 39               CMP B      #'9
ØØØ98 FF33 27 1C               BEQ        C1        S9 END OF FILE
ØØØ99 FF35 C1 31               CMP B      #'1
ØØ1ØØ FF37 26 FØ               BNE        LOAD      SECOND CHAR NOT (1)
ØØ1Ø1 FF39 4F                  CLR A                ZERO THE CHECKSUM
ØØ1Ø2 FF3A 8D 17               BSR        BYTE      READ BYTE
ØØ1Ø3 FF3C CØ Ø2               SUB B      #2
ØØ1Ø4 FF3E D7 F9               STA B      BYTECT    BYTE COUNT
ØØ1Ø5 FF4Ø 8D 2Ø               BSR        BADDR     GET ADDRESS OF BLOCK
ØØ1Ø6 FF42 8D ØF        LOAD11 BSR        BYTE      GET DATA BYTE
ØØ1Ø7 FF44 7A ØØF9             DEC        BYTECT    DECREMENT BYTE COUNT
ØØ1Ø8 FF47 27 Ø5               BEQ        LOAD15    DONE WITH THIS BLOCK
ØØ1Ø9 FF49 E7 ØØ               STA B      X         STORE DATA
ØØ11Ø FF4B Ø8                  INX                  BUMP POINTER
ØØ111 FF4C 2Ø F4               BRA        LOAD11    GO BACK FOR MORE
ØØ112 FF4E 4C           LOAD15 INC A                INCREMENT CHECKSUM
ØØ113 FF4F 27 D8        LLOAD  BEQ        LOAD      ALL OK - IT'S ZERO
ØØ114 FF51 2Ø 58        C1     BRA        CRLF      CHECKSUM ERROR - QUIT
```

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PAGE  003   PROM MON



00117                  **
00118                  * READ BYTE (2 HEX DIGITS)
00119                  * INTO B REG
00120                  * A IS USED FOR PAPER TAPE CHECKSUM
00121                  **
00122 FF53 8D BA   BYTE   BSR       INHEX    GET FIRST HEX DIG
00123 FF55 58             ASL B              SHIFT TO HIGH ORDER 4 BITS
00124 FF56 58             ASL B
00125 FF57 58             ASL B
00126 FF58 58             ASL B
00127 FF59 1B             ABA                ADD TO CHEKSUM
00128 FF5A D7 F8          STA B     TEMP     STORE DIGIT
00129 FF5C 8D B1          BSR       INHEX    GET 2ND HEX DIG
00130 FF5E 1B             ABA                ADD TO CHECKSUM
00131 FF5F DB F8          ADD B     TEMP     COMBINE DIGITS TO GET BYTE
00132 FF61 39             RTS                RETURN
00133                  **
00134                  * READ 16 BIT ADDRESS INTO X
00135                  * STORE SAME ADDRESS IN XHI & XLO
00136                  * CLOBBERS B REG
00137                  **
00138 FF62 8D EF   BADDR  BSR       BYTE     GET HIGH ORDER ADDRESS
00139 FF64 D7 FA          STA B     XHI      STORE IT
00140 FF66 8D EB          BSR       BYTE     GET LOW ORDER ADDRESS
00141 FF68 D7 FB          STA B     XLOW     STORE IT
00142 FF6A DE FA          LDX       XHI      LOAD X WITH ADDRESS BUILT
00143 FF6C 39             RTS                RETURN
00147                  **
00148                  * PRINT BYTE IN A REG
00149                  * CLOBBERS B REG
00150                  **
00151 FF6D 16      OUT2H  TAB                COPY BYTE TO B
00152 FF6E 54             LSR B              SHIFT TO RIGHT
00153 FF6F 54             LSR B
00154 FF70 54             LSR B
00155 FF71 54             LSR B
00156 FF72 8D 01          BSR       OUTHR    OUTPUT FIRST DIGIT
00157 FF74 16             TAB                BYTE INTO B AGAIN
00160 FF75 C4 0F   OUTHR  AND B     #$F      GET RID OF LEFT DIG
00161 FF77 CB 30          ADD B     #$30     GET ASCII
00162 FF79 C1 39          CMP B     #$39
00163 FF7B 23 04          BLS       OUTCH
00164 FF7D CB 07          ADD B     #7       IF IT'S A LETTER ADD 7
00165 FF7F 01             NOP                LINE UP OUTCH ENTRY POINTS
00166 FF80 01             NOP
```

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PAGE  ØØ4   PROM MON


ØØ167 FF81 8C       OUTCH  FCB       $8C       USE CPX SKIP TRICK
ØØ168 FF82 C6 2Ø    OUTS   LDA B     #$2Ø      OUTS PRINTS A SPACE
ØØ171               **
ØØ172               * OUTCH OUTPUTS CHARACTER IN B
ØØ173               **
ØØ174 FF84 37              PSH B               SAVE CHAR
ØØ175 FF85 8D 9D    OUTC1  BSR       POLCAT    ACIA STATUS TO B REG
ØØ176 FF87 57              ASR B
ØØ177 FF88 24 FB           BCC       OUTC1     XMIT NOT READY
