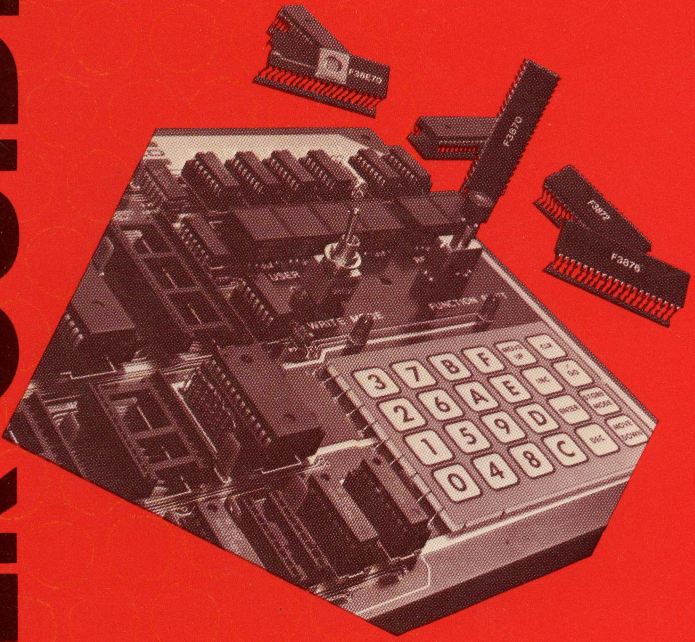
PEPBUG USER GUIDE



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PEPBUG USER GUIDE

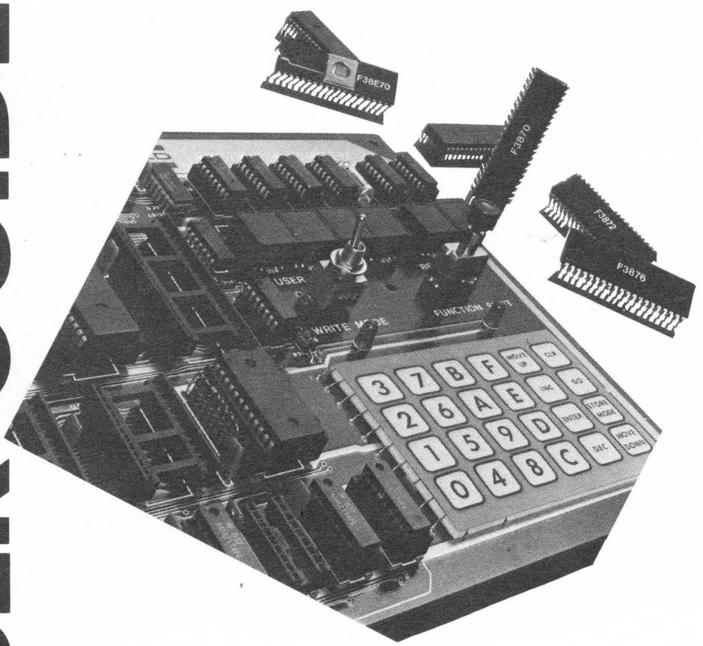

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TABLE OF CONTENTS

Section **Page**

Figures

Appendices

1.0 General Description

A special F38T56 PSU with a debug monitor (PEPBUG) has been developed by Fairchild to provide the user with a convenient and powerful programming debug facility to aid in the development of F8 or F387X programs. The debugging program provides the user with an interactive system via a teletype terminal or via a 4 x 6 keypad.

The PEPBUG PSU is assigned memory addresses '8000'-'87FF', with entry point being '8080'. The port assignments are as follows:

I/O PORT A	'28'
I/O PORT B	'29'
Local Int. Control	'2A'
Timer	'2B'

The Interrupt address vector for the timer is '0300' and for an External Interrupt is '0380'.

1.1 Electrical Specifications

Since this is just a standard PSU with a special program on it, the dc and ac electrical characteristics of the F38T56 are identical to those described in the F38T56 data sheet.

2.0 PEPBUG Overview

PEPBUG provides the following capabilities:

Display or Alter Memory Locations
Display or Alter Scratchpad Registers
Display or Alter I/O Ports
Display or Alter Accumulator,ISAR,Status(W Register)
Display or Alter PC0,PC1,DC0,DC1
Load Formatted Paper Tape (FAIR-BUG or Formulator Format)
Punch Formatted Paper Tape (Formulator Format)
Punch Paper Tape in PROM Format (8-Bit Binary Format)
Entry from Keyboard or by Program Instruction
I/O Subroutines Available to User
Breakpoint
Block Memory Move
Hexadecimal Arithmetic
Program F38E70 or F2716 EPROM.

PEPBUG can be entered in several ways. Execution of a program instruction such as PI'8080', JMP '8080', LR,P0,Q, or PK (when Q or K contains '8080') can be used to achieve entry from another software module. Another technique is to use hardware to decode the RESET state on the ROMC lines and force the high order bit on the Data Bus to a '1' at this time.

PEPBUG will save the state of the machine upon entry and will restore it upon return to the user's program. The interrupt is disabled by PEPBUG and may be re-enabled by the user if desired. RAM at memory locations H'2B80' to H'2BE5' is used as save and work area by PEPBUG. Address 2B80 was chosen for RAM address for two reasons:

1. Keep it out of user's first 8K address space
2. Minimize change of chip select logic necessary to switch from KD-BUG to PEPBUG. KD-BUG uses RAM Bxx or 3xx.

An ideal part to use for this RAM is an F6810 128 x 8 Static RAM.

Two I/O ports (28 and 29) are available to the user when PEPBUG is not executing, as are the Timer and External Interrupt facilities.(PEPBUG does not use either of these.) During PEPBUG execution Port 28 is used for serial input/ output and control functions while Port 29 is used for parallel input from a high speed paper tape reader. Assignments for Port 28 are:

Bit	**Function**			
7	Serial input (0 Volts= MARK)			
6	Character Ready Input (Parallel Device) (+5 V=READY)			
5	TTY or KEYBOARD IO (0 Volts = KEYPAD)			
4	Device Ready Input (Parallel Device) (+5 V=READY)			
3	Step Reader Output (Parallel Device) (0 Volts=Step)			
2-1	**Bit 2**	**Bit 1**	**Baud Rate**	
	0	0	110 Baud for Serial I/O	
	0	1	300 Baud for Serial I/O	1=GND,0=+5V
	1	0	1200 Baud for Serial I/O	
0	Serial Output (0 Volts=MARK)			

If Port 29 is not utilized by PEPBUG, then Pins 3, 4, and 6 of Port 28 are also available to the user. If Port 29 is used for parallel input, the parallel input data should have logic '1' corresponding to a +5 V electrical level.

Bits 1 and 2 of Port 28 are examined when PEPBUG is entered to initialize the Baud Delay Counter. If Bits 2 and 3 are at ground so that the Baud Delay count is being obtained from memory location H'2BC3', then the total delay count (time between bits for a bit serial I/O device) can be adjusted as follows:

```
Bit time interval=(256-count) x 36 us + 55 us
Thus, 110 Baud requires a count of 06
       300 Baud requires a count of A4
      1200 Baud requires a count of EA
```

The above equation assumes a clock of 2MHz. If a different clock frequency is used the 36 usec loop time must be adjusted as well as the 55 usec overhead time. The count must then be recalculated.

2.1 PEPBUG Commands

When PEPBUG is entered a prompt character (?) is sent to the output device. The user then has the option of using any of the debug commands. After each execution the user is again prompted with (?). All data and input parameters are in hexadecimal notation. (C/R) following a command indicates a carriage return.

The keyboard also has a prompt which is a LED. The prompt lite is on when a command is requested, no shift is required. I.e. if PROMPT is on and key 7 is depressed the program will assume ACCumlator display and not the digit 7.

After a command key is depressed the prompt lite will go off and then the keys will be recognized as hexadecimal digits.

If the CHG key is depressed the STORE lite will go on and remain on until two consecutive C/R keys are detected.

The commands from the keypad are the same as they would be from the TTY. However, several functions are not useful; i.e. MO-F on the TTY would print memory locations 0-F; this keypad instruction would not be meaningful.

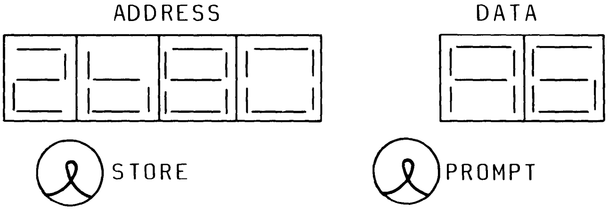
Command Type	Command	Function
Display	A(C/R)	Display the contents of the Accumulator
	D0(C/R)	Display the contents of DC0
	D1(C/R)	Display the contents of DC1
	I(C/R)	Display the contents of ISAR
	Mxxxx(C/R)	Display Memory Location xxxx
	Mxxxx-yyyy(C/R)	Display Memory Location xxxx to yyyy
	Oxx(C/R)	Display Port xx Data
	P0(C/R)	Display the contents of PC0
	P1(C/R)	Display the contents of PC1
	Rxx(C/R)	Display the contents of Register xx
	Rxx-yy(C/R)	Display the contents of Register xx to yy
	S(C/R)	Display the contents of W Register, status
	W(C/R)	Display the contents of W Register, status
Change	Cxx(C/R)(C/R)	Change the previously displayed memory location or port or register to xx
	Cxx(C/R)yy(C/R).. (C/R)(C/R)	Change the sequential registers or memory locations to xx,yy..
	Cxxxx(C/R)(C/R)	Change the PC or DC to xxxx.
Examine	E(C/R)	Display the last addressed register or memory location or port.
Previous	B(C/R)	Display the previous register or memory location or port.
Next	N(C/R)	Display the next register or memory location or port.
Load	L(C/R)	Load formatted object paper tape. If (CK) prints, then checksum error has occurred on block last read.
	H(C/R)	Load formatted object paper tape from the high-speed reader.
Hexadecimal	Xaaaa+bbbb=	Add or subtract value bbbb from value aaaa.

Block Move	Mdddd(C/R)
	Vssss-eeee(C/R)
		Move memory block starting at ssss and ending at address eeee to memory destination address dddd

Punch	Jxxxx-yyyy-z	Binary Punch PROM 8 bit format; xxxx is starting page address and yyyy is ending page address. z is block length code 0=256,1=512. To Punch 0 to BFF then enter B0-C00-0.
	Fxxxx-yyyy(C/R)	Formulator Formatted punch for future load.
Go To	G(C/R)	Go to address of P0.
	Gaaaa(C/R)	Change P0 to address aaaa, then go to aaaa and continue execution.
Delete	[	Delete command and start a new command.
Breakpoint	Uaaaa(C/R)	Set breakpoint at address aaaa.
	T(C/R)	Clear breakpoint restore user instruction.
Find	Kxx(C/R)	Find the matching byte starting with the last memory address displayed and searching through memory.

Figure 1 depicts the keypad organization supported by PEPBUG software routines and Appendix E shows the response a user would receive if utilizing the subroutine SCAN. The schematic diagram for the keyboard and display is in Appendix F. Ports 20 and 21 are used for the keyboard and display I/O functions. Appendix H has the complete PEPBUG program listing.

Figure 2 is a memory map of the area used by PEPBUG. Appendix G demonstrates how this memory area is changed with specific PEPBUG commands.



BRK C	B.CLR D	LOAD E	GO F	-	+
E70 8	HEX 9	MOVE A	FIND B	PORT	CHG
2716 4	IS 5	W 6	ACC 7	REG	DEL
PC 0	DC 1	PREV 2	NEXT 3	MEM	C/R

Fig. 1 PEPBUG Keyboard Display Diagram

RAM Address	Memory Contents							
2B80	R0	R1	R2	R3	R4	R5	R6	R7
2B88	R8	R9	R'A'	R'B'	R'C'	R'D'	R'E'	R'F'
2B90	R'10'	R'11'	R'12'	R'13'	R'14'	R'15'	R'16'	R'17'
2B98	R'18'	R'19'	R'1A'	R'1B'	R'1C'	R'1D'	R'1E'	R'1F'
2BA0	R'20'	R'21'	R'22'	R'23'	R'24'	R'25'	R'26'	R'27'
2BA8	R'28'	R'29'	R'2A'	R'2B'	R'2C'	R'2D'	R'2E'	R'2F'
2BB0	R'30'	R'31'	R'32'	R'33'	R'34'	R'35'	R'36'	R'37'
2BB8	R'38'	R'39'	R'3A'	R'3B'	R'3C'	R'3D'	R'3E'	R'3F'
2BC0	ACC	IS	W	BAUD	D0	D0	P1	P1
2BC8	D1	D1	EI/DI	JMP	P0	P0	--	--
2BD0	◄BRK ADDR►		◄USER INST SAVE►				--	--
2BD8	◄PROM PROGRAM PARAMETERS►							◄
2BE0	PORT DISPLAY + CHANGE WORK►							--
2BE8 -2BFF	◄NOT USED►							

Fig. 2 RAM Utilization by PEPBUG

Note: See Appendix G PEPBUG examples for further clarification of the RAM utilization.
(--) indicates RAM space not used by PEPBUG and is available to the user.

3.0 Detailed Command Explanation

In the following list of commands the TTY key is in ( ) when different from keypad. All data and addresses are in hexadecimal notation.

C/R — Carriage return. The keypad C/R operates the same as a TTY C/R. It is the termination of all command strings, except for the change command which is explained below. All commands except delete must be terminated with C/R.

DEL([) — The Delete command cancels any previous command string that has not yet been terminated with a C/R.

CHG(C) — The change command will change the last displayed register, memory location, register, or port. If the previous display was PC or DC then the change expects four ASCII digits. If a port was the last displayed item then only the last keyed field will be accepted; port changes cannot be chained. If PC or DC change is chained then memory starting at the PC address will be changed in 2-byte segments.

+ or - — These characters are delimiters only. They are only valid for the commands Hex, Block Move, Punch, and multiple display of Mem, Reg, or Port.

REG (R) — Display the register as addressed. RXX will display register XX. RXX-YY will display the block of register that include XX-YY. If XX is 13 and YY is 21, then registers 10-2F will be displayed. The same block addressing also applies to Memory and Port displays.

Port(P) — Display the port as addressed. This command builds an executable command sequence in Memory and then executes the instructions. See the Memory Map and also refer to the examples in the Appendix. Port change also builds a sequence of instructions to be executed. The same address blocks apply as in the Reg command. A port change will immediately change the contents of a port; register changes are done in RAM and the real register changes occur when a GO command is issued.

BRK(U) Set a breakpoint at the given memory address. The, sequence of instructions stored in the users program are:

1. OUTS 'C' to save the accumulator.
2. JMP to PEPBUG address H'80E0'.

The breakpoint address and the user's original instructions are saved in the PEPBUG RAM area. Only the information from the last breakpoint is saved. If a user requires multiple breakpoints the 4 bytes of code may be stored; however address and data must be logged and the code manually restored where the breakpoints were stored.

Since this is a 4 byte sequence care must be used as to where a breakpoint may be stored. It must be the first byte of an instruction; branch or JMP instructions into the middle of the 4-byte sequence will result in erroneous execution. See section 4.0 for further information.

C.BRK(T) Clear breakpoint will restore the 4 bytes of user code that were saved by the last set breakpoint command.

LOAD(L) Load from the RS232 device an object formatted program. Normally this would be a TTY paper tape. However it may also be data being down-loaded from an RS232 line from the Formulator or from any other computer system. The two formats which are accepted are Fairbug or Formulator formats as detailed in Appendix C.

(H) Load from a high speed paper tape. There is no corresponding key pad instruction; however, a GO H'84B8' will execute the high speed load routine.

GO(G) GO to PCO address and execute after restoring all registers. The Accumulator is not restored so it is necessary to be careful as to what instruction will execute next.

MEM(M) Display the memory as addressed. The same address blocks apply as in the Reg Command.

NEXT(N) Display the next register, port or memory location.

PREV(B) Display the previous register, port, or memory location.

(E) Examine current register, port or memory location. This TTY command has no corresponding command on the keypad.

ACC(A) Display the contents of the accumulator.

W Display the contents of the status register.

Bit	Meaning	
0	Sign	- 1 means positive or zero
1	Carry	- 1 means carry from bit 7 on previous arithmetic instruction
2	Zero	- 1 means zero result
3	Overflow	- 1 means overflow
4	ICB	- 1 means interrupt control is enabled.

When entering PEPBUG the ICB is set to zero before the status register is saved in RAM. The user may set ICB to 1 prior to executing a GO command. The GO sequence will restore the low 4 bits of the status register then execute an Enable or Disable Interrupt instruction prior to executing a JMP to the PCO address.

IS(I) Display the contents of the Indirect Scratchpad Address Register(ISAR)

PC(P) Display the contents of the Program Counter (PCO) on the Stack Register (PCI)

DC(D) Display the contents of either Data Counter (DCO or DC1).