ØØ178 FF8A 33              PUL B               CHAR BACK TO B REG
ØØ179 FF8B F7 FØØ1         STA B     ACIADA    OUTPUT CHARACTER
ØØ18Ø FF8E 39              RTS
ØØ183               **
ØØ184               * EXAMINE AND DEPOSIT NEXT
ØØ185               * USES CONTENTS OF XHI & XLO AS POINTER
ØØ186               **
ØØ187 FF8F DE FA    NCHANG LDX       XHI       INCREMENT POINTER
ØØ188 FF91 Ø8              INX
ØØ189 FF92 DF FA           STX       XHI
ØØ19Ø FF94 96 FA           LDA A     XHI
ØØ191 FF96 8D D5           BSR       OUT2H     PRINT OUT ADDRESS
ØØ192 FF98 96 FB           LDA A     XLOW
ØØ193 FF9A 8D D1           BSR       OUT2H
ØØ194 FF9C 8C              FCB       $8C       USE CPX SKIP TRICK
ØØ195               **
ØØ196               * EXAMINE & DEPOSIT
ØØ197               **
ØØ198 FF9D 8D C3    CHANGE BSR       BADDR     BUILD ADDRESS
ØØ199 FF9F 8D E1           BSR       OUTS      PRINT SPACE
ØØ2ØØ FFA1 A6 ØØ           LDA A     X         BYTE INTO A
ØØ2Ø1 FFA3 8D C8           BSR       OUT2H     PRINT BYTE
ØØ2Ø2 FFA5 8D DB           BSR       OUTS      PRINT SPACE
ØØ2Ø3 FFA7 8D AA           BSR       BYTE      GET NEW BYTE
ØØ2Ø4 FFA9 E7 ØØ           STA B     X         STORE NEW BYTE
ØØ2Ø6               **
ØØ2Ø7               * COMMAND DECODING SECTION
ØØ2Ø8               **
ØØ2Ø9 FFAB 9E F6    CRLF   LDS       SAVSTK
ØØ21Ø FFAD C6 ØD           LDA B     #$D       CARRIAGE RETURN
ØØ211 FFAF 8D DØ           BSR       OUTCH
ØØ212 FFB1 C6 ØA           LDA B     #$A       LINE FEED
ØØ213 FFB3 8D CC           BSR       OUTCH
ØØ214 FFB5 C6 2E           LDA B     #'.       PROMPT CHARACTER
ØØ215 FFB7 8D C8           BSR       OUTCH
ØØ216 FFB9 BD FFØØ         JSR       INCH      READ CHARACTER
ØØ217 FFBC 17              TBA                 MAKE A COPY
ØØ218 FFBD 8D C3           BSR       OUTS      PRINT SPACE
ØØ219 FFBF 81 4C           CMP A     #'L
ØØ22Ø FFC1 27 8C           BEQ       LLOAD     LOAD PAPER TAPE
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PAGE  005   PROM MON


00221 FFC3 81 4A             CMP A     #'J
00222 FFC5 26 04             BNE       NOTJ
00223 FFC7 8D 99             BSR       BADDR     GET ADDRESS TO JUMP TO
00224 FFC9 6E 00             JMP       X         JUMP TO IT
00225 FFCB 81 4D      NOTJ   CMP A     #'M
00226 FFCD 27 CE             BEQ       CHANGE    EXAMINE & DEPOSIT
00227 FFCF 81 4E             CMP A     #'N
00228 FFD1 27 BC             BEQ       NCHANG    E & D NEXT
00229 FFD3 81 50             CMP A     #'P
00230 FFD5 26 D4             BNE       CRLF
00231 FFD7 3B                RTI                 PROCEDE FROM BREAKPOINT
00233                 **
00234                 * RESET ENTRY POINT
00235                 **
00236 FFD8 8E 00F3    RESET  LDS       #ECHO     INITIALIZE STACK POINTER
00237 FFDB C6 03             LDA B     #3        INIT ECHO AND BRKADR FLAGS
00238 FFDD 37                PSH B
00239 FFDE 37                PSH B
00240 FFDF F7 F000           STA B     ACIACS    MASTER RESET ACIA
00241 FFE2 F6 F002           LDA B     STRAPS    LOOK AT STRAPS
00242 FFE5 2B 19             BMI       NOTERM    NO TERM - JUMP TO 0
00243 FFE7 C4 04             AND B     #4        GET # OF STOP BITS
00244 FFE9 CA D1             ORA B     #$D1
00245 FFEB F7 F000           STA B     ACIACS    INIT ACIA PORT
00246                 **
00247                 * SOFTWARE INTERRUPT ENTRY POINT
00248                 **
00249 FFEE 9F F6      INTRPT STS       SAVSTK    SAVE STACK POINTER
00250 FFF0 9F FA             STS       XHI       SAVE SP FOR N COMMAND
00251 FFF2 D6 F2             LDA B     BRKADR    IF BIT 7 OF BRKADR IS SET
00252 FFF4 2B 0A             BMI       NOTERM    JUMP TO 0
00253 FFF6 20 B3             BRA       CRLF      GOTO COMMAND DECODER
00256                 **
00257                 * NOW COME THE INTERRUPT VECTORS
00258                 **
00260 FFF8                   ORG       $FFF8
00263 FFF8 0100              FDB       MIVEC     MI VECTOR