HEX(X) Add or Subtract the two hexadecimal numbers and display the answer.

MOVE(V) Move a block of memory. This command must be preceded by a Memory display command which displays the first byte of the destination where the memory block is to be moved. Then the Move command provides the starting and ending address of data to be moved. The block may be moved up or down and may overlap itself. There are no restrictions on the move.

FIND (K) Find the matching bit pattern. Start the search at the last displayed Memory address. If the last displayed item was not memory this command will not work correctly. When a match is displayed a subsequent key in of the save command will start a new search at the next memory location.

E70 Program the F38E70. This command may be accomplished from the TTY by a GO H'8745'. Before executing there are several things to be accomplished:

1. Set Port 0 to H'FF'
2. Set Port 1 to zero
3 . Connect 25V power supply
4. Store memory starting address at H'2BD8' & H'2BD9'
5. Store Eprom starting address at H'2BDA' & H'2BDB'
6. Store Eprom ending address at H'2BDC' & H'2BDD'
7. Store at H'2BDE' a H'FF' for blank check or store zero to skip the blank check.

Note: Since the addresses are supplied to the EPROM programmer small segments of data may be put on the EPOM and more added later. This is useful when developing subroutines; after a routine is debugged it can be put into EPOM and executed. This eliminates reloading that portion of code. A library of routines can be built in this manner. See Appendix F for the pinouts required.

2716 Program the F2716 EPROM. This command may be accomplished from the TTY by executing a GO H'8741' command. The same rules apply to 2716 programming as to the E70 Programming.

3.1 PEPBUG Command Usage

A brief study of Appendix B will assist the reader in understanding the TTY command utilization. From these examples many advantages over Keypad debugging are quite apparent. First and most important a history is recorded of the steps taken and the results displayed. Second is the simple access from the console to the user.

One advantage that is not so apparent is that when a user wishes to end a debug session the modified program may be saved by punching the memory using the F command. In a subsequent debug session this "updated" program may be loaded and debugging continued. If program patches were extensive much time and effort is saved. Of course the program may be re-assembled after editing the changes in order to obtain an updated program.

Another advantage and also not so apparent is the fact the TTY input is much less error prone. If the one uses a little care and examines the keyed input prior to the carriage return, errors can almost be totally eliminated. In addition, a debug session achieves more results in a quicker time.

3.2 Input/Output

The input/output rountines assume that Port A of the U4 socket is available and is configured as shown in Appendix F. In order to communciate with an 11-bit serial type device such as a Teletype ASR 33 or a compatible TTY or CRT is required. PEPBUG has options to vary the baud rate by changing the counters for delay loops between bits. The timer is not utilized so the user is not deprived of this valuable resource. The counter value for 110 Baud is six which counts by incrementing an 8-bit register until zero; the six gives a loop count of 250. For 300 Baud the counter is initailly H'A4' giving a loop count of H'5C' or 92 decimal. Other baud rates can be achieved by modifying the counter. These c ounts assumed a system clock of 2MHz. For a faster clock, the counter must be changed to produce more delay loops, while for a slower clock the counter must be changed to product less delay loops. This is due to the fact that each instruction time will change and the total loop time will change while the device spelled is always constant. When the baud rate is not set to default to either 110 or 300 or 1200 then the Baud Rate must be put into RAM loation H'2BC3'.

3.3 Load from Parallel Input Device

The loader in PEPBUG can load from either a teletype or from a parallel source. The usual parallel source would be a high-speed paper tape reader which reads 100 to 300 characters per second. The parallel device is controlled using a "handshaking" protocol. The handshaking eliminates synchronizing problems because it forces the device to wait for the microprocessor and forces the microprocessor to wait for the device.

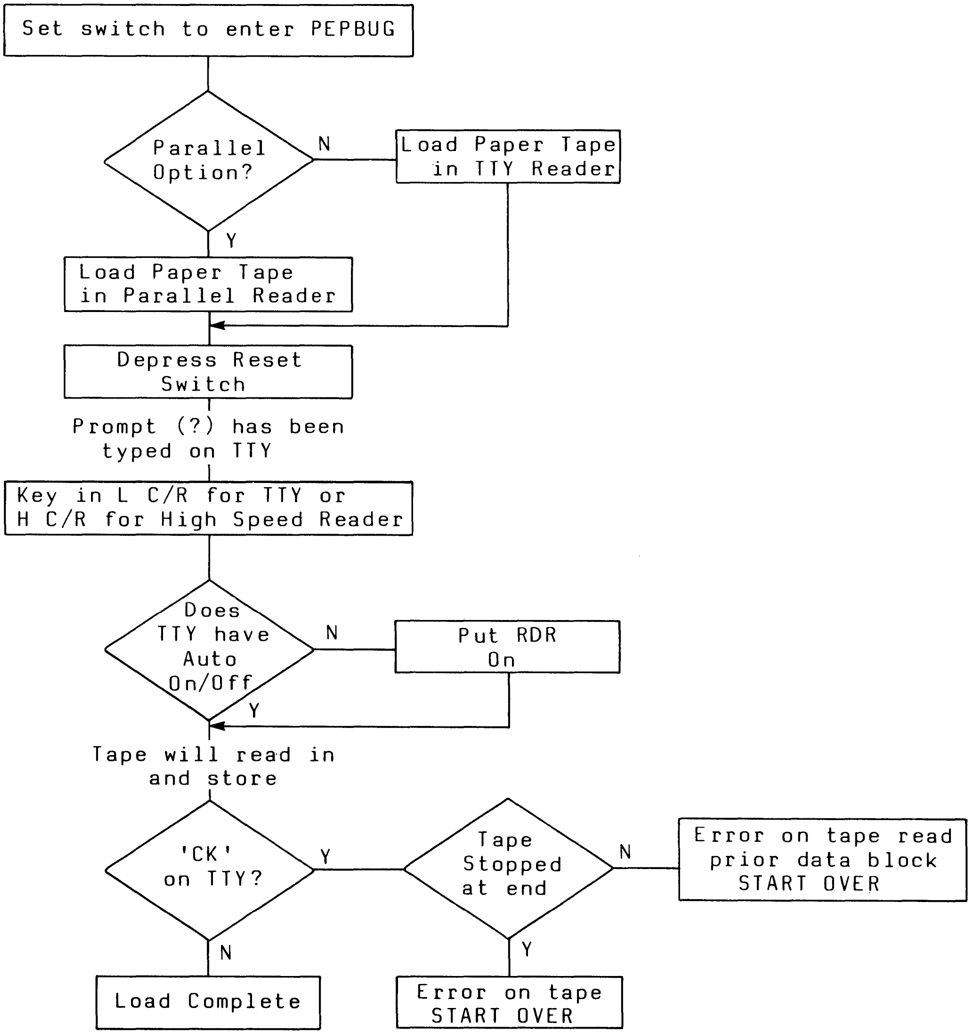

Set switch to enter PEPBUG
Parallel Option?
N
Load Paper Tape in TTY Reader
Y
Load Paper Tape in Parallel Reader
Depress Reset Switch
Prompt (?) has been typed on TTY
Key in L C/R for TTY or H C/R for High Speed Reader
Does TTY have Auto On/Off
N
Put RDR On
Y
Tape will read in and store
'CK' on TTY?
Y
Tape Stopped at end
N
Error on tape read prior data block START OVER
N
Load Complete
Y
Error on tape START OVER

Fig. 3

The PEPBUG parallel read routine examines DEVICE READY and waits for the ready signal, looks for Character Ready and delays 100us after detecting the ready, and then reads a character before the output of Step Reader. This sequence is repeated for each character. Only the formats shown in Appendix C can be read by PEPBUG with the Load Command. However, the user may use the subroutine PINP to read other formats. Bits 1-2 are examined when is entered to initialize the baud delay counter. See Appendix A for the I/O port pin assignments. The flow chart in Figure 3 indicates the steps necessary to load a paper tape program formatted as shown in Appendix C. If a checksum error occurs the FAIRBUG format has no recovery capability since the address is on the beginning of the tape.

4.0 PEPBUG Subroutines

I/O Subroutines on the PSU are available to the user. These are listed below and documented in Appendix E.

	ENTRY	
NAME	ADDRESS	FUNCTION
TTX	85C7	Input 1 byte from TTY type device (11 bits serial/character).
TTYX	8617	Output 1 byte to TTY type device (11 bits serial/character).
TCRX	85F9	Output CR,LF & delay 250 ms using TTYX subroutine.
PINP	85A3	Input 1 byte from the parallel IP device (150usec minimum delay between characters).
FOP1	812A	Output 1 or 2 hexadecimal digits in ASCII format from a memory location.
FOP2	812C	Output 1 or 2 hexadecimal digits in ASCII format from register QL.
BYTE	857B	Input 2 ASCII digits from a parallel or serial IP device; then covert them to one hexadecimal byte.
SCAN	8636	Read keyboard until new character is received; also output to the the six 7-segment displays and two LED's.
DISPX	87E2	Output to the six 7-segment displays and two LED's.

5.0 Programming Examples

The following program linkages to PEPBUG are cited as examples as how to utilize PEPBUG as a "snap shot" display or breakpoint.vehicle.

The two general ways to enter PEPBUG are either through programmed instructions or by manual intervention from the console. The manual entry is normally used for the following situations:

For initial program loading
For program punch and save
To start tracing a runaway program
To display or take further action following a BR*

Programmed entry to PEPBUG can be achieved by building trace routines into the source program prior to assembly or else by patching the object program after loading it. In either case the following instructions provide the necessary linkage.

JMP H'8080' This is a 3-byte instruction that destroys the accumulator and does not save the program counter.

PI H'8080' This is a 3-byte instruction that destroys the accumulator and pushes the program counter (PC0) to the stack (PC1).

LR P0,Q This is a 1-byte instruction that does not destroy the accumulator and does not save the program counter.

PK This is a 1-byte instruction that does not destroy the accumulator and pushes the program counter (PC0) to the stack (PC1).

These instructions are explained in detail in the F8 USERS GUIDE. It should be noted that all except the LR P0,Q are priviledged instructions and that an interrupt cannot be serviced following these instructions. Furthermore, the first instruction executed at H'8080' is a disable interrupt which inhibits interrupts until an Enable instruction is issued.

Examination of these instructions discloses that the PK instruction is the most desirable to use since it is 1 byte, saves the accumulator, and saves the PC0; however, it does require the K register (R12 and R13) be preset. If K is not used in the program being tested this is an ideal instruction. A recommended procedure is to code in to the users program at location 0 the following instructions:

```
LI  H'80'
LR  KU,A
LR  KL,A
```

If one of the above housekeeping procedures is used, patching the user's program for tracing or display purposes becomes an easier proposition. The simpler PK may be used and the prompt(?) will indicate that a desired point has been reached. Display of PC1 will then determine which (if more than one) of the trace points has been reached. The disadvantage of using PK or PI is that the object program PC1 has been lost. If this is detrimental for a particular section of code being debugged the JMP or LR P0,Q instructions are available. If LR P0,Q is used the Q register must be preset in the same fashion as above, substituting Q for K. The type of breakpoint to be used will depend on which registers are not used in the portion of the code being debugged.

It can be noted that the options are numerous and the user must decide which one or which combination is most desirable for a given purpose.

It is suggested that the user try a small program as shown in Appendix G and utilize all the options of PEPBUG until all the options are understood. This will save much time and effort in future debug sessions.

APPENDIX A
ASCII CHARACTER CODES

Character	Hex Code 7 Bit	Character	Hex Code 7 Bit	Character	Hex Code 7 Bit
(Space)	20	0	30	H	48
!	21	1	31	I	49
"	22	2	32	J	4A
#	23	3	33	K	4B
$	24	4	34	L	4C
%	25	5	35	M	4D
&	26	6	36	N	4E
'(Quote)	27	7	37	O	4F
(	28	8	38	P	50
)	29	9	39	Q	51
*	2A	:	3A	R	52
+	2B	;	3B	S	53
,(Comma)	2C	>	3C	T	54
-	2D	=	3D	U	55
.	2E	<	3E	V	56
/	2F	?	3F	W	57
Line Feed	0A	@	40	X	58
Carriage RTN	0D	A	41	Y	59
Bell	87	B	42	Z	5A
Punch ON	92	C	43	[	5B
Punch OFF	94	D	44	\	5C
Reader ON	91	E	45	]	5D
Reader OFF	93	F	46	↑	5E
Null	7F	G	47	←	5F
Null	FF				

APPENDIX B
PEPBUG PORT ASSIGNMENTS

Assignments for Port 28

Bit	Function
7	Serial input
6	Character Ready (Parallel Device)
5	Enter Key/Display Monitor
4	Device Ready(Parallel Device)
3	Step Reader(Parallel Device)

Bit 2	Bit 1	Baud Rate
0	0	110 baud
0	1	300 baud
1	0	1200 baud
1	1	Baud delay counter in memory at H'2BC3'

Note: 0=+5;1-GND,0 V.

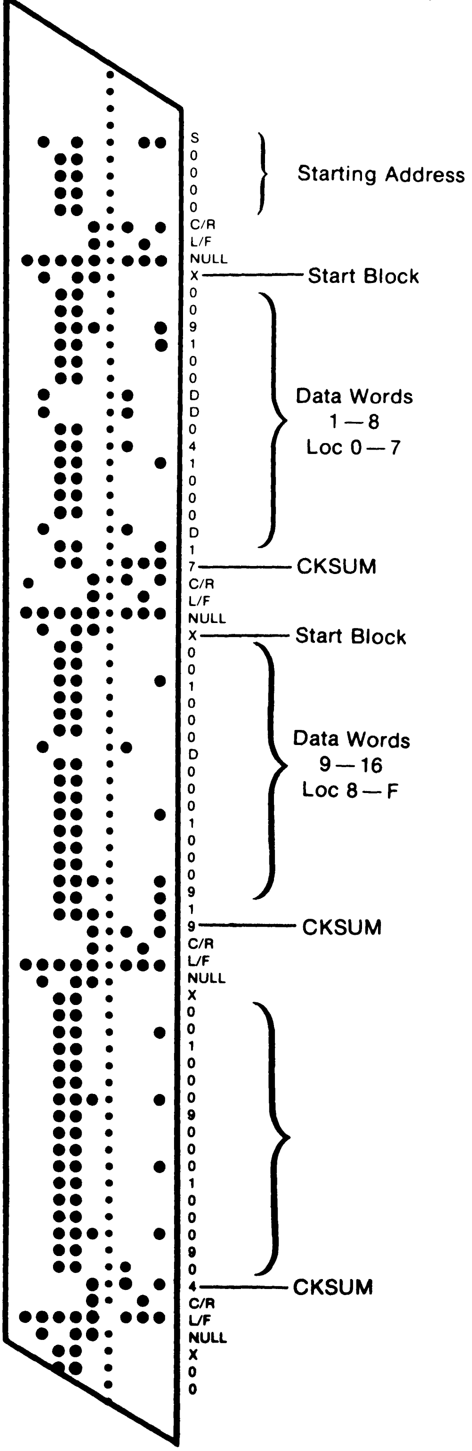
0 Serial Output

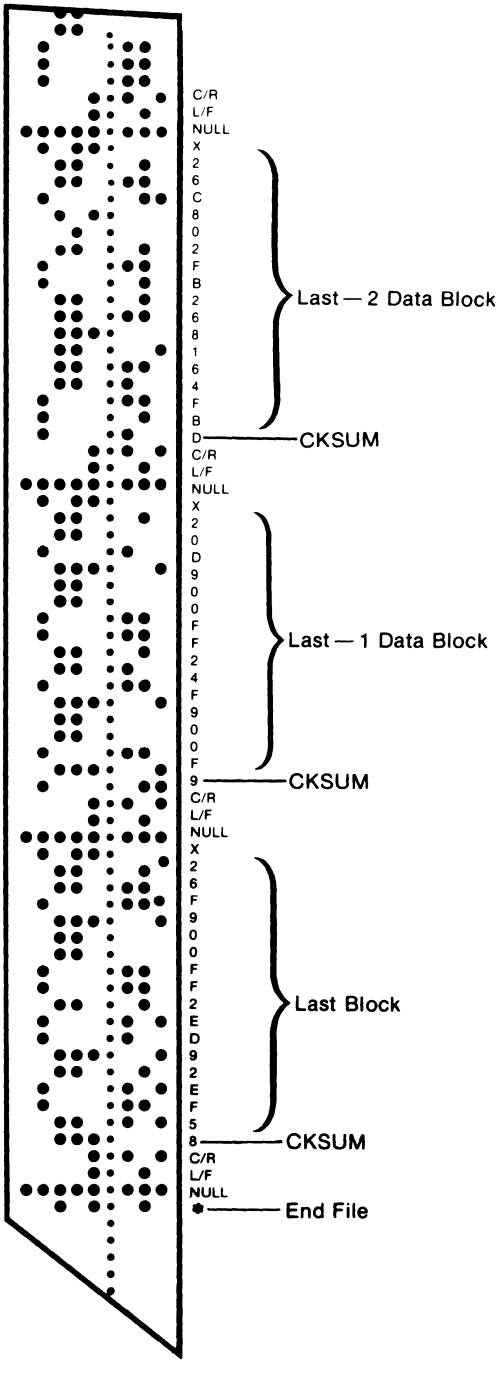
Assignments for Port 29

Bit	Function
7	Parallel input byte - MSB
6	Parallel input byte
5	Parallel input byte
4	Parallel input byte
3	Parallel input byte
2	Parallel input byte
1	Parallel input byte
0	Parallel input byte - LSB

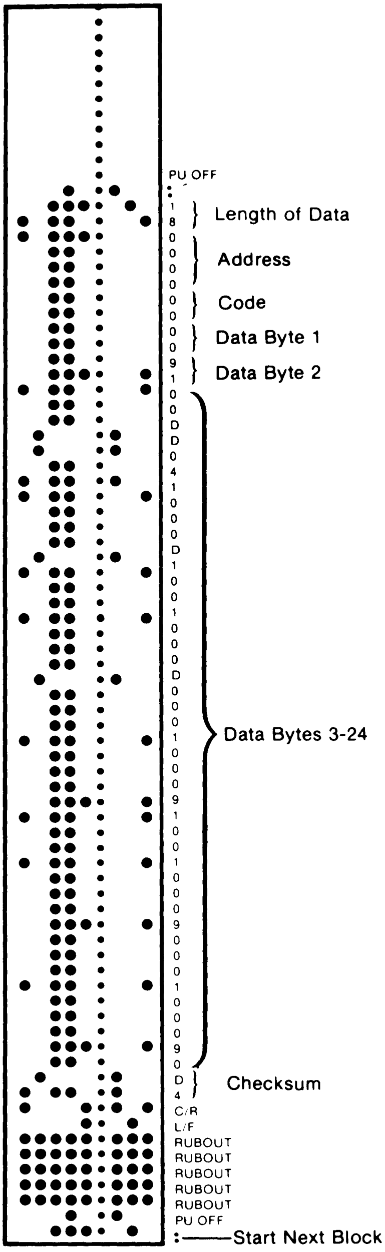
APPENDIX C
FORMATTED TAPE
(FAIRBUG FORMAT)

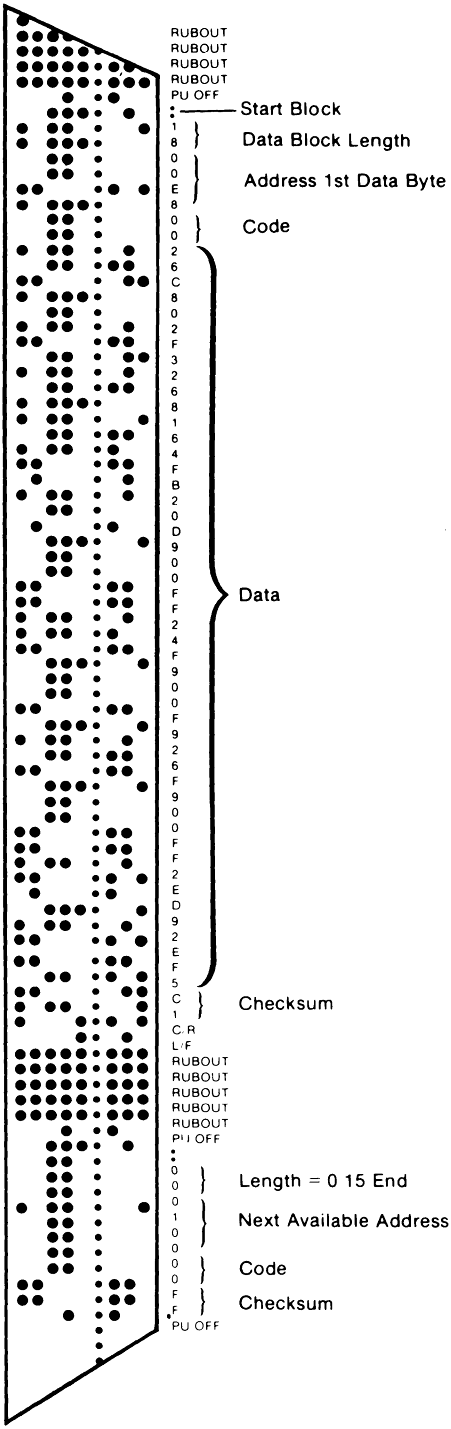
Note: This example was loaded (L) by the instruction shown in Appendix B. This is ASCII 7 bit format.





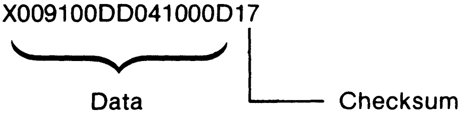
APPENDIX C (Continued)
FORMATTED TAPE
(FORMULATOR FORMAT)





FAIRBUG FORMAT AND CHECKSUM

The following line of code is from Appendix C. The checksum is the sum of all the nibbles in the block.

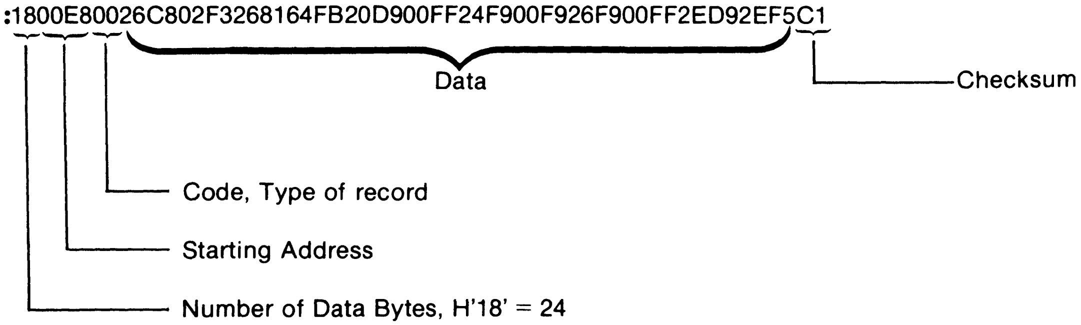


X009100DD041000D17

```
0   0
0   4
9   1          4
1   0          3
0   0          —
0   0          7 = Checksum
D   D
D   1
—   —
4   3
```

FORMULATOR FORMAT AND CHECKSUM

The following line of code is from example 2. The checksum is the 2's complement of the sum of all the bytes in the record. Notice that when the checksum is also added to the sum the total is always zero for the low 16 bits.

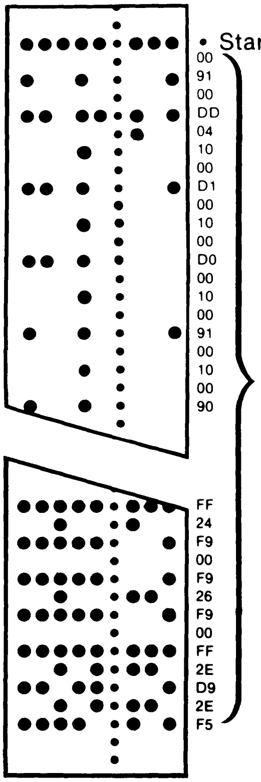


:1800E80026C802F3268164FB20D900FF24F900F926F900FF2ED92EF5C1

```
18   26   24   2E        E3
00   81   F9   D9        FE
E8   64   00   2E        34
00   FB   F9   F5        2A
26   20   26   —         —
C8   D9   F9   2A        3F = Total Sum
02   00   00             2's Complement (3̅F̅+1=C1)
F3   FF   FF
—    —    —
E3   FE   34
```

APPENDIX D
PEPBUG
(PROM PUNCH FORMAT)

PROM 8 BIT FORMAT



• Start Block

This format is 8 bits wide and is punched by: JXX00-YY00-L when: J0-100-0 it will punch data from Memory Address 0 to H'FF'.
L = 0 -256 bytes
L = 1 -512 bytes
L = 3 -1024 bytes

Data

Input Command JXX00-YY00-L	Decimal Memory Addresses Punched	# Blocks	Block Length
J 0-100-0	0-255	1	256
J 0-400-0	0-1023	4	256
J 100-200-0	256-511	1	256
J 0-400-1	0-1023	2	512
J 0-1000-1	0-4095	8	512
J 200-400-1	512-1023	1	512

APPENDIX E
PEPBUG SUBROUTINES

The following INPUT and OUTPUT subroutines exist in PEPBUG and may be called by the user's program. All subroutines should be entered by: (PI Address).

TTX - Input 1 byte from TTY type device, without echo. Data is 11 bits/character being received on Port 28 Pin 7.

Address:	H'85C7'	
Enter:	R0	Delay Counter
Exit:	W Reg	Destroyed
	PC1	User return address
	Accum	Input byte
	R0	Unchanged
	R1	Input byte
	R2	-1

TTYX- Output 1 byte to TTY type device. Data transmitted is 11 bits/character being output on Port 28 Pin 0.

Address:	H'8617'	
Enter:	R0	Delay Counter
	R1	Byte to output
Exit:	W Reg	Destroyed
	PC1	User return address
	Accum	0
	R0	Unchanged
	R1	-1
	R2	0

TCRX- Output CR/LF/NULL to TTY type device; subroutine TTYO is called.

Address:	H'85F9'	
Enter:	R0	Delay Counter
Exit:	W Reg	Destroyed
	PC1	Destroyed
	Accum	0
	K Reg	User return address
	R0	Unchanged
	R1	-1
	R2	0

PINP- Input 1 byte from parallel input device; minimum delay between characters is 150 us. Byte is received on Port 29 with control bits on Port 28, pins 3,4, and 6. See Appendix B.

Address:	H'85A3'	
Enter:	No setup	
Exit:	W Reg	Destroyed
	PC1	User return address
	Accum	Input byte
	R1	Input byte

BYTE - Input 2 ASCII hexadecimal characters and convert to 1 byte; also accumulate the checksum. If input is not ASCII characters 0-9 or A-F meaningless results will be returned. Either TTYI or PINP is called as input routine.

Address:	H'857B'	
Enter:	Q	H'85A3'(for parallel input)
	Q	H'85C7'(serial input) R0=Delay Counter
	R7	Previously accumulated checksum
Exit:	W Reg	Destroyed
	PC1	Destroyed
	Accum	Input byte
	K	User return address
	Q	Unchanged
	R0	Unchanged
	R1	Destroyed
	R2	-1 (if serial IP), unchanged for Parallel IP
	R7	Checksum
	R8	0
	R11	Input byte

FOP1 - Output byte of data from memory to TTY type device using TTYO subroutine. Byte is converted to 1 or 2 ASCII hexidecimal characters.

Address:	H'812A'	
Enter:	R0	Delay Counter
	R8	Flag pos# = OP Hi 4 bits, then Lo 4 as ASCII Neg# OP Lo 4 bits as ASCII
	DC0	Memory address of data
Exit:	W Reg	Destroyed
	PC1	Destroyed
	Accum	Destroyed
	DC0	DC0 + 1
	K Reg	User return address
	QL	Data byte
	R0	Unchanged
	R1	-1
	R2	0
	R7	Checksum (low 4 bits significant)

FOP2 - Output byte of data from QL. Same routine as FOP1 except DC0 is not used.

Address	H'812C'	
Enter:	R0	Delay Counter
	R8	Same as FOP1
	QL	Data byte to output
Exit:	Same as FOP1	

APPENDIX E (continued)

DISPX Display data to six 7-segment displays and two LED's.

Address:	H'87E2'	
Enter:	R'30'to'35'	Low 4 bits from each register are displayed.
	R'36'	Bit 7 is Prompt LED Bit 6 is Change LED
Exit:	ISAR	is destroyed
	R1	is destroyed
	Port '20'&'21'	are destroyed
	ACC	is destroyed
	W	is destroyed

SCAN Display data to six 7-segment displays and two LED's and scan keyboard for new key in. This routine will wait for new key before returning to the user.

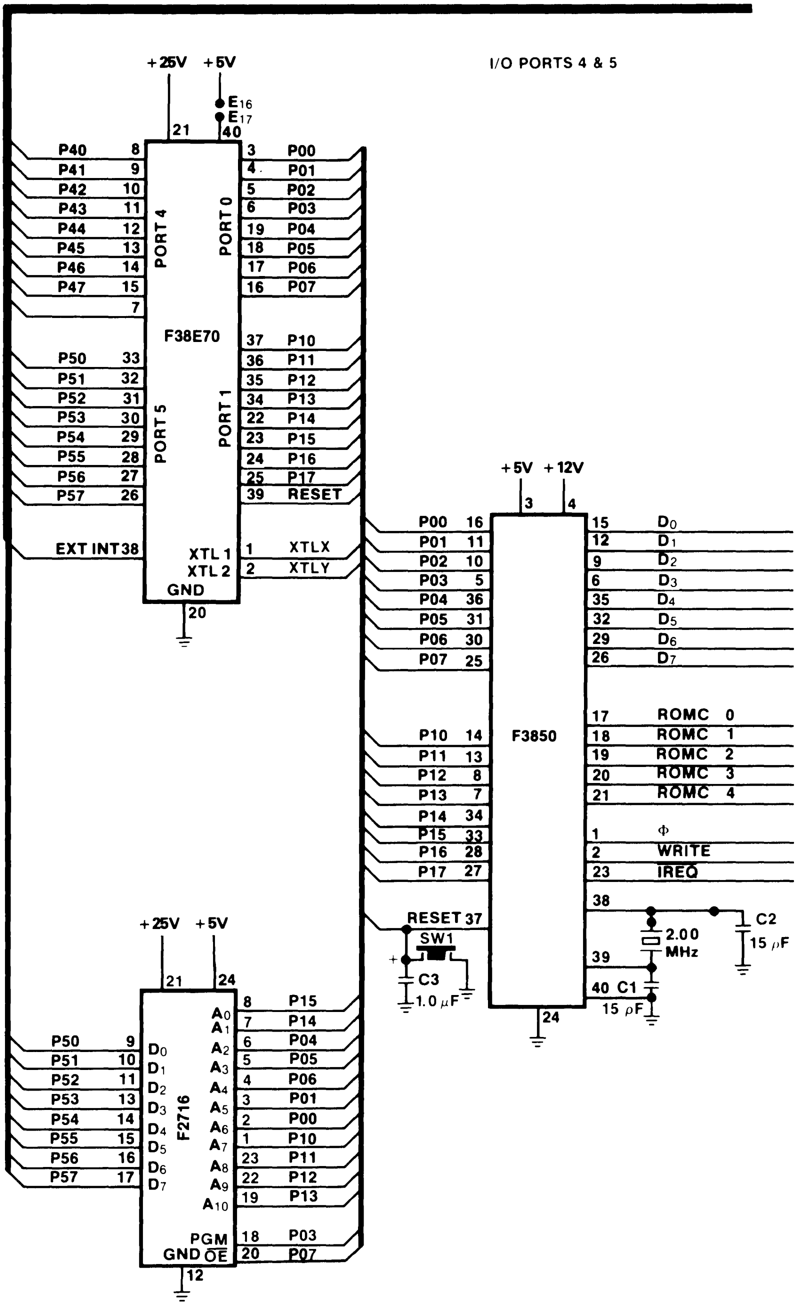
Address:	H'8636'	
Enter:	R'30'to'35'	Low 4 bits from each register are displayed.
	R'36'	Bit 7 is Prompt LED Bit 6 is Change LED
Exit:	R'36'	is changed
	R'37'	is number of C/Rs expected to complete change command
	DCO	is destroyed
	W	is destroyed
	R2	is keypad location code in Hex
	Port '20'&'21'	are destroyed
	R'28'to'2F'	are destroyed
	ACC and R1	new key character in ASCII

The characters returned by this routine are dependent upon the setting of Bit 7 of Reg H'36'. This flag bit determines when a keypad shift is invoked. This bit is set to a 1 when Del is keyed in or when C/R is keyed in. It also causes the Prompt LED to be lit. It will be set to 0 on the next key in except on Del. The follwing tables show the returned characters.