00264 FFFA FFEE              FDB       INTRPT    SWI VECTOR
00265 FFFC 0104              FDB       NMIVEC    NMI VECTOR
00266 FFFE FFD8              FDB       RESET     RESET VECTOR
00268                        END
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PAGE  006    PROM MON


MIVEC   0100
NMIVEC  0104
STRAPS  F002
NOTERM  0000
ACIACS  F000
ACIADA  F001
STACK   00F1
BRKADR  00F2
ECHO    00F3
EXTFLG  00F4
BUFULL  00F5
SAVSTK  00F6
TEMP    00F8
BYTECT  00F9
XHI     00FA
XLOW    00FB
SHIFT   00FC
SAVEX   00FD
BUFFER  00FF
INCH    FF00
INHEX   FF0F
IN1HG   FF23
POLCAT  FF24
LOAD    FF29
LOAD11  FF42
LOAD15  FF4E
LLOAD   FF4F
C1      FF51
BYTE    FF53
BADDR   FF62
OUT2H   FF6D
OUTHR   FF75
OUTCH   FF81
OUTS    FF82
OUTC1   FF85
NCHANG  FF8F
CHANGE  FF9D
CRLF    FFAB
NOTJ    FFCB
RESET   FFD8
INTRPT  FFEE


TOTAL ERRORS 00000
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PAGE  001    PROM MON      X  PROM MONITOR SOURCE LISTING (BAUDOT VERSION)


                           NAM         PROM       MONITOR
                    **
                    ** ALTAIR 680B PROM MONITOR
                    ** BAUDOT VERSION 1.0
                    **
                           OPT         S          PRINT SYMBOL TABLE
                           OPT         PAGE       PAGINATED LISTING
          FE00      MIVEC  EQU         $FE00
          0104      NMIVEC EQU         $104
          0100      CRAZY  EQU         $100
          F002      STRAPS EQU         $F002
          0000      NOTERM EQU         0
          F000      ACIACS EQU         $F000
          F001      ACIADA EQU         $F001
     00F1                  ORG         $F1
     00F1 0001      STACK  RMB         1          BOTTOM OF MONITOR'S STACK
     00F2 0001      BRKADR RMB         1          BREAKPOINT ADDRESS FLAG
     00F3 0001      ECHO   RMB         1          TTY ECHO FLAG
     00F4 0001      EXTFLG RMB         1          EXTENDED CHARACTER FLAG
     00F5 0001      BUFULL RMB         1          BUFFER FULL FLAG
     00F6 0002      SAVSTK RMB         2          TEMP FOR STACK POINTER
     00F8 0001      TEMP   RMB         1          TEMPORARY STORAGE
     00F9 0001      BYTECT RMB         1          BYTE COUNT
     00FA 0001      XHI    RMB         1          XREG HIGH
     00FB 0001      XLOW   RMB         1          XREG LOW
     00FC 0001      SHIFT  RMB         1          BAUDOT SHIFT FLAG
     00FD 0002      SAVEX  RMB         2          TEMP FOR INDEX REG
     00FF 0001      BUFFER RMB         1          BAUDOT CHARACTER BUFFER
                    **
                    * START OF PROM
                    **
     FE00                  ORG         $FE00
                    **
                    * MASKABLE INTERRRUPT VECTOR POINTS TO GET
                    **
     FE00 86 40     GET    LDA A       #$40       THIS BIT ROTATES INTO CARRY
                    *                               TO SIGNAL STOP BIT ARRIVAL
     FE02 F6 F002          LDA B       STRAPS     IF BIT 0 OF F002 IS LOW
     FE05 56               ROR B                  THEN INTERRUPT CAME FROM BAUDOT
     FE06 24 21            BCC         GETBIT     SO CLOCK IN CHAR CODE
     FE08 7E               FCB         $7E        IF BIT 0 IS HIGH
     FE09 01               FCB         001        JUMP TO 0100 (HEX)
                    **
                    * THIS IS THE UPPPER CASE CONVERSION TABLE
                    **
     FE0A 00        UPCAS  FCB         0          NULL
     FE0B 33               FCC         /3/
     FE0C 0A               FCB         $A         LINE FEED
     FE0D 2D               FCC         /-/
     FE0E 20               FCB         $20        BLANK
     FE0F 07               FCB         7          CONTROL G (BELL)
     FE10 38               FCC         /87/
     FE11 37
     FE12 0D               FCB         $D         CARRIAGE RETURN
```

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PAGE  002    PROM MON