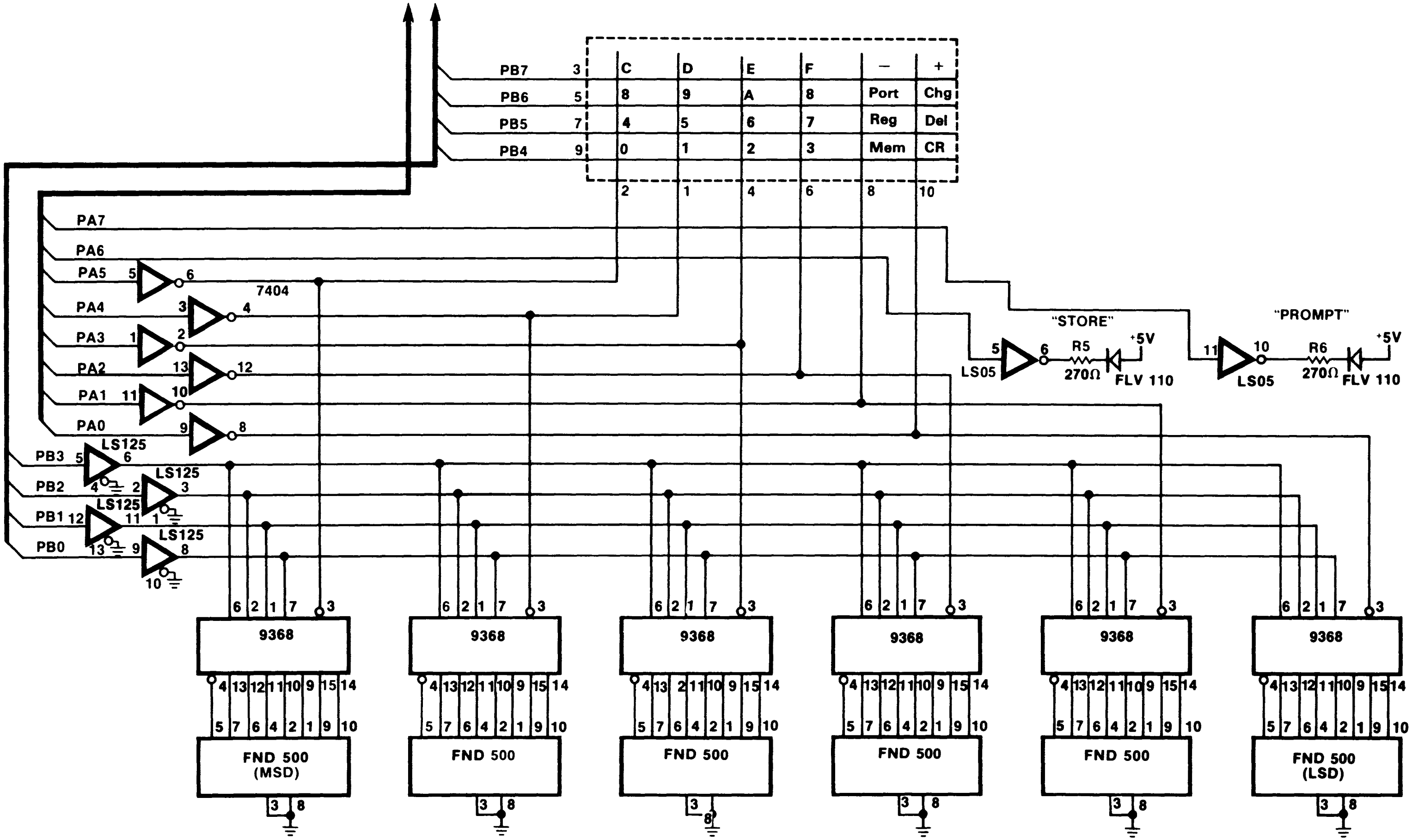
	Results in R1 in ASCII						Results in R2 in Hex					
Reg '36'= 0	C	D	E	F	-	+	3	7	B	F	13	17
	8	9	A	B	0	C	2	6	A	E	12	16
	4	5	6	7	R	H'5B'	1	5	9	D	11	15
	0	1	2	3	M	H'0D'	0	4	8	C	10	14
Reg '36'=1	U	T	L	G	-	+	1B	1F	23	27	13	17
	*	X	V	K	0	C	*	1E	22	26	12	16
	*	I	W	A	R	H'5B'	*	1D	21	25	11	15
	P	D	B	N	M	H'0D'	18	1C	20	24	10	14

NOTE: * These keys cause a direct JMP to the E70 or 2716 EPROM routines and do not return to the user.

APPENDIX F
F2716 AND F38E70 PROM PROGRAM I/O INTERCONNECT DIAGRAM

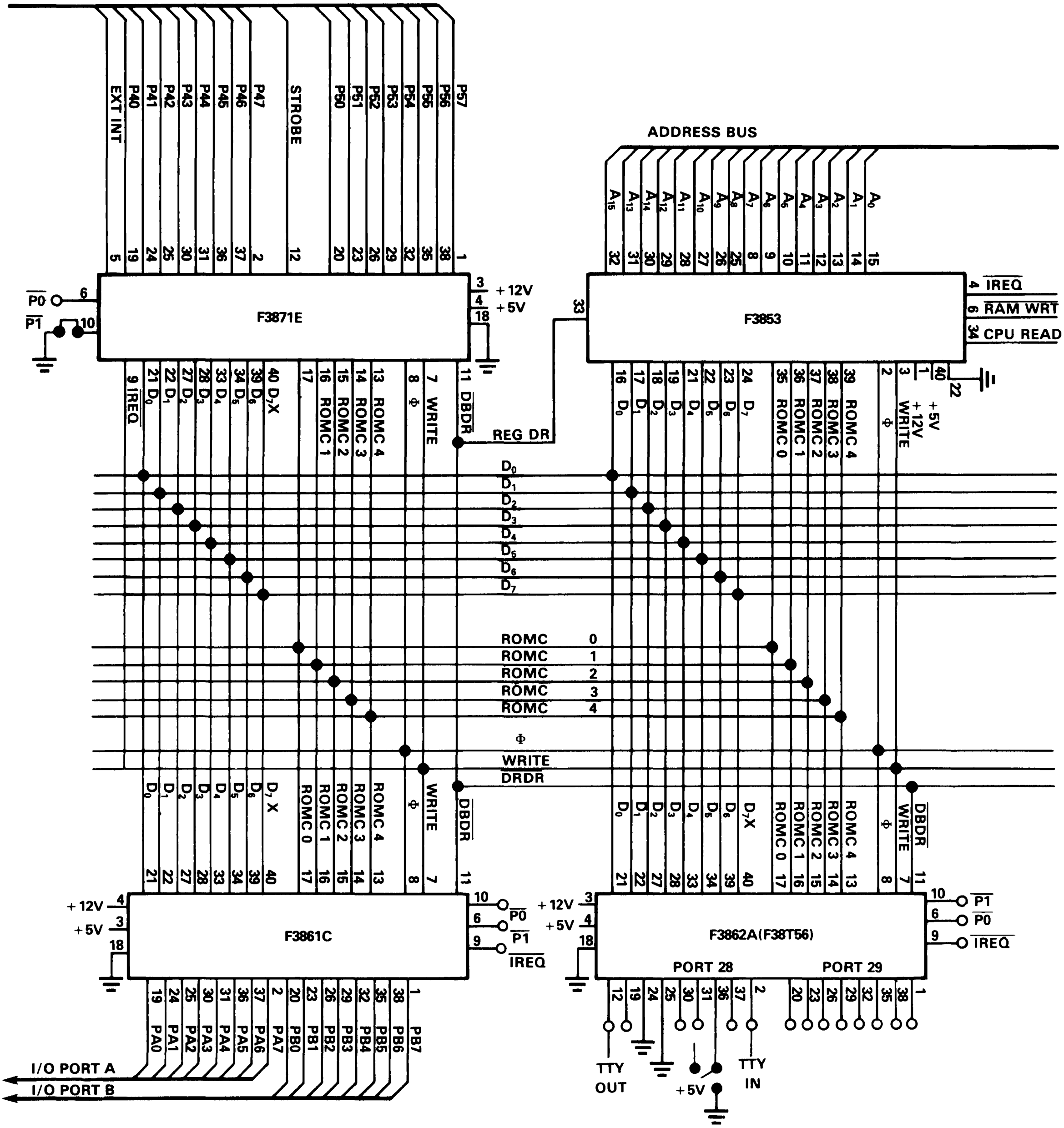


APPENDIX F (Continued)
KEYBOARD/DISPLAY SCHEMATIC DIAGRAM



Notes:
PA7 = PORT 20 Bit 7
PB7 = PORT 21 Bit 7
Resistors are ¼ watt

I/O Ports to Keypad and TTY Interconnect Diagram
Appendix F (Continued)



APPENDIX G
PEPBUG EXAMPLES

```
M0(CR)
 M0000= FF                                      Store a program to put an
?C70(CR)(CR)                                    incrementing counter in
?N(CR) M0002= 6A                                scratchpad registers 0-3F.
?B(CR) M0001= 8B                                Note the use of the various
?E(CR) M0001= 8B                                instructions.
?C0B(CR)(CR)
?E(CR) M0002= 6A
?C5C(CR)(CR)
?E(CR) M0003= 81
?C1F(CR)25(CR)40(CR)94(CR)F9(CR)29(CR)80(CR)80(CR)(CR)
?M0-A(CR)                                         <-----Display the program
 M0000=(70 0B 5C 1F  25 40 94 F9  29 80 80)A9  B0 89 11 93
?R0-3F(CR)
R0000=  04 00 02 00  00 00 00 00  00 00 00 00  00 00 00 00   Display
R0010=  FF 61 EE 5E  F7 E4 85 5C  FA D2 E6 E6  DD DE BB 90   registers
R0020=  00 00 00 00  02 00 00 00  00 00 02 00  01 00 00 00   before.
R0030=  FF D6 FF B3  B6 A3 FE 9A  DF D4 7F 76  F7 88 E7 91
?M2B80-2B87(CR)                                              Memory
 M2B80= 04 00 02 00  00 00 00 00  00 00 00 00  00 00 00 00   where R0-F
?G0(CR) <---------- Execute.                                 is saved.
        <---------- Program did not return, manually reset
?M7(CR)
 M0007= F9 <------- Change displacement of BR instruction
?CFA(CR)(CR)
?G0(CR) <---------- Execute
?R0-3F(CR)
 R0000= 00 01 02 03  04 05 06 07  08 09 0A 0B  0C 0D 0E 0F   All
 R0010= 10 11 12 13  14 15 16 17  18 19 1A 1B  1C 1D 1E 1F   registers
 R0020= 20 21 22 23  24 25 26 27  28 29 2A 2B  2C 2D 2E 2F   are
 R0030= 30 31 32 33  34 35 36 37  38 39 3A 3B  3C 3D 3E 3F   changed
?P0(CR)=0000<------ Go 0 set this address                    OK.
?P1(CR)=8080<------ Return address not saved
?M8(CR)
 M0008=   29        Oh! We used a jump
?C28(CR)(CR)        Change it to PI.
?G0(CR)             Execute Again.
?P0(CR)0000
?P1(CR)=000B<------ Now OK.
?A(CR)=   80
?I(CR)=   3F        Displays
?W(CR)=   07
?D0(CR)=0001                              See RAM map to verify
?D1(CR)=0000                              display of registers.
?CI234(CR)(CR)<---- Change
?D1(CR)=1234
?M2B80-2BFF
 M2B80= 00 01 02 03  04 05 06 07  08 09 0A 0B  0C 0D 0E 0F
 M2B90= 10 11 12 13  14 15 16 17  18 19 1A 1B  1C 1D 1E 1F
 M2BA0= 20 21 22 23  24 25 26 27  28 29 2A 2B  2C 2D 2E 2F
 M2BB0= 30 31 32 33  34 35 36 37  38 39 3A 3B  3C 3D 3E 3F
 M2BC0= 80 3F 07 06  00 01 00 0B  12 34 1A 29  00 00 FF EB
 M2BD0= 66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF EF
 M2BE0= 72 FF 00 10  89 02 FF EF  76 FF 00 10  89 00 FF EF
 M2BF0= 76 FF 00 10  89 00 FB EF  72 FF 00 10  89 20 FF EF
```

APPENDIX G (continued)

```
?00-9(CR)          Display Ports. Note 2-3
00000=  88 FF 8D 8D  80 80 80 80  FF FF FF FF  00 80 FF FF
?01(CR)                                         Port changes not chained.
00001=  FF                                      Port 1 was set to last.
?CAA(CR)BB(CR)CC(CR)DD(CR)EE(CR)FF(CR)(CR)  Old value FF changed to FF.
00-F(CR)
00000=  88 FF 8D 8D  80 80 80 80  FF FF FF FF  00 80 FF FF
?01(CR)
00001=  FF
?C1(CR)2(CR)3(CR)4(CR)5(CR)6 (CR) (CR)  Try again to change Port 1.
?00-F(CR)
00000=  88 06 8D 8D  80 80 80 80  FF FF FF FF  00 80 FF FF
?M2BD0-2BE4(CR)
M2BD0=  66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF B1
M2BE0=  AF 07 29 84  8D 02 FF EF  76 FF 00 10  89 00 FF EF
?01(CR)        Last set of instructions executed when display of 00-F.
 00001= 06     Port data saved in QL then JMP back into PEPBUG.
?M2BD0-2BE4(CR)
 M2BD0- 66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF B1
 M2BE0= A1 07 29 84  8D 02 FF EF  76 FF 00 10  89 00 FF EF
?01(CR)
 00001= 06                      Start of sequence of instructions
?CAA(CR)(CR)    KILL            to change Port 1. Data from R4
?M2B80-[(CR)                    to port then JMP to PEPBUG.
?M2BD0-2BE4(CR)
 M2BD0= 66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF B1
 M2BE0= 44 B1 29 83  30 02 FF EF  76 FF 00 10  89 00 FF EF
?021 (CR)
 00021=  0A                   Display sequence for long IO instruction
?M2BD0-2BE4-2BE4(CR)
 M2BD0= 66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF B1
 M2BE0= 26 21 07 29  84 8D FF EF  76 FF 00 10  89 00 FF EF
?C55 (CR)(CR)
?M2BDF-2BE0 (CR)     Last displayed value was M2BEF,and is changed.
 M2BD0= 66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF B1
 M2BE0= 26 21 07 29  84 8D FF EF  76 FF 00 10  89 00 FF 55
?021 (CR)
 00021= 0A    Try again to change port 21.
?C55(CR) (CR)
?M2BD4-2BEF(CR)                 Instructions for change command.
 M2BD0= 66 FF 00 10  89 00 DF EF  76 FF 00 10  83 00 FF 27
 M2BE0= 21 44 27 21  29 83 30 EF  76 FF 00 10  89 00 FF 55

?00-21(CR)      Display of ports again with changes noted.

 00000= 88 AA 8D 8D  80 80 80 80  FF FF FF FF  00 80 FF FF
 00010= FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
 00020= 2B 55 FF FF  81 FF FF FF  FF FF FF FF  FF FF FF FF
```

```
?U7(CR)◄─────────Set breakpoint at M7. Note instructions put in user
?M7(CR)          program and data saved in RAM to restore.
 M0007=  BC
?M7-A(CR)
 M0000=  70 0B 5C 1F  25 40 94 BC  29 80 E0 A9  B0 89 11 93
?M2BC0-2BEF(CR)
 M2BC0=  80 3F 07 06  00 01 00 0B  12 34 1A 29  00 00 FF EB
 M2BD0=  00 07 FA 28  80 80 DF EF  76 FF 00 10  83 00 FF 27
 M2BE0=  21 44 27 21  29 83 30 EF  76 FF 00 10  89 00 FF 55
?T(CR)           Clear breakpoint. Display User instructions.
?M7-A(CR)
 M0000=  70 0B 5C 1F  25 40 94 FA  28 80 80 A9  B0 89 11 93
?M2B80-2B8[(CR)
?M2B80-2BFF(CR)
 M2B80=  00 01 02 03  04 05 06 07  08 09 0A 0B  0C 0D 0E 0F  Note RAM
 M2B90=  10 11 12 13  14 15 16 17  18 19 1A 1B  1C 1D 1E 1F  is still
 M2BA0=  20 21 22 23  24 25 26 27  28 29 2A 2B  2C 2D 2E 2F  intact. we
 M2BB0=  30 31 32 33  34 35 36 37  38 39 3A 3B  3C 3D 3E 3F  may still
 M2BC0=  80 3F 07 06  00 01 00 0B  12 34 1A 29  00 00 FF EB  return to
 M2BD0=  00 07 FA 28  80 80 DF EF  76 FF 00 10  83 00 FF 27  user
 M2BE0=  21 44 27 21  29 83 30 EF  76 FF 00 10  89 00 FF 55  correctly
 M2BF0=  76 FF 00 10  89 00 FB EF  72 FF 00 10  89 20 FF EF
?U7(CR)◄────────Now set breakpoint & execute the Go and return to
?G7(CR)         PEPBUG users instructions are not restored.
?M0-F(CR)
 M0000=  70 0B 5C 1F  25 40 94 BC  29 80 E0 A9  B0 89 11 93
?T(CR) ◄────────Now CLR restores users instructions.
?M0-F(CR)
 M0000=  70 0B 5C 1F  25 40 94 FA  28 80 80 A9  B0 89 11 93
?F0-7(CR):18000000700B5C1F254094FA288080A9B0891193 1EC5476A83FA999512
:0000000000000000                            Formulator dump format.Note
                    Using(CR) leader         long delay before and after.
?X1234-5678BBBC     and trailer              These are null characters for
?X1234-5678=BBBC                             paper tape leader and trailer.
?X1234+5678=68AC    Use of= as delimiter
?X1234-F034=2200    is neater
?X1234-204=1030
?L(CR) CK ◄───────────── Keyboard load. Keyed in S0000X12345678911223344
                            and 44 is checksum error
?M0-F(CR)
 M0000=  12 34 56 78  90 11 22 33  28 80 80 A9  B0 89 11 93
?M3(CR)
 M0003=  78 ───────────Execute MOVE of location 7-B to 3-7
?V7-B(CR)
?M0-F(CR)
 M0000=  12 34 56 33  28 80 80 A9  28 80 80 A9  B0 89 11 93
?MA(CR)
 M000A=  80 ───────────Move 8-B to A-D
?V8-B(CR)
?M0-F(CR)
 M0000=  12 34 56 33  28 80 80 A9  28 80 28 80  80 A9 11 93
```

APPENDIX H
PEPBUG PROGRAM LISTING

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      0001  *PEPBUG
                      0002  *R VATERT
                      0003  *FOR 2K PSU F38T56
                      0004  *  REVISED 2/20/79
                 0000 0005  RAM      CORG      0
                 8000 0006  XX       RORG      H'8000'
                 82CB 0007  A        EQU       (HEX-1)
                 0000 0008  BAUD     EQU       0
                 0001 0009  CHRS     EQU       1
                 0002 0010  BCNT     EQU       2
                 0008 0011  HFLG     EQU       8
                 0005 0012  CCNT     EQU       5
                 0006 0013  XFLG     EQU       6
                 0007 0014  CKSM     EQU       7
                 0008 0015  FCNT     EQU       8
                 0009 0016  FLG      EQU       9
                 0007 0017  SIZE     EQU       CKSM
                 0003 0018  SA       EQU       3
                 0005 0019  EA       EQU       5
                 0006 0020  EALO     EQU       XFLG
                 0005 0021  EAHI     EQU       CCNT
                 000C 0022  OO       EQU       12        IO DISPLAY PORT
                 000D 0023  PP       EQU       13
                 000F 0024  RR       EQU       15        FLG+H'43'=REGISTER
                 000A 0025  MM       EQU       10        FLG+H'43'=MEMORY
                 000B 0026  CC       EQU       11
                 000B 0027  CHR1     EQU       11
                 000D 0028  CR       EQU       H'0D'
                 000A 0029  LF       EQU       H'0A'
                 00EB 0030  NUSE     EQU       H'EB'     UNUSED PORT ADDRESS
                 0028 0031  OPOR     EQU       H'28'     SERIAL PORT,OUTPUT
                 0028 0032  IPOR     EQU       H'28'     SERIAL PORT,INPUT
                 0028 0033  PSTS     EQU       H'28'     PARALLEL PORT,STATUS BITS
                 0029 0034  PPRT     EQU       H'29'     PARALLEL PORT,DATA 8 BITS
                 0044 0035  D0       EQU       RAM+68    D0 ADDRESS IN RAM
                 0009 0036  RA9      EQU       RAM+9     REG 9 ADDR IN RAM
                 0020 0037  PORTA    EQU       H'20'     PORT TO SAVE IN
                 0021 0038  PORTB    EQU       H'21'       "    "    "    "
                 0029 0039  PORTC    EQU       H'29'     TIMER TO SAVE IN
                 004A 0040  EX       EQU       RAM+74    EXIT INSTRUCTIONS TO USER
                 000A 0041  HII      EQU       10
                 000B 0042  LO       EQU       11
                 0020 0043  P8       EQU       H'20'
                 0021 0044  P9       EQU       H'21'
                 0058 0045  BRAM     EQU       RAM+88    MEM FOR BURN PARAMETERS
                      0046  *
                      0047  *
      8000 298080 8080 0048          JMP   SAVER     NO ENTRY @8000 GO TO 8080
                      0049  *
                      0050  *
                      0051  *BOOTSTRAP FORMAT PUNCH SUBROUTINE
                      0052  *   START ADDRESS INDC ON ENTRY
                      0053  *   END ADDRESS IN R6-7 ON ENTRY
                      0054  *WRITE BLANK LEADER
      8003 45         0055  FPUN     LR        A,EAHI
      8004 18         0056           COM
      8005 55         0057           LR        EAHI,A    NOW 1'S COMPLIMENT HIGH
      8006 46         0058           LR        A,EALO
      8007 18         0059           COM                 NEGATIVE
      8008 1F         0060           INC                 2'S COMPLIMENT
      8009 56         0061           LR        EALO,A
```

APPENDIX H (continued)

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     800A 45               0062          LR        A,EAHI
     800B 19               0063          LNK
     800C 55               0064          LR        EAHI,A    NOW 2'S COMPLIMENT
     800D 2092             0065          LI        H'92'     NUMBER OF NULLS
     800F 57               0066          LR        CKSM,A
     8010 51               0067  FPN1    LR        CHRS,A
     8011 288610 8610 0068          PI        TTYO      WRITE BLANKS
     8014 37               0069          DS        CKSM
     8015 70               0070          LIS       0
     8016 94F9   8010 0071          BNZ       FPN1      CONTINUE BLANKING
     8018 E8               0072          XS        HFLG
     8019 810A   8024 0073          BP        FCON      THIS WAS LEADER
                           0074  *TRAILER PUNCHED NOW FINISH
     801B 2094             0075          LI        H'94'
     801D 51               0076          LR        CHRS,A
     801E 288610 8610 0077          PI        TTYO
     8021 298076 8076 0078          JMP       TZE
                           0079  *
                           0080  *WRITE STARTING ADDRESS
     8024 20FF             0081  FCON    LI        H'FF'
     8026 51               0082          LR        CHRS,A
     8027 288610 8610 0083          PI        TTYO
     802A 203A             0084          LI        H'3A'     COLON FORMULATOR START
     802C 51               0085          LR        CHRS,A
     802D 288610 8610 0086          PI        TTYO
     8030 2018             0087          LI        24        LENGTH=24
     8032 58               0088          LR        HFLG,A
     8033 07               0089          LR        QL,A      OUTPUT BYTE
     8034 28812C 812C 0090          PI        FOP2      WRITE LENGTH
     8037 4A               0091          LR        A,10
     8038 07               0092          LR        QL,A
     8039 28812C 812C 0093          PI        FOP2      OUTPUT HI ADDRESS
     803C 4B               0094          LR        A,11
     803D 07               0095          LR        QL,A
     803E 28812C 812C 0096          PI        FOP2      OUTPUT LO ADDRESS
     8041 70               0097          LIS       0
     8042 07               0098          LR        QL,A      RECORD TYPE=0
     8043 28812C 812C 0099          PI        FOP2
     8046 10               0100          LR        DC,H
     8047 2018             0101          LI        24
     8049 58               0102          LR        HFLG,A    SET TO 24
     804A 28812A 812A 0103  FLOP    PI        FOP1      WRITE 2 CHAR FROM MEMORY
     804D 11               0104          LR        H,DC
     804E 38               0105          DS        HFLG      COUNT-1
     804F 94FA   804A 0106          BNZ       FLOP      NOT 24 YET
                           0107  *NOW CHECKSUM
     8051 47               0108          LR        A,CKSM
     8052 18               0109          COM
     8053 1F               0110          INC
     8054 07               0111          LR        QL,A
     8055 78               0112          LIS       8
     8056 58               0113          LR        HFLG,A    FLAG PLUS FOR 2 CHAR O/P
     8057 28812C 812C 0114          PI        FOP2      WRITE 2 CHAR CKSM
     805A 2885F2 85F2 0115          PI        TTCR      TYPE CR/LF
                           0116  *NOW CHECK IF ALL MEMORY IS PUNCHED,HI MUST =LO
     805D 4B               0117          LR        A,11      LAST LOW ADDRESS
     805E C6               0118          AS        EALO      ENDING LOW ADDRESS
     805F 4A               0119          LR        A,10      LAST HI ADDRESS
     8060 19               0120          LNK
     8061 C5               0121          AS        EAHI
     8062 92C1   8024 0122          BNC       FCON      NOT DONE YET
```

APPENDIX H (continued)

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8064 07          0123          LR        QL,A      ZERO
                      0124  *
                      0125  *NOW WROTE ZERO RECORD PRIOR TO TRAILER
                      0126  *
     8065 203A        0127          LI        H'3A'     COLON
     8067 51          0128          LR        CHRS,A
     8068 288610 8610 0129          PI        TTYO      PUNCH VCOLON
     806B 78          0130          LIS       8
     806C 58          0131          LR        HFLG,A
     806D 28812C 812C 0132  HERE    PI        FOP2   PUNCH 2 ZERO CHAR
     8070 38          0133          DS        HFLG
     8071 94FB   806D 0134          BNZ       HERE      REPEAT IF NOT 0
     8073 38          0135          DS        HFLG      SET TO -1
     8074 9090   8005 0136          BR        (FPUN+2)  TRAILER
                      0137  *
                      0138  *TEST FOR KEYBOARD OR TTY
                      0139  *
     8076 66          0140  TZE     LISU  6
     8077 6E          0141          LISL  6
     8078 2080        0142          LI    H'80'
     807A 5D          0143          LR    I,A
     807B 70          0144          LIS   0
     807C 5D          0145          LR    I,A
     807D 298160 8160 0146          JMP   STRT
                      0147  *
                      0148  *
                      0149  *
                      0150  *
                      0151  *
                      0152  *ENTRY POINT TO SAVE ALL REGISTERS EXCEPT PC0
                      0153  *    IF ENTRY IS FROM RESET MOST REGISTERS
                      0154  *    WILL BE MEANINGLESS DUE TO SWITCH BOUNCE.
                      0155  *
                      0156  *
     8080 1A          0157  SAVER  DI             MUST DO
     8081 2720        0158         OUT    PORTA  SAVE ACC VALID OR NOT
     8083 71          0159         LIS    1
     8084 2728        0160         OUT    OPOR   MARK BIT FOR TTY TO KEEP QUIET
     8086 4A          0161         LR     A,10
     8087 2721        0162         OUT    PORTB  SAVE R10 TEMP
     8089 4B          0163         LR     A,11
     808A 2729        0164         OUT   PORTC  SAVE R11 TEMP
     808C 11          0165         LR     H,DC   FREE DC0
                      0166  *SAVE R0-R63,IS,W
     808D 2A0000 0000 0167         DCI    RAM
     8090 40          0168.        LR     A,0
     8091 17          0169         ST            R0 SAVED
     8092 41          0170         LR     A,1
     8093 17          0171         ST            R1 SAVED
     8094 49          0172         LR     A,9
     8095 51          0173         LR     1,A    R9 TEMP TO R1
     8096 1E          0174         LR     J,W    W TEMP TO R9
     8097 0A          0175         LR     A,IS
     8098 50          0176         LR     0,A    ISAR TEMP TO R0
                      0177  *NOW SAVE R2 TO R63
     8099 72          0178         LIS    2
     809A 0B          0179         LR     IS,A   ISAR TO R2
     809B 4C          0180  ZC     LR     A,S
     809C 17          0181         ST
                      0182  *INC ISAR
     809D 0A          0183         LR     A,IS
```

APPENDIX H (continued)

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     809E 1F          0184         INC
     809F 0B          0185         LR     IS,A
                      0186   *TEST FOR H'40' IF DONE
     80A0 13          0187         SL     1
     80A1 81F9   809B 0188         BP     ZC
                      0189   *NOW SAVE ACC,IS,W FROM TEMPS
     80A3 2620        0190         IN     PORTA
     80A5 17          0191         ST
     80A6 40          0192         LR     A,0
     80A7 17          0193         ST            ISAR NOW SAVED
     80A8 49          0194         LR     A,9
     80A9 17          0195         ST            W NOW SAVED
     80AA 16          0196         LM            BAUD COUNT TO R0
     80AB 50          0197         LR     0,A    MAYBE IT IS VALID
                      0198   *NOW SAVE DC0,DC1,PC1
     80AC 2C          0199         XDC
     80AD 0E          0200         LR     Q,DC   DC1 TO Q
     80AE 2C          0201         XDC
     80AF 08          0202         LR     K,P    PC1 TO K
     80B0 7A          0203         LIS    10
     80B1 0B          0204         LR     IS,A   ISAR TO H,K,Q
     80B2 4D          0205   ZD    LR     A,I
     80B3 17          0206         ST
     80B4 8FFD   80B2 0207         BR7    ZD
     80B6 03          0208         LR     A,QL   BR7 DID NOT FINISH
     80B7 17          0209         ST
     80B8 2A0009 0009 0210         DCI    RA9
     80BB 41          0211         LR     A,1
     80BC 17          0212         ST            R9 NOW SAVED
     80BD 2621        0213         IN     PORTB
     80BF 17          0214         ST            R10 NOW SAVED
     80C0 2629        0215         IN    PORTC
     80C2 17          0216         ST            R11 NOW SAVED
     80C3 0E          0217         LR     Q,DC   QU=RAM PAGE ADDRESS
                      0218   *
                      0219   *NOW TEST FOR TTY AND IF SO GET BAUD COUNT
                      0220   *
     80C4 70          0221         CLR
     80C5 2728        0222         OUT    IPOR
     80C7 2628        0223         IN     IPOR   PORT0 FROM DEBUG
     80C9 18          0224         COM
     80CA 2106        0225         NI     6      BITS 1,2 FOR DEFAULT
     80CC 84A9   8076 0226         BZ     TZE    DEFAULT TO RAM VALUE
     80CE 2306        0227         XI     6
     80D0 12          0228         SR     1
     80D1 2A80DD 80DD 0229         DCI    BAUDT  TABLE
     80D4 8E          0230         ADC
     80D5 16          0231         LM
     80D6 2A0043 0043 0232         DCI    RAM+67 STORE AREA FOR BAUD
     80D9 17          0233         ST
     80DA 50          0234         LR     0,A
     80DB 909A   8076 0235   ZE    BR     TZE
                      0236   *
                      0237   *
                      0238   *
                 80DD 0239   BAUDT  EQU    *     NO 0 VALUE FOR TABLE
     80DD 06          0240         DC     H'06'  110 BAUD VALUE
     80DE A4          0241         DC     H'A4'  300 BAUD VALUE
     80DF EA          0242         DC     H'EA'  1200 BAUD VALUE
                      0243   *
                      0244   * RETURN FROM BREAKPOINT
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      0245 *
      80E0 AC         0246        INS     H'C'     ACC SAVE
      80E1 909E   8080 0247        BR      SAVER
                      0248 *
                      0249 *
                      0250 *
                      0251 *RESTORE BEFORE RETURN TO USER,  ALL BUT ACC IS OK
                      0252 *
                      0253 * MOVE DO,P1,D1 TO H,K,Q
                      0254 *
      80E3 2A0044 0044 0255 REST   DCI    D0
      80E6 7A         0256        LIS    10      HU
      80E7 0B         0257        LR     IS,A
      80E8 16         0258 ZA     LM
      80E9 5D         0259        LR     I,A
      80EA 8FFD   80E8 0260        BR7    ZA
      80EC 16         0261        LM             GET D1 LOW
      80ED 5D         0262        LR     I,A     TO QL,WITH 'ISAR' TO 0
                      0263 *RESTORE D1,P1
      80EE 60         0264        LISU    0
      80EF 0F         0265        LR     DC,Q
      80F0 2C         0266        XDC            TO DC1
      80F1 09         0267        LR     P,K     TO PC1
                      0268 *RESTORE R0-R63
      80F2 2A0000 0000 0269        DCI    RAM
      80F5 16         0270 ZB     LM
      80F6 5C         0271        LR     S,A
      80F7 0A         0272        LR     A,IS
      80F8 1F         0273        INC
      80F9 0B         0274        LR     IS,A    ISAR +1
      80FA 13         0275        SL     1
      80FB 81F9   80F5 0276        BP     ZB      IF NOT H'40' DO MORE
                      0277 *NOW RESTORE IS,W
      80FD 16         0278        LM             SKIP ACC
      80FE 16         0279        LM             ISAR
      80FF 0B         0280        LR     IS,A
      8100 16         0281        LM
      8101 59         0282        LR     9,A     W NOW IN J
                      0283 *GET D0 IN H
      8102 16         0284        LM             SKIP BAUD COUNT
      8103 16         0285        LM
      8104 5A         0286        LR     10,A
      8105 16         0287        LM
      8106 5B         0288        LR     11,A
                      0289 *GET ICB BIT AND ADD TO DI INST
      8107 74         0290        LIS     4
      8108 8E         0291        ADC
      8109 49         0292        LR     A,9
      810A 14         0293        SR     4       ICB NOW BIT 0
      810B 241A       0294        AI     H'1A'   IF ICB ON DI BECOMES EI
      810D 17         0295        ST             IN EXECUTION SEQUENCE
      810E 2029       0296        LI     H'29'   JMP OP CODE
      8110 17         0297        ST             RETURN TO USER PC0
                      0298 *NOW STRIP ICB FROM STATUS
      8111 7F         0299        LIS    15
      8112 F9         0300        NS     9
      8113 59         0301        LR     9,A
                      0302 *GET R9-11 AGAIN
      8114 2A0009 0009 0303        DCI    RA9
      8117 16         0304        LM
      8118 2720       0305        OUT    PORTA  SAVE R9
```