00054 FE13 24            FCC       /$4'/
      FE14 34
      FE15 27
00055 FE16 2C            FCC       /,/
00056 FE17 21            FCC       /!:(5/
      FE18 3A
      FE19 28
      FE1A 35
00057 FE1B 22            FCC       /"/
00058 FE1C 29            FCC       /)/
00059 FE1D 32            FCC       /2/
00060 FE1E 00            FCB       0         SLOT FOR STOP
00061 FE1F 36            FCC       /6019?/
      FE20 30
      FE21 31
      FE22 39
      FE23 3F
00062 FE24 00            FCB       0         SLOT FOR &
00063 FE25 00            FCB       0         SLOT FOR FIGURES SHIFT
00064 FE26 2E            FCC       /./
00065 FE27 2F            FCC       !/!
00066 FE28 3B            FCC       /;/
00067               **
00068               * END OF UPPER CASE TABLE
00069               **
00070 FE29 8D 3D    GETBIT BSR     WAIT11    WAIT HALF A BIT TIME
00071 FE2B F6 F002         LDA B   STRAPS
00072 FE2E 56              ROR B             PUT DATA BIT INTO CARRY
00073 FE2F 8D 37           BSR     WAIT11    FINISH UP BIT TIME
00074 FE31 46              ROR A             COLLECT CODE IN A
00075 FE32 24 F5           BCC     GETBIT    IF MORE TO COME GO GET EM
00076 FE34 48              ASL A             GET RID OF STOP BIT
00077 FE35 44              LSR A             RIGHT JUSTIFY CODE
00078 FE36 44              LSR A
00079 FE37 44              LSR A
00080               **
00081               * WE HAVE THE CODE IN A NOW
00082               **
00083 FE38 81 1B           CMP A   #$1B      IF IT'S AN UPSHIFT
00084 FE3A 26 03           BNE     NTUP      SET THE SHIFT FLAG
00085 FE3C D7 FC    CLRSF  STA B   SHIFT     AND RETURN FROM INTERRUPT
00086 FE3E 3B              RTI
00088 FE3F 5F       NTUP   CLR B
00089 FE40 81 1F           CMP A   #$1F      IF IT'S A DOWNSHIFT
00090 FE42 27 F8           BEQ     CLRSF     CLEAR THE SHIFT FLAG
00092 FE44 D1 F4           CMP B   EXTFLG    IF EXTENDED CHARACTER
00093 FE46 2B 31           BMI     EXTCAR    IS SET GO TO EXT
00094               *                        CHARACTER SEARCH
00095 FE48 CE FEE2         LDX     #LOWCAS-2
00096               * SET POINTER TO LOWER CASE
00097 FE4B D1 FC           CMP B   SHIFT     IF SHIFT FLAG IS SET
00098 FE4D 2B 20           BMI     UPCAR     THEN INDEX INTO UPPER CASE TABLE
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PAGE  ØØ3   PROM MON


3ØØ99 FE4F Ø8        ADDAX   INX                   ADD A REG TO X REG
ØØ1ØØ FE5Ø 4A                DEC A
ØØ1Ø1 FE51 2A FC             BPL        ADDAX
ØØ1Ø2 FE53 53        DONE    COM B                 FORM MASK
ØØ1Ø3 FE54 D7 F5             STA B      BUFULL     SET BUFFER FULL FLAG
ØØ1Ø4 FE56 E4 Ø1             AND B      1,X        MASK OFF LOW 6 OR ALL 8
ØØ1Ø5 FE58 D7 FF             STA B      BUFFER     STORE CHAR INTO BUFFER
ØØ1Ø6 FE5A 3B                RTI                   RETURN FROM THE INTERRUPT
ØØ1Ø7                **
ØØ1Ø8                * PUT CLOCKS OUT THE CHARACTER CODE
ØØ1Ø9                **
ØØ11Ø FE5B 48        PUT     ASL A                 ROTATE IN START BIT
ØØ111 FE5C 8A 4Ø             ORA A      #$4Ø       OR IN STOP BIT
ØØ112 FE5E B7 FØØ2   NXTBIT  STA A      $FØØ2      SEND A BIT
ØØ113 FE61 8D Ø5             BSR        WAIT11
ØØ114 FE63 8D Ø3             BSR        WAIT11     WAIT AROUND FOR 22 MIL SECS
ØØ115 FE65 44                LSR A                 SHIFT TO NEXT BIT
ØØ116 FE66 26 F6             BNE        NXTBIT     IF MORE TO SEND THEN DO SO
ØØ118 FE68 CE Ø2AF   WAIT11  LDX        #687       11 MIL SEC DELAY
ØØ119 FE6B Ø9        WAIT    DEX
ØØ12Ø FE6C 26 FD             BNE        WAIT
ØØ121 FE6E 39                RTS
ØØ123 FE6F CE FEØ8   UPCAR   LDX        #UPCAS-2 POINT TO UPPER CASE TABLE
ØØ124 FE72 81 1A             CMP A      #$1A       IF IT'S THE EXTEND CHAR THEN
ØØ125 FE74 26 D9             BNE        ADDAX      SET THE EXTENDED CHAR FLAG
ØØ126 FE76 97 F4             STA A      EXTFLG     AND RETURN FROM INTERRUPT
ØØ127 FE78 3B                RTI
ØØ129 FE79 CE FFEØ   EXTCAR  LDX        #EXTEND-2 POINT TO EXTENDED CHAR TABLE
ØØ13Ø FE7C D7 F4             STA B      EXTFLG     CLEAR THE EXTEND FLAG
ØØ131 FE7E Ø8        CHKNXT  INX
ØØ132 FE7F Ø8                INX
ØØ133 FE8Ø A1 ØØ             CMP A      X          SEARCH THE EXTENDED CHAR TABLE
ØØ134 FE82 27 CF             BEQ        DONE       IF MATCH FOUND THEN WE ARE DONE
ØØ135 FE84 6D ØØ             TST        X          IF MINUS ENCOUNTERED THEN CODE NOT
ØØ136 FE86 2A F6             BPL        CHKNXT     IN TABLE SO MAKE INTO CONTROL CHAR
ØØ137 FE88 CE FEE2           LDX        #LOWCAS-2 BY TAKING LOWER CASE ASCII AND
ØØ138 FE8B C6 CØ             LDA B      #$CØ       SETTING MASK TO GET RIG OF HI
ØØ139 FE8D 2Ø CØ             BRA        ADDAX      ORDER 2 BITS
ØØ14Ø FE8F 96 FC     CHKUP   LDA A      SHIFT      BEFORE CHECKING UPPPER CASE TABLE
ØØ141 FE91 26 Ø6             BNE        OKUP       CHECK THE SHIFT FLAG
ØØ142 FE93 86 1B             LDA A      #$1B       SEND OUT FIGURES SHIFT AND SET
ØØ143 FE95 97 FC             STA A      SHIFT      SHIFT FLAG AS NECESSARY
ØØ144 FE97 8D C2             BSR        PUT
ØØ145 FE99 CE FEØA   OKUP    LDX        #UPCAS     SET POINTER TO UPPER CASE TABLE
ØØ146 FE9C 8D 39             BSR        SEARCH     CALL SEARCH ROUTINE
ØØ147 FE9E 2A 2F             BPL        RESTR      IF POSITIVE, SEARCH WAS SUCCESSFUL
ØØ148 FEAØ 86 1A             LDA A      #$1A       SEARCH FAILED SO OUTPUT EXTEND
ØØ149 FEA2 8D B7             BSR        PUT        CHARACTER
ØØ15Ø FEA4 CE FFEØ           LDX        #EXTEND-2
ØØ151 FEA7 E1 Ø1     NXT     CMP B      1,X        SEARCH THROUGH EXTENDED CHAR
ØØ152 FEA9 27 24             BEQ        RESTR      TABLE
```

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PAGE  ØØ4   PROM MON


FEAB Ø8                   INX
FEAC Ø8                   INX                   BUMP POINTER TWICE
FEAD A6 ØØ                LDA A       X         LOAD THE BAUDOT CODE INTO B
FEAF 2A F6                BPL         NXT       IF MINUS - END OF TABLE
FEB1 C6 2Ø                LDA B       #$2Ø      NO MATCH FOUND - OUTPUT BLANK
FEB3 8D Ø4                BSR         BOUT2
FEB5 2Ø 1A                BRA         REST2
                  **
                  * BOUTCH IS THE OUTPUT CHARACTER ROUTINE
                  **
FEB7 DF FD        BOUTCH  STX         SAVEX     SAVE X,A,&B
FEB9 ØF           BOUT2   SEI                   DISENABLE INTERRUPTS
FEBA 36                   PSH A
FEBB 37                   PSH B
FEBC CE FEE4              LDX         #LOWCAS   SET POINTER TO LOWER CASE
FEBF 8D 16                BSR         SEARCH    TABLE AND CALL SEARCH ROUTINE
FEC1 2B CC                BMI         CHKUP     IF MINUS, THEN SEARCH FAILED
FEC3 D6 FC                LDA B       SHIFT     CHECK THE SHIFT FLAG
FEC5 27 Ø8                BEQ         RESTR
FEC7 36                   PSH A                 IF FLAG IS SET THEN SEND OUT
FEC8 86 1F                LDA A       #$1F      LETTERS SHIFT AND CLEAR FLAG
FECA 8D 8F                BSR         PUT
FECC 97 FC                STA A       SHIFT     A IS CLEAR ON RETURN FROM PUT
FECE 32                   PUL A
FECF 8D 8A        RESTR   BSR         PUT
FED1 33           REST2   PUL B                 RESTORE B
FED2 32                   PUL A                 RESTORE A REG
FED3 DE FD                LDX         SAVEX     RESTORE X REG
FED5 ØE                   CLI                   ENABLE INTERRUPTS
FED6 39           RET     RTS                   RETURN
                  **
                  * SUBROUTINE TO SEARCH CONVERSION TABLES
                  * RETURNS WITH CODE IN A IF FOUND
                  * RETURNS WITH N BIT SET IF NOT FOUND
                  **
FED7 4F           SEARCH  CLR A
FED8 6D ØØ        NXTCHK  TST         X
FEDA 2B FA                BMI         RET       IF MINUS - END OF TABLE
FEDC E1 ØØ                CMP B       X
FEDE 27 F6                BEQ         RET       MATCH - RETURN
FEEØ Ø8                   INX                   INCREMENT POINTER
FEE1 4C                   INC A                 INCPEMENT OUTPUT CODE
FEE2 2Ø F4                BRA         NXTCHK    CONTINUE SEARCH
                  **
                  * LOWER CASE CONVERSION TABLE
                  **
FEE4 ØØ           LOWCAS  FCB         Ø         NULL
FEE5 45                   FCC         /E/
FEE6 ØA                   FCB         $A        LINE FEED
FEE7 41                   FCC         /A/
FEE8 2Ø                   FCB         $2Ø       BLANK
FEE9 53                   FCC         /SIU/
FEEA 49
FEEB 55
```

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PAGE  005   PROM MON


00205 FEEC 0D              FCB      $D        CARRIAGE RETURN
00206 FEED 44              FCC      /DRJNFCKTZLWHYPQOBG/
      FEEE 52
      FEEF 4A
      FEF0 4E
      FEF1 46
      FEF2 43
      FEF3 4B
      FEF4 54
      FEF5 5A
      FEF6 4C
      FEF7 57
      FEF8 48
      FEF9 59
      FEFA 50
      FEFB 51
      FEFC 4F
      FEFD 42
      FEFE 47
00207 FEFF 00              FCB      0         SLOT FOR FIGURES SHIFT
00208               **
00209               * INCH ENTRY POINT MUST BE AT START OF SECOND PROM
00210               **
00211 FF00 4D       INCH   FCC      /MXV/
      FF01 58
      FF02 56
00213 FF03 8D 1F    HANG   BSR      POLCAT    IF BUFFER IS EMPTY
00214 FF05 24 FC           BCC      HANG      HANG AROUND FOR INTERRUPT
00215 FF07 7F 00F5         CLR      BUFULL    CLEAR THE BUFFER FULL FLAG
00216 FF0A D6 FF           LDA B    BUFFER    PUT CHAR INTO B
00217 FF0C 39              RTS                RETURN
00218               **
00219               * INPUT ONE HEX DIGIT INTO B REG
00220               * RETURN TO CALLING PROGRAM IF
00221               * CHARACTER RECEIVED IS A HEX
00222               * DIGIT.  IF NOT HEX, GO TO CRLF
00223               **
00224 FF0D 8D F1    INHEX  BSR      INCH      GET A CHARACTER
00225 FF0F C0 30           SUB B    #'0
00226 FF11 2B 3D           BMI      C1        NOT HEX
00227 FF13 C1 09           CMP B    #$9
00228 FF15 2F 0A           BLE      IN1HG     NOT HEX
00229 FF17 C1 11           CMP B    #$11
00230 FF19 2B 35           BMI      C1        NOT HEX
00231 FF1B C1 16           CMP B    #$16
00232 FF1D 2E 31           BGT      C1        NOT HEX
00233 FF1F C0 07           SUB B    #7        IT'S A LETTER-GET BCD
00234 FF21 39       IN1HG  RTS                RETURN
00235               **
00236               * THIS HELPS LINE UP ENTRY POINTS
00237               **
00238 FF22 20 93    BBOUTC BRA      BOUTCH
00239               **
```

```
00240                       * POLE FOR CHARACTER
00241                       * SET CARRY IF CHAR IN BUFFER IS CURRENT
00242                       * CLEAR CARRY IF NOT CURRENT
00243                       **
00244 FF24 D6 F5            POLCAT LDA B      BUFULL
00245 FF26 57                      ASR B
00246 FF27 39                      RTS
00247                       **
00248                       * LOAD PAPER TAPE
00249                       * LOAD ONLY S1 TYPE RECORDS
00250                       * TERMINATE ON S9 OR CHECKSUM ERROR
00251                       **
00252 FF28 8D D6            LOAD    BSR       INCH      READ FRAME
00253 FF2A C0 53                    SUB B     #'S
00254 FF2C 26 FA                    BNE       LOAD      FIRST CHAR NOT (S)
00255 FF2E 8D D0                    BSR       INCH      READ FRAME
00256 FF30 C1 39                    CMP B     #'9
00257 FF32 27 1C                    BEQ       C1        S9 END OF FILE
00258 FF34 C1 31                    CMP B     #'1
00259 FF36 26 F0                    BNE       LOAD      SECOND CHAR NOT (1)
00260 FF38 4F                       CLR A               ZERO THE CHECKSUM
00261 FF39 8D 17                    BSR       BYTE      READ BYTE
00262 FF3B C0 02                    SUB B     #2
00263 FF3D D7 F9                    STA B     BYTECT    BYTE COUNT
00264 FF3F 8D 20                    BSR       BADDR     GET ADDRESS OF BLOCK
00265 FF41 8D 0F            LOAD11  BSR       BYTE      GET DATA BYTE
00266 FF43 7A 00F9                  DEC       BYTECT    DECREMENT BYTE COUNT
00267 FF46 27 05                    BEQ       LOAD15    DONE WITH THIS BLOCK
00268 FF48 E7 00                    STA B     X         STORE DATA
00269 FF4A 08                       INX                 BUMP POINTER
00270 FF4B 20 F4                    BRA       LOAD11    GO BACK FOR MORE
00271 FF4D 4C               LOAD15  INC A               INCREMENT CHECKSUM
00272 FF4E 27 D8            LLOAD   BEQ       LOAD      ALL OK - IT'S ZERO
00273 FF50 20 4D            C1      BRA       CRLF      CHECKSUM ERROR - QUIT
00274                       **
00275                       * READ BYTE (2 HEX DIGITS)
00276                       * INTO B REG
00277                       * A IS USED FOR PAPER TAPE CHECKSUM
00278                       **
00279 FF52 8D B9            BYTE    BSR       INHEX     GET FIRST HEX DIG
00280 FF54 58                       ASL B               SHIFT TO HIGH ORDER 4 BITS
00281 FF55 58                       ASL B
00282 FF56 58                       ASL B
00283 FF57 58                       ASL B
00284 FF58 1B                       ABA                 ADD TO CHEKSUM
00285 FF59 D7 F8                    STA B     TEMP      STORE DIGIT
00286 FF5B 8D B0                    BSR       INHEX     GET 2ND HEX DIG
00287 FF5D 1B                       ABA                 ADD TO CHECKSUM
00288 FF5E DB F8                    ADD B     TEMP      COMBINE DIGITS TO GET BYTE
00289 FF60 39                       RTS                 RETURN
00290                       **
00291                       * READ 16 BIT ADDRESS INTO X
00292                       * STORE SAME ADDRESS IN XHI & XLO
00293                       * CLOBBERS B REG
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PAGE  007   PROM MON


00294                   **
00295 FF61 8D EF        BADDR  BSR         BYTE      GET HIGH ORDER ADDRESS
00296 FF63 D7 FA               STA B       XHI       STORE IT
00297 FF65 8D EB               BSR         BYTE      GET LOW ORDER ADDRESS
00298 FF67 D7 FB               STA B       XLOW      STORE IT
00299 FF69 DE FA               LDX         XHI       LOAD X WITH ADDRESS BUILT
00300 FF6B 39                  RTS                   RETURN
00301                   **
00302                   * PRINT BYTE IN A REG
00303                   * CLOBBERS B REG
00304                   **
00305 FF6C 16           OUT2H  TAB                   COPY BYTE TO B
00306 FF6D 54                  LSR B                 SHIFT TO RIGHT
00307 FF6E 54                  LSR B
00308 FF6F 54                  LSR B
00309 FF70 54                  LSR B
00310 FF71 8D 01               BSR         OUTHR     OUTPUT FIRST DIGIT
00311 FF73 16                  TAB                   BYTE INTO B AGAIN
00312 FF74 C4 0F        OUTHR  AND B       #$F       GET RID OF LEFT DIG
00313 FF76 CB 30               ADD B       #$30      GET ASCII
00314 FF78 C1 39               CMP B       #$39
00315 FF7A 23 05               BLS         OUTCH
00316 FF7C CB 07               ADD B       #7        IF IT'S A LETTER ADD 7
00317 FF7E 8C                  FCB         $8C
00318 FF7F C6 20        OUTS   LDA B       #$20      OUTS PRINTS A SPACE
00319                   **
00320                   * OUTCH OUTPUTS CHAR IN B
00321                   **
00322 FF81 20 9F        OUTCH  BRA         BBOUTC
00323                   **
00324                   * EXAMINE AND DEPOSIT NEXT
00325                   * USES CONTENTS OF XHI & XLO AS POINTER
00326                   **
00327 FF83 DE FA        NCHANG LDX         XHI       INCREMENT POINTER
00328 FF85 08                  INX
00329 FF86 DF FA               STX         XHI
00330 FF88 96 FA               LDA A       XHI
00331 FF8A 8D E0               BSR         OUT2H     PRINT OUT ADDRESS
00332 FF8C 96 FB               LDA A       XLOW
00333 FF8E 8D DC               BSR         OUT2H
00334 FF90 8C                  FCB         $8C
00335                   **
00336                   * EXAMINE & DEPOSIT
00337                   **
00338 FF91 8D CE        CHANGE BSR         BADDR     BUILD ADDRESS
00339 FF93 8D EA               BSR         OUTS      PRINT SPACE
00340 FF95 A6 00               LDA A       X         BYTE INTO A
00341 FF97 8D D3               BSR         OUT2H     PRINT BYTE
00342 FF99 8D E4               BSR         OUTS      PRINT SPACE
00343 FF9B 8D B5               BSR         BYTE      GET NEW BYTE
00344 FF9D E7 00               STA B       X         STORE NEW BYTE
00345                   **
00346                   * COMMAND DECODING SECTION
00347                   **
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00348 FF9F 9E F6    CRLF   LDS        SAVSTK
00349 FFA1 C6 0D           LDA B      #$D      CARRIAGE RETURN
00350 FFA3 8D DC           BSR        OUTCH
00351 FFA5 C6 0A           LDA B      #$A      LINE FEED
00352 FFA7 8D D8           BSR        OUTCH
00353 FFA9 C6 2E           LDA B      #'.      PROMPT CHARACTER
00354 FFAB 8D D4           BSR        OUTCH
00355 FFAD BD FF00         JSR        INCH     READ CHARACTER
00356 FFB0 17              TBA                 MAKE A COPY
00357 FFB1 8D CC           BSR        OUTS     PRINT SPACE
00358 FFB3 81 4C           CMP A      #'L
00359 FFB5 27 97           BEQ        LLOAD    LOAD PAPER TAPE
00360 FFB7 81 4A           CMP A      #'J
00361 FFB9 26 04           BNE        NOTJ
00362 FFBB 8D A4           BSR        BADDR    GET ADDRESS TO JUMP TO
00363 FFBD 6E 00           JMP        X        JUMP TO IT
00364 FFBF 81 4D    NOTJ   CMP A      #'M
00365 FFC1 27 CE           BEQ        CHANGE   EXAMINE & DEPOSIT
00366 FFC3 81 4E           CMP A      #'N
00367 FFC5 27 BC           BEQ        NCHANG   E & D NEXT
00368 FFC7 81 50           CMP A      #'P
00369 FFC9 26 D4           BNE        CRLF
00370 FFCB 3B              RTI                 PROCEDE FROM BREAKPOINT
00371 FFCC 8E 00F5 RESET   LDS        #BUFULL  INIT STACK POINTER
00372 FFCF 4F              CLR A
00373 FFD0 36              PSH A               INIT BUFFER FULL FLAG
00374 FFD1 36              PSH A               INIT EXT CHAR FLAG
00375 FFD2 36              PSH A               INIT ECHO FLAG
00376 FFD3 36              PSH A               INIT BRKADR FLAG
00377               **
00378               * SOFTWARE INTERRUPT ENTRY POINT
00379               **
00380 FFD4 9F F6    INTRPT STS        SAVSTK   SAVE STACK POINTER
00381 FFD6 9F FA           STS        XHI      SAVE SP FOR N COMMAND
00382 FFD8 0E              CLI                 ENABLE INTERRUPTS
00383 FFD9 B6 F002         LDA A      STRAPS   IF NO TERMINAL BIT IS SET
00384 FFDC 9A F2           ORA A      BRKADR   OR BIT 7 OF BRKADR IS SET
00385 FFDE 2B 20           BMI        NOTERM   JUMP TO 0
00386 FFE0 20 BD           BRA        CRLF     TO COMMAND DECODER
00387               **
00388               * EXTENDED CHARACTER TABLE
00389               **
00390 FFE2 03       EXTEND FCB        3
00391 FFE3 5F              FCC        / /
00392 FFE4 1E              FCB        $1E
00393 FFE5 3D              FCC        /=/
00394 FFE6 09              FCB        $9
00395 FFE7 1B              FCB        $1B      ESCAPE CHARACTER
00396 FFE8 0D              FCB        $D
00397 FFE9 5E              FCC        / /
00398 FFEA 1A              FCB        $1A
00399 FFEB 2B              FCC        /+/
00400 FFEC 0F              FCB        $F
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PAGE  009   PROM MON


00401 FFED 3C              FCC     /</
00402 FFEE 12              FCB     $12
00403 FFEF 3E              FCC     />/
00404 FFF0 1C              FCB     $1C
00405 FFF1 2A              FCC     /*/
00406 FFF2 11              FCB     $11
00407 FFF3 23              FCC     /#/
00408 FFF4 19              FCB     $19
00409 FFF5 25              FCC     /%/
00410 FFF6 0C              FCB     $C
00411 FFF7 40              FCC     /@/
00412               **
00413               * NOW COME THE INTERRUPT VECTORS
00414               **
00415 FFF8                 ORG     $FFF8
00416 FFF8 FE00            FDB     MIVEC    MI VECTOR
90417 FFFA FFD4            FDB     INTRPT   SWI VECTOR
00418 FFFC 0104            FDB     NMIVEC   NMI VECTOR
00419 FFFE FFCC            FDB     RESET    RESET VECTOR
00420                      END


MIVEC   FE00
NMIVEC  0104
CRAZY   0100
STRAPS  F002
NOTERM  0000
ACIACS  F000
ACIADA  F001
STACK   00F1
BRKADR  00F2
ECHO    00F3
EXTFLG  00F4
BUFULL  00F5
SAVSTK  00F6
TEMP    00F8
BYTECT  00F9
XHI     00FA
XLOW    00FB
SHIFT   00FC
SAVEX   00FD
BUFFER  00FF
GET     FE00
UPCAS   FE0A
GETBIT  FE29
CLRSF   FE3C
NTUP    FE3F
ADDAX   FE4F
DONE    FE53
PUT     FE5B
NXTBIT  FE5E
WAIT11  FE68
WAIT    FE6B
UPCAR   FE6F
EXTCAR  FE79
CHKNXT  FE7E

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PAGE  010   PROM MON



CHKUP  FE8F
OKUP   FE99
NXT    FEA7
BOUTCH FEB7
BOUT2  FEB9
RESTR  FECF
REST2  FED1
RET    FED6
SEARCH FED7
NXTCHK FED8
LOWCAS FEE4
INCH   FF00
HANG   FF03
INHEX  FF0D
IN1HG  FF21
BBOUTC FF22
POLCAT FF24
LOAD   FF28
LOAD11 FF41
LOAD15 FF4D
LLOAD  FF4E
C1     FF50
BYTE   FF52
BADDR  FF61
OUT2H  FF6C
OUTHR  FF74
OUTS   FF7F
OUTCH  FF81
NCHANG FF83
CHANGE FF91
CRLF   FF9F
NOTJ   FFBF
RESET  FFCC
INTRPT FFD4
EXTEND FFE2


TOTAL ERRORS 00000

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