APPENDIX H (continued)

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     811A 16           0306        LM
     811B 2721         0307        OUT    PORTB  SAVE R10
     811D 16           0308        LM
     811E 10           0309        LR      DC,H   DC0 NOW RESTORED
     811F 5B           0310        LR     11,A
     8120 2621         0311        IN     PORTB
     8122 5A           0312        LR     10,A
     8123 2620         0313        IN     PORTA  R9 TO ACC
     8125 1D           0314        LR     W,J    STATUS RESTORED
     8126 59           0315        LR     9,A    FINALLY R9
     8127 29004A 004A  0316        JMP    EX     NOW EXECUTE EI OR DI THEN JMP
                       0317 *
                       0318 *
                       0319 *
                       0320 *
                       0321 *
                       0322 ***********
                       0323 *SUBROUTINE TO OUTBYTE 1 BYTE AS 2  4 BIT ASC CHARS
                       0324 *CKSM IS ACCUMULATED
                       0325 *HFLG MUST BE POSITIVE NUMBER
                       0326 *
     812A 16           0327 FOP1     LM
     812B 07           0328          LR        QL,A
                       0329 *ENTRY WITH CHARACTER IN REG SAVE
     812C 08           0330 FOP2     LR        K,P       SAVE RETURN INK
     812D 48           0331 FLP1     LR        A,HFLG
     812E 18           0332          COM                 SET STATUS
     812F 58           0333          LR        HFLG,A    FLIP-FLOP FLAG
     8130 03           0334          LR        A,QL
     8131 9102    8134 0335          BM        FHI       DO HI 4 BITS IF -
     8133 15           0336          SL        4         LOSE HI 4 BITS
     8134 14           0337 FHI      SR        4         MOVE TO LO 4 BITS
                       0338 *CONVERT TO ASC 0='30',9='39',A='41',F='46'
     8135 2430         0339          AI        H'30'
     8137 2539         0340          CI        H'39'
     8139 8103    813D 0341          BP        FINT      NOT A-F
     813B 2407         0342          AI        7
     813D 51           0343 FINT     LR        CHRS,A
     813E 288610 8610  0344          PI        TTYO      TYPE FRAME
     8141 38           0345          DS        HFLG
     8142 91EA    812D 0346          BM        FLP1      DO LOW HALF WORD
                       0347 *DO CHECKSUM
     8144 03           0348          LR        A,QL      LAST BYTE OUTPUTTED
     8145 C7           0349          AS        CKSM      ADD TO PROIR CKSM
     8146 57           0350          LR        CKSM,A    SAVE UPDATED CKSM
     8147 0C           0351          PK                  RETURN FROM K REGISTERS
                       0352 *
                       0353 *
     8148 2B           0354 TBLS     DC     AL1(A1-A)   ACCUMULATOR DISPLAY
     8149 B2           0355          DC     AL1(B-A)     PREVIOUS OR BACK 1 ADDRESS
     814A 33           0356          DC     AL1(C-A)     CHANGE FIELD
     814B 69           0357          DC     AL1(D-A)     DC DISPLAY
     814C 6F           0358          DC     AL1(E-A)     EXAMINE
     814D 75           0359          DC     AL1(F-A)     FORMATTED PUNCH
     814E 78           0360          DC     AL1(G-A)     GO TO
     814F 96           0361          DC     AL1(H-A)     HIGH SPEED LOADER
     8150 87           0362          DC     AL1(I-A)     ISAR DISPLAY
     8151 93           0363          DC     AL1(J-A)     8 BIT PROM PUNCH
     8152 A2           0364          DC     AL1(K-A)       FIND BIT PATTERN
     8153 9C           0365          DC     AL1(L-A)     LOAD
     8154 9F           0366          DC     AL1(M-A)     MEMORY DISPLAY
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APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8155 B7          0367          DC     AL1(N-A)     NEXT DISPLAY
     8156 99          0368          DC     AL1(O-A)     PORT DISPLAY
     8157 C3          0369          DC     AL1(P-A)     PC DISPLAY
     8158 FF          0370          DC     AL1(-1)        Q
     8159 F7          0371          DC     AL1(R-A)     REGISTER DISPLAY
     815A F3          0372          DC     AL1(S-A)     STATUS DISPLAY
     815B 2F          0373          DC     AL1(T-A)     CLEAR BREAK POINT
     815C 31          0374          DC     AL1(U-A)     BREAKPOINT
     815D 96          0375          DC     AL1(V-A)     MOVE BLOCK
     815E F3          0376          DC     AL1(S-A)     W (STATUS) DISPLAY
     815F 01          0377 HXX      DC     AL1(X-A)     HEX ARITHMETIC
     8160 4B          0378 STRT     LR    A,11      FREE R11
     8161 07          0379          LR    QL,A
     8162 2885F2 85F2 0380 STR1     PI         TTCR      WRITE CR/LF
     8165 203F        0381          LI         C'?'      PROMPT CHARACTER
     8167 51          0382          LR         CHRS,A
     8168 288610 8610 0383          PI         TTYO
                      0384 *READ INPUT CHARACTER
     816B 2885BE 85BE 0385          PI         TTYI
     816E 53          0386          LR         3,A       SAVE CHAR
     816F 288610 8610 0387          PI         TTYO      ECHO CHAR
     8172 43          0388          LR         A,3
     8173 217F        0389          NI         H'7F'     7 BITS ONLY
     8175 2540        0390          CI         H'40'
     8177 81EA   8162 0391          BP         STR1      LESS THAN 'A' INVALID
     8179 2558        0392          CI         C'X'
     817B 91E6   8162 0393          BM         STR1      GREATER THAN 'W' INVALID
     817D 211F        0394          NI         H'1F'     SAVE 5 BITS ONLY
     817F 2A8147 8147 0395          DCI        (TBLS-1)
     8182 8E          0396          ADC
     8183 16          0397          LM                   GET TABLE VALUE
     8184 05          0398 RPTC     LR         KL,A      SAVE INDEX IN R13
     8185 1F          0399          INC                  SET STATUS
     8186 84DB   8162 0400          BZ         STR1      INVALID CONTROL CHAR
                      0401 *NOW INPUT PARAMETERS IF ANY
                      0402 *FETCH PARAMETERS AFTER LEGIT CODE IS IN
                      0403 *MAX FIELD 1 AND 2 IS 4 HEX DIGITS
                      0404 *MAX FIELD 3 IS 1 HEX DIGIT
     8188 73          0405          LIS        3
     8189 58          0406          LR         FCNT,A    PARAMETER COUNT
     818A 0B          0407          LR         IS,A      ISAR=3
     818B 74          0408 FA       LIS        4
     818C 5B          0409          LR         CC,A      CHAR CNT=4
                      0410 *
                      0411 *ZERO DISPLAY R60-66
     818D 0A          0412          LR    A,IS
     818E 52          0413          LR    2,A       TEMP
     818F 66          0414          LISU  6
     8190 6D          0415          LISL  5
     8191 70          0416          LIS   0
     8192 5E          0417 FAA      LR    D,A
     8193 8FFE   8192 0418          BR7   FAA
     8195 42          0419          LR    A,2
     8196 0B          0420          LR    IS,A      RESTORE
                      0421 *
                      0422 *READ CHARACTER
     8197 2885BE 85BE 0423 FB       PI         TTYI      GET CHAR
     819A 217F        0424          NI         H'7F'
     819C 57          0425          LR         7,A
     819D 250D        0426          CI         CR
     819F 844E   81EE 0427          BZ         CORT      CORRECT FIELD BOUNDARIES
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     81A1 288610 8610 0428          PI        TTYO       ECHO INPUT CHAR
     81A4 47          0429          LR        A,7
     81A5 252D        0430          CI        C'-'       FIELD SEPARATOR
     81A7 8445   81ED 0431          BZ        CORN
     81A9 252B        0432          CI        C'+'
     81AB 8441   81ED 0433          BZ        CORN
     81AD 253D        0434          CI        C'='
     81AF 843E   81EE 0435          BZ        CORT
     81B1 255B        0436          CI        H'5B'      KILL CHAR?
     81B3 84AE   8162 0437          BZ        STR1       KILL INPUT
                      0438 *MUST BE HEX 0-9, OR A-F
     81B5 252F        0439          CI        H'2F'      LESS THAN ZERO
     81B7 81DF   8197 0440          BP        FB         ERROR IGNORE
     81B9 2546        0441          CI        H'46'      F?
     81BB 91DB   8197 0442          BM        FB         ERROR IGNORE
     81BD 24D0        0443          AI        H'D0'
     81BF 2509        0444          CI        H'9'
     81C1 8107   81C9 0445          BP        FOK
     81C3 2510        0446          CI        H'10'
     81C5 81D1   8197 0447          BP        FB         ERROR, IGNORE IT
     81C7 24F9        0448          AI        H'F9'
     81C9 3B          0449 FOK      DS        CC
     81CA 91CC   8197 0450          BM        FB         FULL FIELD IGNORE THIS
                      0451 *ZERO LO 4 BITS, THEN ADD THIS DIGIT
     81CC 52          0452          LR        2,A
                      0453 *
                      0454 *SHIFT NEW DIGIT INTO DISPLAY
     81CD 0A          0455          LR    A,IS
     81CE 04          0456          LR    KU,A      TEMP
     81CF 66          0457          LISU  6
     81D0 69          0458          LISL  1
     81D1 4E          0459          LR    A,D       R61
     81D2 5D          0460          LR    I,A       TO R60
     81D3 6A          0461          LISL  2
     81D4 4E          0462          LR    A,D       R62
     81D5 5D          0463          LR    I,A       TOR61
     81D6 6B          0464          LISL  3
     81D7 4E          0465          LR    A,D       R63
     81D8 5D          0466          LR    I,A       TO R62
     81D9 42          0467          LR    A,2       NEW DIGIT
     81DA 5C          0468          LR    S,A
     81DB 00          0469          LR    A,KU
     81DC 0B          0470          LR    IS,A      RESTORE
     81DD 4C          0471          LR        A,S
     81DE 15          0472          SL        4
     81DF C2          0473          AS        2
     81E0 5D          0474          LR        I,A        TO PARAMETER LOC
     81E1 71          0475          LIS       1
     81E2 FB          0476          NS        CC
     81E3 84B3   8197 0477          BZ        FB         EVEN CHAR,2DIGITS,GO READ
     81E5 4E          0478          LR        A,D        SET ISAR BACK 1
     81E6 8FB0   8197 0479          BR7       FB         GET NEXT DIGIT
     81E8 73          0480          LIS       3
     81E9 9033   821D 0481          BR        COR7       PARAMETERS FULL,NOW EXIT
     81EB 909F   818B 0482 FAX      BR        FA        LINK TO FA
     81ED 59          0483 CORN     LR        9,A
                      0484 *CORRECT HEX FIELD, RIGHT JUSTIFY
                      0485 *   IF AB0C THEN 0ABC
                      0486 *   IF ABCD THEN IT IS OK
                      0487 *   IF A00 THEN 000A
                      0488 *   IF AB00 THEN 00AB
```

APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     81EE 74          0489  CORT     LIS       4
     81EF EB          0490           XS        CC
     81F0 841F   8210 0491           BZ        COR6     NO PARAMETERS
     81F2 3B          0492           DS        CC
     81F3 911B   820F 0493           BM        COR5     FIELD ABCD,AOK
     81F5 940C   8202 0494           BNZ       COR1
     81F7 7F          0495           LIS       15
     81F8 FC          0496           NS        S
     81F9 5E          0497           LR        D,A
     81FA 4D          0498           LR        A,I
     81FB 15          0499           SL        4
     81FC EC          0500           XS        S
     81FD 5E          0501           LR        D,A
     81FE 4C          0502           LR        A,S
     81FF 14          0503           SR        4
     8200 900C   820D 0504           BR        COR4
     8202 3B          0505  COR1     DS        CC
     8203 8405   8209 0506           BZ        COR2
     8205 7F          0507           LIS       15
     8206 FD          0508           NS        I
     8207 9003   820B 0509           BR        COR3
     8209 4E          0510  COR2     LR        A,D
     820A 4D          0511           LR        A,I
     820B 5E          0512  COR3     LR        D,A
     820C 70          0513           LIS       0
     820D 5D          0514  COR4     LR        I,A
     820E 4D          0515           LR        A,I
     820F 38          0516  COR5     DS        FCNT
     8210 47          0517  COR6     LR        A,7
     8211 250D        0518           CI        CR
     8213 8405   8219 0519           BZ        COR8
     8215 253D        0520           CI        C'='
     8217 94D3   81EB 0521           BNZ       FAX       LAST CHAR NOT CR OR =
     8219 48          0522  COR8     LR        A,FCNT
     821A 18          0523           COM
     821B 2404        0524           AI        4
     821D 58          0525  COR7     LR        FCNT,A
     821E 03          0526           LR        A,QL
     821F 5B          0527           LR        11,A     RESTORE R11
                      0528  *TEST FOR 2 OR 3 PARAMETERS
                      0529  *   MAKE LO ADDRESS START ON 8 BYTE BOUNDRY
                      0530  *  MAKE HI ADDRESS END ON 8 BYTE BOUNDRY
     8220 72          0531           LIS       2
     8221 F8          0532           NS        FCNT
     8222 8418   823B 0533           BZ        RTN1     NOT 2 OR 3 PARAMETERS
     8224 01          0534           LR    A,KL
     8225 2596        0535           CI    (V-A)    HEX
     8227 8422   824A 0536           BZ    MOVE
     8229 2575        0537           CI    (F-A)    DUMP
     822B 840A   8236 0538           BZ    FF
     822D 12          0539           SR    1
     822E 840C   823B 0540           BZ    RTN1     HEX
     8230 46          0541           LR        A,6
     8231 220F        0542           OI        15
     8233 56          0543           LR        6,A
     8234 20F0        0544           LI        H'F0'
     8236 F4          0545  FF       NS        4
     8237 54          0546           LR        4,A
     8238 5B          0547           LR        11,A
     8239 43          0548           LR        A,3
     823A 5A          0549           LR        10,A
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APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      0550  *CALC ADDRESS TO GET TO PROCESS ROUTINE
      823B 2A8248 8248 0551  RTN1     DCI       STB
      823E 16          0552           LM
      823F 04          0553           LR        KU,A      SAVE
      8240 01          0554           LR        A,KL
      8241 88          0555           AM
      8242 05          0556           LR        KL,A
      8243 00          0557           LR        A,KU       HI 8 BIT ADDRESS OF 'A'
      8244 19          0558           LNK
      8245 04          0559           LR        KU,A
      8246 02          0560           LR        A,QU       HI ADDRESS IF NEEDED
      8247 0C          0561           PK
      8248 82CB        0562  STB      DC        AL2(HEX-1)
                       0563  *MOVE MEMORY BLOCK
                       0564  *  TO ACCOMPLISH,DO  MXXXXX WHERE XXXX IS DESTINATION START ADDRESS
                       0565  *                     VSSSS-EEEE WHERE SSSS IS SOURCE ADDRFESS START
                       0566  *               AND EEEE IS SOURCE ENDING ADDRESS
                       0567  *INPUT
                       0568  *  R10-11  =DESTINATION START ADDRESS
                       0569  *  R3-4     =SOURCE START ADDRESS
                       0570  *  R5-6    =SOURCE END ADDRESS
                       0571  *WORK REGISTERS
                       0572  *  R10-11   =CORRENT SOURCE BYTE ADDRESS
                       0573  *  R5-6     =SOURCE START IF MOVING FROM END FORWARD
                       0574  *          =SOURCE END ADDRESS IF MOVE START TO END
      824A 4A          0575  MOVE     LR        A,10        DESTINATION HI AYTE
      824B 18          0576           COM
      824C 1F          0577           INC
      824D C3          0578           AS        3          SOURCE START HI BYTE
      824E 840B   825A 0579           BZ        MBY2       EQUAL,TEST LO BYTE
      8250 910F   8260 0580           BM        MEND       MO V E BACKWARDS
      8252 10          0581  MBGN     LR        DC,H
      8253 43          0582           LR        A,3
      8254 5A          0583           LR        10,A
      8255 44          0584           LR        A,4
      8256 5B          0585           LR        11,A
      8257 70          0586           LIS 0
      8258 9026   827F 0587           BR        MCOM
      825A 4B          0588  MBY2     LR        A,11
      825B 18          0589           COM
      825C 1F          0590           INC
      825D C4          0591           AS        4
      825E 81F3   8252 0592           BP       MBGN
                       0593  *CALC LENGTH OF BLOCK
      8260 43          0594  MEND     LR        A,3
      8261 18          0595           COM
      8262 51          0596           LR        1,A
      8263 44          0597           LR        A,4
      8264 18          0598           COM
      8265 1F          0599           INC
      8266 1E          0600           LR        J,W
      8267 C6          0601           AS        6
      8268 9202   826B 0602           BNC       MXX
      826A 1E          0603           LR        J,W
      826B CB          0604  MXX      AS        11
      826C 5B          0605           LR        11,A
      826D 41          0606           LR        A,1
      826E 19          0607           LNK
      826F 1D          0608           LR        W,J
      8270 19          0609           LNK
      8271 C5          0610           AS        5
```

APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8272 CA          0611          AS        10
     8273 5A          0612          LR        10,A
                      0613 *MOVE TO DC THEN IONCREMENT TO ADD 1 TO LENGTH
     8274 10          0614          LR        DC,H
                      0615 *MOVE SOURCE START ADDRESS TO R10-11
     8275 45          0616          LR        A,5
     8276 5A          0617          LR        10,A
     8277 46          0618          LR        A,6
     8278 5B          0619          LR        11,A
                      0620 *NOW MOVE SOURCE START TO R5-6 FOR END COMPARE
     8279 43          0621          LR        A,3
     827A 55          0622          LR        5,A
     827B 44          0623          LR        A,4
     827C 56          0624          LR        6,A
     827D 20FE        0625          LI        -2        MEMORY ADDRESS INCREMENT
     827F 57          0626 MCOM     LR        7,A
     8280 2C          0627          XDC
     8281 10          0628          LR        DC,H
     8282 11          0629 MLOP     LR        H,DC      SAVE ADDRESS FOR COMPARE
     8283 16          0630          LM
     8284 2C          0631          XDC
     8285 17          0632          ST
     8286 47          0633          LR        A,7
     8287 8E          0634          ADC
     8288 2C          0635          XDC
     8289 8E          0636          ADC
                      0637 *COMPARE FOR ADDRESS END
     828A 4A          0638          LR        A,10
     828B E5          0639          XS        5
     828C 94F5   8282 0640          BNZ       MLOP
     828E 4B          0641          LR        A,11
     828F E6          0642          XS        6
     8290 94F1   8282 0643          BNZ       MLOP
     8292 298160 8160 0644 BXX      JMP       STRT      ALL DONE
                      0645 *BREAKPOINT TO MEMORY SAVE 4 BYTES OF USER CODE.
                      0646 *  REPLACE WITH SAVE ACC IN PORT, THEN JUMP TO BRKPT
                      0647 *  PROCESS.  BRKPT STAYS IN MEMORY UNTIL CLEARED.
     8295 20D0        0648 BRAK     LI        H'D0'     SCRATCH MEM LO ADDRESS BYTE
     8297 07          0649          LR        QL,A
     8298 0F          0650          LR        DC,Q
     8299 43          0651          LR        A,3
     829A 5A          0652          LR        10,A
     829B 17          0653          ST
     829C 44          0654          LR        A,4
     829D 5B          0655          LR        11,A
     829E 17          0656          ST
                      0657 *NOW FETCH USER BYTE
     829F 2C          0658          XDC       LR        DC,H
     82A0 10          0659          LR        DC,H
     82A1 6B          0660          LISL      3
     82A2 16          0661 BLP      LM
     82A3 2C          0662          XDC
     82A4 17          0663          ST
     82A5 2C          0664          XDC
     82A6 4E          0665          LR        A,D    DEC ISAR
     82A7 8FFA   82A2 0666          BR7       BLP
                      0667 *NOW STORE IN MEMORY
     82A9 10          0668          LR        DC,H
     82AA 20BC        0669          LI       H'BC'
     82AC 17          0670          ST
                      0671 *NOW CHANGE USER  TO RESTORE ADDRESS
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     82AD 2029        0672          LI      H'29'    JMP INSTRUCTION
     82AF 17          0673          ST
     82B0 2080        0674          LI       H'80'
     82B2 17          0675          ST
     82B3 20E0        0676          LI       H'E0'     RETURN FROM BREAKPOINT
     82B5 17          0677         ST
     82B6 90DB   8292 0678          BR       BXX       TO START
                      0679 *RESTORE BYTE TO USER MEMORY
     82B8 20D0        0680 TT       LI       H'D0'     SCRATCH AREA
     82BA 07          0681          LR       QL,A
     82BB 0F          0682          LR       DC,Q
     82BC 16          0683          LM
     82BD 5A          0684          LR       10,A
     82BE 16          0685          LM
     82BF 5B          0686          LR       11,A
     82C0 2C          0687          XDC
     82C1 6B          0688          LISL     3
     82C2 10          0689          LR       DC,H      USER ADDRESS
     82C3 2C          0690 TTLP     XDC
     82C4 16          0691          LM
     82C5 2C          0692          XDC
     82C6 17          0693          ST       RESTORE USER CODE
     82C7 4E          0694          LR       A,D
     82C8 8FFA   82C3 0695          BR7      TTLP
     82CA 90C7   8292 0696          BR       BXX       TO START
                      0697 *HEX ARITHMETIC
                 82CC 0698 X        EQU   *
     82CC 49          0699 HEX      LR       A,9
     82CD 252B        0700          CI       C'+'
     82CF 840B   82DB 0701          BZ       PLUS
                      0702 *COMPLEMENT BEFORE ADD=SUBTRACT
     82D1 46          0703          LR       A,6
     82D2 18          0704          COM
     82D3 1F          0705          INC                2'S COMPLEMENT
     82D4 1E          0706          LR       J,W
     82D5 56          0707          LR       6,A
     82D6 45          0708          LR       A,5
     82D7 18          0709          COM
     82D8 1D          0710          LR       W,J
     82D9 19          0711          LNK
     82DA 55          0712          LR       5,A
                      0713 *ADDITION
     82DB 44          0714 PLUS     LR       A,4
     82DC C6          0715          AS       6
     82DD 54          0716          LR       4,A
     82DE 43          0717          LR       A,3
     82DF 19          0718          LNK
     82E0 C5          0719          AS       5
                      0720 *NOW WRITE TO DISPLAY RESULTS
     82E1 07          0721          LR       QL,A
     82E2 66          0722          LISU  6
     82E3 68          0723          LISL  0
     82E4 14          0724          SR    4
     82E5 5D          0725          LR    I,A
     82E6 03          0726          LR    A,QL
     82E7 5D          0727          LR    I,A
     82E8 28812C 812C 0728          PI       FOP2
     82EB 44          0729          LR       A,4
     82EC 07          0730          LR       QL,A
     82ED 14          0731          SR    4
     82EE 5D          0732          LR    I,A
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APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE           SOURCE STATEMENT

      82EF 03            0733           LR    A,QL
      82F0 5D            0734           LR    I,A
      82F1 28812C 812C 0735           PI        FOP2
      82F4 909D   8292 0736 BXT      BR        BXX
                       0737 *PRINT ACCUMULATOR
      82F6 2040        0738 A1       LI        64        LOC OF ACC
      82F8 905B   8354 0739          BR        I1
                       0740 *CLEAR BREAK POINT ENTRY
      82FA 90BD   82B8 0741 T        BR        TT
                       0742 *BREAKPOINT ENTRY FROM TABLE
      82FC 9098   8295 0743 U        BR        BRAK      TEMP NOP
                       0744 *CHANGE LAST USED FIELD
      82FE 38          0745 C        DS        FCNT
      82FF 91F4   82F4 0746          BM        BXT       NO PARAMETERS SUPPLIED
      8301 49          0747          LR        A,FLG
      8302 10          0748          LR        DC,H
      8303 250C        0749          CI        OO        CK FOR PORT
      8305 9404   830A 0750          BNZ       C0        NOT PORT CHANGE
      8307 298546 8546 0751          JMP       PORT      GO CHANGE PORT
      830A 250D        0752 C0       CI        PP
      830C 910B   8318 0753          BM        C2        REGISTER CHANGE
      830E 9403   8312 0754          BNZ       C1        MEMORY CHANGE 1 WORD
      8310 43          0755          LR        A,3
      8311 17          0756          ST                  PC OR DC 1ST HALF
      8312 44          0757 C1       LR        A,4
      8313 17          0758          ST
      8314 11          0759          LR        H,DC
      8315 4B          0760          LR        A,11
      8316 900C   8323 0761          BR        (C3+4)
      8318 2080        0762 C2       LI        H'80'
      831A CB          0763          AS        11
      831B 07          0764          LR        QL,A
      831C 0F          0765          LR        DC,Q
      831D 44          0766          LR        A,4
      831E 17          0767          ST
      831F 4B          0768 C3       LR        A,11
      8320 1F          0769          INC
      8321 213F        0770          NI        H'3F'
      8323 07          0771          LR        QL,A
      8324 2020        0772 C5       LI        H'20'     BLANK
      8326 51          0773          LR        CHRS,A
      8327 288610 8610 0774          PI        TTYO
      832A 2033        0775          LI        (C-A)     TABLE VALUE OF C ENTRY
      832C 05          0776          LR        KL,A
      832D 298185 8185 0777          JMP        (RPTC+1)
      8330 46          0778 C55      LR        A,6
      8331 07          0779          LR        QL,A
      8332 90F1   8324 0780          BR        C5
                       0781 *DISPLAY DC
      8334 5A          0782 D        LR        10,A      HI STORE ADDRESS
      8335 44          0783          LR        A,4       DET LO ADDR OF DC
      8336 13          0784          SL        1         MEM0=2 OR 3
      8337 13          0785          SL        1         MAKE 4 OR 6
      8338 905C   8395 0786          BR        P1
                       0787 *EXAMINE THIS ADDRESS
      833A 7D          0788 E        LIS       PP
      833B E9          0789          XS        FLG
      833C 845D   839A 0790          BZ        P2        PC OR DC
      833E 9047   8386 0791          BR        N1
                       0792 *FORMATTED PUNCH,FOR BOOT LOAD INPUT
      8340 298003 8003 0793 F        JMP       FPUN
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                     0794  *GO TO
     8343 38              0795  G        DS        FCNT
     8344 910A   834F 0796           BM        G1
                     0797  *GET NEW PC FROM PARAMETERS
     8346 5A              0798           LR        10,A
     8347 20CC            0799           LI        H'CC'
     8349 5B              0800           LR        11,A      SET PC MEMORY ADDRESS
     834A 10              0801           LR        DC,H
     834B 43              0802           LR        A,3
     834C 17              0803           ST                  PC UPPER
     834D 44              0804           LR        A,4
     834E 17              0805           ST                  PC LOWER
     834F 2980E3 80E3 0806  G1       JMP       REST      RESTORE REGISTERS ,RETURN TO USER
                     0807  *ISAR DISPLAY
     8352 2041            0808  I        LI        65        REGISTER OF ISAR
     8354 54              0809  I1       LR        4,A
     8355 56              0810           LR        6,A
     8356 70              0811           LIS       0
     8357 53              0812           LR        3,A       SET TO REGISTER FETCH
     8358 55              0813           LR        5,A
     8359 7F              0814           LIS       RR
     835A 59              0815           LR        FLG,A
     835B 2983F2 83F2 0816           JMP       R23
                     0817  *
     835E 298444 8444 0818  J        JMP       PPUN
                     0819  *
                 8361 0820  V        EQU    *       JUST SO TABLE VALUE IS NOT FF
                     0821  *HIGH SPEED READER LOAD ROUTINE
     8361 2984B8 84B8 0822  H        JMP       HIGH
                     0823  * PORT PRINT
     8364 7C              0824  O        LIS       OO        CODE FOR PORT
     8365 905E   83C4 0825           BR        R1        PRINT PORT DATA
                     0826  *BOOT LOAD
     8367 2984AD 84AD 0827  L        JMP       LOAD
                     0828  *MEMORY PRINT
     836A 7A              0829  M        LIS       MM
     836B 9058   83C4 0830           BR        R1
                     0831  *
                     0832  *FIND MATCHING BYTE
                     0833  *
     836D 10              0834  K        LR    DC,H
     836E 16              0835           LM              DUMMY TO SKIP BYTE
     836F 16              0836  F1       LM
     8370 E4              0837           XS    4
     8371 8414   8386 0838           BZ    N1        MATCH DECREMENT DC
     8373 11              0839           LR    H,DC
     8374 70              0840           LIS   0
     8375 EA              0841           XS    10
     8376 94F8   836F 0842           BNZ   F1        CONTINUE SEARCH
     8378 EB              0843           XS    11
     8379 94F5   836F 0844           BNZ   F1        CONTINUE SEARCH
     837B 900A   8386 0845           BR    N1      WRAPPED AROUND
                     0846  *
                     0847  *DISPLAY PREVIOUS LOCATION
                     0848  *
     837D 10              0849  B        LR    DC,H
     837E 20FF            0850           LI    H'FF'     -1
     8380 9003   8384 0851           BR    N2
                     0852  *
                     0853  *NEXT--DISPLAY NEXT MEMORY OR REGISTER LOC
     8382 10              0854  N        LR        DC,H
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8383 71           0855           LIS       1
     8384 8E           0856  N2       ADC
     8385 11           0857           LR        H,DC
     8386 4A           0858  N1       LR        A,10
     8387 53           0859           LR        3,A
     8388 55           0860           LR        5,A
     8389 4B           0861           LR        A,11
     838A 54           0862           LR        4,A
     838B 56           0863           LR        6,A
     838C 9044    83D1 0864           BR        R22
                       0865  *PC PRINT
     838E 5A           0866  P        LR        10,A
     838F 44           0867           LR        A,4        PC0 OR 1
     8390 13           0868           SL        1
     8391 9403    8395 0869           BNZ       P1         PC1 OK
     8393 2408         0870           AI        8          TO REACH P0
     8395 24C4         0871  P1       AI        H'C4'      ADD PC0 OR PC1 OR DC
     8397 5B           0872           LR        11,A
     8398 7D           0873           LIS       PP
     8399 59           0874           LR        FLG,A      SET TO P FOR 2 WORDS
     839A 10           0875  P2       LR        DC,H
     839B 203D         0876           LI        C'='       EQUAL
     839D 51           0877           LR        CHRS,A
     839E 288610 8610 0878           PI        TTYO
     83A1 28812A 812A 0879           PI        FOP1       OP HEX WD,2 CHAR FROM MEM
     83A4 66           0880           LISU  6
     83A5 68           0881           LISL  0
     83A6 03           0882           LR    A,QL
     83A7 14           0883           SR    4
     83A8 5D           0884           LR    I,A
     83A9 03           0885           LR    A,QL
     83AA 5D           0886           LR    I,A
     83AB 02           0887           LR    A,QU
     83AC 28812A 812A 0888           PI    FOP1      OP HEX WD,2 CHAR
     83AF 03           0889           LR    A,QL
     83B0 14           0890           SR    4
     83B1 5D           0891           LR    I,A
     83B2 03           0892           LR    A,QL
     83B3 5D           0893           LR    I,A
     83B4 0F           0894           LR    DC,Q
     83B5 16           0895           LM              DATA @ PC/DC ADDRESS
     83B6 07           0896           LR    QL,A      TEMP
     83B7 14           0897           SR    4
     83B8 5D           0898           LR    I,A
     83B9 03           0899           LR    A,QL
     83BA 5D           0900           LR    I,A
     83BB 298160 8160 0901  P3       JMP       STRT
                       0902  *S-FETCH STATUS REGISTER
     83BE 2042         0903  S        LI        66         LOC OF STATUS STORE
     83C0 9093    8354 0904           BR        I1
                       0905  *R-ENTRY FOR REGISTER DISPLAY
     83C2 200F         0906  R        LI        RR
     83C4 59           0907  R1       LR        FLG,A      SET TO R OR M
     83C5 38           0908           DS        FCNT
     83C6 91F4    83BB 0909           BM        P3         NO PARAMETERS GIVEN
     83C8 9405    83CE 0910           BNZ       R2
                       0911  *MAKE HI ADDR=LO ADDR
     83CA 43           0912           LR        A,3
     83CB 55           0913           LR        5,A
     83CC 44           0914           LR        A,4
     83CD 56           0915           LR        6,A
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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      0916 *PRINT CR LF BLANK BLANK (R OR M) BLANK XXXX=
     83CE 2885F2 85F2 0917 R2       PI        TTCR       WRITE CR/LF
     83D1 2020        0918 R22      LI        H'20'      BLANK
     83D3 51          0919          LR        CHRS,A
     83D4 288610 8610 0920          PI        TTYO
     83D7 49          0921          LR        A,FLG
     83D8 2443        0922          AI        H'43'
     83DA 51          0923          LR        CHRS,A
     83DB 288610 8610 0924          PI        TTYO
     83DE 43          0925          LR        A,3        START LO ADDRESS
     83DF 07          0926          LR        QL,A
     83E0 66          0927          LISU  6
     83E1 68          0928          LISL  0
     83E2 14          0929          SR    4
     83E3 5D          0930          LR    I,A
     83E4 03          0931          LR    A,QL
     83E5 5D          0932          LR    I,A
     83E6 28812C 812C 0933          PI        FOP2
     83E9 44          0934          LR        A,4
     83EA 07          0935          LR        QL,A
     83EB 14          0936          SR    4
     83EC 5D          0937          LR    I,A
     83ED 03          0938          LR    A,QL
     83EE 5D          0939          LR    I,A
     83EF 28812C 812C 0940          PI        FOP2
     83F2 203D        0941 R23      LI        C'='
     83F4 51          0942          LR        CHRS,A
     83F5 288610 8610 0943          PI        TTYO
     83F8 903D   8436 0944          BR        BLNK
                      0945 *NOW PRINT DATA
     83FA 43          0946 R4       LR        A,3
     83FB 5A          0947          LR        10,A
     83FC 44          0948          LR        A,4
     83FD 5B          0949          LR        11,A
     83FE 49          0950          LR        A,FLG
     83FF 250C        0951          CI        OO         PORT?
     8401 846A   846C 0952          BZ        PIO        GO TO PORT ROUTINE
     8403 250F        0953          CI        RR         TEST FOR REGISTER CHANGE
     8405 9407   840D 0954          BNZ       R5         MEMORY LOC
                      0955 *
                      0956 *REGISTER FETCH IS IT IN SCRATCH OR TEMP MEMORY
     8407 44          0957          LR        A,4
                      0958 *UPDATE REG 0-15 ADDRESS TO MEM LOC
     8408 2480        0959          AI        H'80'      LO RAM-START OF REG 0
     840A 5B          0960          LR        11,A
     840B 02          0961          LR        A,QU       HI ADDRESS
     840C 5A          0962          LR        10,A       HI RAM ADDRESS
                      0963 *FETCH DATA FROM MEMORY
     840D 10          0964 R5       LR        DC,H
                      0965 *DATA NOW IN NOW PRINT
     840E 28812A 812A 0966          PI        FOP1       TYPE 2 CHAR FROM MEM
     8411 66          0967 R77      LISU  6
     8412 6C          0968          LISL  4
     8413 03          0969          LR    A,QL
     8414 14          0970          SR    4
     8415 5D          0971          LR    I,A
     8416 03          0972          LR    A,QL
     8417 5D          0973          LR    I,A
     8418 2020        0974          LI        H'20'      BLANK
     841A 51          0975          LR        CHRS,A
     841B 288610 8610 0976          PI        TTYO       BLANK
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      0977  *CHECK FOR END
      841E 44         0978          LR      A,4
      841F 5B         0979          LR      11,A      SAVE FOR REENTRY
      8420 E6         0980          XS      6
      8421 43         0981          LR      A,3
      8422 5A         0982          LR      10,A      SAVE FOR REENTRY
      8423 9404  8428 0983          BNZ     R7
      8425 E5         0984          XS      5
      8426 8494  83BB 0985          BZ      P3
      8428 44         0986  R7      LR      A,4
                      0987  *UPDATE FOR NEXT WORD,LINE HAS MAX OF 8
      8429 1F         0988          INC
      842A 54         0989          LR      4,A       INCREMENT ADDRESS
      842B 43         0990          LR      A,3
      842C 19         0991          LNK
      842D 53         0992          LR      3,A       INCR HI ADDRESS
      842E 7F         0993          LIS     15
      842F F4         0994          NS      4
      8430 849D  83CE 0995          BZ      R2        NEW LINE
                      0996  *ADD 2 BLANKS BETWEEN EACH 4 PRINTS
      8432 2103       0997          NI    3
      8434 94C5  83FA 0998          BNZ   R4
      8436 2020       0999  BLNK    LI    H'20'     BLANK
      8438 51         1000          LR    CHRS,A
      8439 288610 8610 1001         PI    TTYO
      843C 2020       1002          LI    H'20'
      843E 51         1003          LR    CHRS,A
      843F 288610 8610 1004         PI    TTYO
      8442 90B7  83FA 1005          BR      R4        CONTINUE THIS LINE
                      1006  *PUNCH HEADER,THEN 256 X 8.
                      1007  *  THEN HEADER 256 X 8.
                      1008  *  CONTINUE AS ABOVE UNTIL LAST ADDRESS IS COMPLETE
                      1009  *  HFLG INITIALLY=SIZE,WHEN=0 PUNCH LEADER,WHEN =-SIZE DONE
      8444 70         1010  PPUN    LIS     0
      8445 5B         1011          LR      11,A      LOW DC ADDRESS
      8446 2092       1012          LI      H'92'
      8448 51         1013          LR      CHRS,A
      8449 288610 8610 1014         PI      TTYO
      844C 73         1015  PPA     LIS     3
      844D 58         1016          LR      HFLG,A    NEG SIZE MINUS 1
      844E F7         1017          NS      SIZE      MASK HI BITS
      844F 57         1018          LR      SIZE,A
      8450 43         1019          LR      A,SA
      8451 5A         1020          LR      10,A
      8452 10         1021          LR      DC,H
      8453 47         1022          LR      A,SIZE    LENGTH OF BLOCK X 256
      8454 54         1023          LR      4,A
      8455 2030       1024  PBLK    LI      H'30'     48 BLANKS
      8457 56         1025          LR      XFLG,A
      8458 70         1026  PLP     LIS     0
      8459 51         1027          LR      CHRS,A
      845A 288610 8610 1028         PI      TTYO      WRITE BLANK
      845D 36         1029          DS      XFLG
      845E 94F9  8458 1030          BNZ     PLP CONTINUE BLANKS
                      1031  *CHECK FOR DONE
      8460 38         1032          DS      HFLG
      8461 8134  8496 1033          BP      PPC
                      1034  *****DONE*******
      8463 2094       1035          LI      H'94'
      8465 51         1036          LR      CHRS,A
      8466 288610 8610 1037  PLXX   PI      TTYO      PUNCH OFF
```

APPENDIX H (continued)

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

      8469 298076 8076 1038         JMP       TZE
                       1039  *POR T DISPLAY
      846C 20E0        1040  PIO    LI        H'E0'     SCRATCH MEMORY
      846E 07          1041         LR        QL,A
      846F 0F          1042         LR        DC,Q      SCRATCH MEMORY
      8470 44          1043         LR        A,4       PORT ADDRESS
      8471 250F        1044         CI        15        SHORT PORT ADDRESS
      8473 821E   8492 1045         BC        INS       BUILD INS INSTRUCT
      8475 2026        1046         LI        H'26'     LONG INPUT
      8477 17          1047         ST
      8478 44          1048         LR        A,4       PORT ADDRESS
      8479 17          1049         ST
      847A 77          1050  PXX    LIS       7
      847B 17          1051         ST
      847C 2029        1052         LI        H'29'     JMP INST
      847E 17          1053         ST
      847F 2C          1054         XDC
      8480 2A848B 848B 1055         DCI      PXA
      8483 16          1056         LM
      8484 2C          1057         XDC
      8485 17          1058         ST
      8486 2C          1059         XDC
      8487 16          1060         LM
      8488 2C          1061         XDC
      8489 17          1062         ST
      848A 0D          1063         LR        P0,Q      GO EXECUTE
                       1064  *
      848B 848D        1065  PXA    DC        AL2(PXXY)    ADDRESS OF RETURN
                       1066  *
                       1067  *RETURN AFTER READ
      848D 28812C 812C 1068  PXXY   PI        FOP2      TO PRINT
      8490 9080   8411 1069         BR        R77
                       1070  *SHORT INS
      8492 24A0        1071  INS    AI        H'A0'
      8494 90E4   8479 1072         BR        (PXX-1)
                       1073  *OUTPUT 2 RUBOUTS,REGISTER CHRS  HAS -1 AFTER
                       1074  *    RETURN FROM TTYO OF BLANKS
                       1075  * PUNCH BLOCK OF 256
      8496 70          1076  PPC    LIS       0
      8497 56          1077         LR        XFLG,A
                       1078  *8 BIT FORMAT
      8498 16          1079  EGHT   LM
      8499 51          1080         LR        CHRS,A
      849A 288610 8610 1081         PI        TTYO      OUTPUT BYTE
      849D 36          1082         DS        XFLG
      849E 94F9   8498 1083         BNZ       EGHT      NEXT BYTE
      84A0 34          1084         DS        4         PAGES PER BLOCK
      84A1 81F4   8496 1085         BP        PPC       START NEXT BLOCK
      84A3 58          1086         LR        HFLG,A
                       1087  *UPDATE TO NEXT PAGE
      84A4 43          1088         LR        A,SA
      84A5 1F          1089         INC
      84A6 C7          1090         AS        SIZE
      84A7 53          1091         LR        SA,A
      84A8 E5          1092         XS        EA        END PAGE
      84A9 84AB   8455 1093         BZ        PBLK      DO TRAILER
      84AB 90A0   844C 1094         BR        PPA       START NEXT HI BLOCK
                       1095  *  START OF BOOT LOAD
      84AD 2091        1096  LOAD   LI        H'91'     READER ON COMMAND
      84AF 51          1097         LR        CHRS,A    PASS IT
      84B0 288610 8610 1098         PI        TTYO      AND TYPE IT
```

APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     84B3 2A85BE 85BE 1099          DCI      TTYI      SERIAL INPUT PROCESS
     84B6 900F   84C6 1100          BR       BOT1      SKIP OVER PARALLEL CODE
     84B8 2A85A3 85A3 1101 HIGH     DCI      PINP
     84BB 70          1102          LIS      0
     84BC 2729        1103 SLF1     OUT      PPRT      INITIALIZE PARALLEL IN PORT
     84BE 2728        1104          OUT      PSTS      INIT CONTROL PORT FOR READER OFF
     84C0 2628        1105          IN       PSTS
     84C2 12          1106          SR       1
     84C3 15          1107          SL       4
     84C4 91F7   84BC 1108          BM       SLF1      LOCK IN LOOP TIL READER READY
     84C6 70          1109 BOT1     LIS      0
     84C7 56          1110          LR       XFLG,A    CLEAR FIRST X DETECT FLAG
     84C8 0E          1111          LR       Q,DC      SET TO TTYI OR PB00 ENTRY
     84C9 57          1112          LR       CKSM,A
     84CA 2885A2 85A2 1113 IDLE     PI       CHAR      GET HEADER CHARACTER
     84CD 13          1114          SL       1         CLEAR PARITY BIT
     84CE 12          1115          SR       1
     84CF 253A        1116          CI       H'3A'     COLON
     84D1 8449   851B 1117          BZ       FORM      FORMULATOR FORMAST
     84D3 2553        1118          CI       C'S'      IS IT AN LOAD ADDRESS?
     84D5 8431   8507 1119          BZ       SETA
     84D7 252A        1120          CI       C'*'      IS IT THE END OF THE TAPE?
     84D9 8438   8512 1121          BZ       ENDX
     84DB 2358        1122          XI       C'X'      WELL, IF IT ISN'T AN X, THEN LET'S GO
     84DD 94EC   84CA 1123          BNZ      IDLE
                      1124 ******   HAVE THE START OF A DATA LINE   *******
     84DF 57          1125          LR       CKSM,A    INITIALIZE CHK SUM (ACC=0)
     84E0 78          1126          LIS      H'08'
     84E1 55          1127          LR       CCNT,A    INITIALIZE BYTE COUNT TO 8
     84E2 56          1128          LR       XFLG,A    SHOW THAT X HAS BEEN DETECTED
     84E3 28857B 857B 1129 CONT     PI       BYTE
     84E6 17          1130          ST                 STORE THE BYTE
     84E7 35          1131          DS       CCNT                     AND DECREMENT BYTE COUNT
     84E8 94FA   84E3 1132          BNZ      CONT
     84EA 2885A2 85A2 1133          PI       CHAR      GET CHK CHAR FROM TAPE
     84ED 213F        1134          NI       H'3F'     MASK TO SIX BITS
     84EF 24D0        1135          AI       H'D0'     ASCII CONVERT-- FIRST 0-9
     84F1 8203   84F5 1136          BC       *+4       CARRY IF IT WAS TWEEN A AND F
     84F3 2439        1137          AI       H'39'     FINISH CONVERSION OF A TO F
     84F5 E7          1138          XS       CKSM      MAKE THE COMPARE
     84F6 15          1139          SL       4         LO 4 BITS TO HI
     84F7 84D2   84CA 1140          BZ       IDLE     IF OK , LET'S GET SOME MORE
                      1141 **********     CHK SUM ERROR HALT   ****************
     84F9 2043        1142 SLF2     LI       C'C'
     84FB 51          1143          LR       CHRS,A
     84FC 288610 8610 1144          PI       TTYO
     84FF 204B        1145          LI       C'K'
     8501 51          1146          LR       CHRS,A
     8502 288610 8610 1147          PI       TTYO
     8505 900F   8515 1148          BR       STPP
     8507 28857B 857B 1149 SETA     PI       BYTE      GET NEW LOAD ADDRESS FROM TAPE
     850A 5A          1150          LR       10,A
     850B 28857B 857B 1151          PI       BYTE
     850E 5B          1152          LR       11,A
     850F 10          1153          LR       DC,H       SET THE ADDRESS INTO DC
     8510 90B9   84CA 1154          BR       IDLE
     8512 F6          1155 ENDX     NS       XFLG      HAVE AN *, BUT DOES IT FOLLOW ANY DATA ?
     8513 84B6   84CA 1156          BZ       IDLE      MUST BE ONLY AT THE HEAD OF THE TAPE
                      1157 *                           WAS 2A+0  OR 2A+8
                      1158 *********    HALT LOOP FOR WHEN FINISHED  ******
     8515 2093        1159 STPP     LI       H'93'     READER OFF COMMAND
```

APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8517 51          1160          LR        CHRS,A               PASS IT IN CHRS
     8518 298466 8466 1161          JMP       PLXX
     851B 70          1162  FORM    LIS       0
     851C 57          1163          LR        CKSM,A    ZERO CKSM TO START
     851D 18          1164          COM
     851E 56          1165          LR        XFLG,A
     851F 28857B 857B 1166          PI        BYTE      LENGTH OF BLOCK
     8522 55          1167          LR        CCNT,A
     8523 F5          1168          NS        CCNT
     8524 84F0   8515 1169          BZ        STPP      ZERO RECORD IS END
     8526 28857B 857B 1170          PI        BYTE      ADDRESS HI
     8529 5A          1171          LR        10,A
     852A 28857B 857B 1172          PI        BYTE      ADDRESS LO
     852D 5B          1173          LR        11,A
     852E 10          1174          LR        DC,H
     852F 28857B 857B 1175          PI        BYTE      CODE BYTE
     8532 FB          1176          NS        CHR1
     8533 9496   84CA 1177          BNZ       IDLE      NOT DATA RECORD
     8535 28857B 857B 1178  FMLP    PI        BYTE      DATA FETCH
     8538 17          1179          ST
     8539 35          1180          DS        CCNT      LENGTH
     853A 94FA   8535 1181          BNZ       FMLP      LOOP FOR MORE DATA
     853C 28857B 857B 1182          PI        BYTE      FETCH CKSM
     853F 47          1183          LR        A,CKSM
     8540 F7          1184          NS        CKSM      SHOULD BE ZERO
     8541 94B7   84F9 1185          BNZ       SLF2      CKSM ERROR
     8543 2984CA 84CA 1186          JMP       IDLE      GET NEXT BLOCK
                      1187  *PORT CHANGE ROUTINE
     8546 20DF        1188  PORT    LI        H'DF'
     8548 07          1189          LR        QL,A
     8549 0F          1190          LR        DC,Q
     854A 46          1191          LR        A,6
     854B 5B          1192          LR        11,A
     854C 250F        1193          CI        15
     854E 821F   856E 1194          BC        OUTS      DO SHORT OUTS
     8550 2027        1195          LI        H'27'
     8552 17          1196          ST
     8553 46          1197          LR        A,6
     8554 17          1198          ST
     8555 2044        1199          LI        H'44'
     8557 17          1200          ST
     8558 2027        1201          LI        H'27'
     855A 17          1202          ST
     855B 46          1203          LR        A,6
     855C 17          1204  JMP     ST
     855D 2029        1205          LI        H'29'
     855F 17          1206          ST
     8560 2C          1207          XDC
     8561 2A8579 8579 1208          DCI     RETX
     8564 16          1209          LM
     8565 2C          1210          XDC
     8566 17          1211          ST
     8567 2C          1212          XDC
     8568 16          1213          LM
     8569 2C          1214          XDC
     856A 17          1215          ST
     856B 2000        1216          LI        0
     856D 0D          1217          LR        P0,Q      NOW EXECUTE
     856E 24B0        1218  OUTS    AI        H'B0'
     8570 17          1219          ST
     8571 2044        1220          LI        H'44'
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APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

      8573 17           1221             ST
      8574 20B0         1222             LI         H'B0'
      8576 C6           1223             AS         6
      8577 90E4    855C 1224             BR         JMP
                        1225   *
      8579 8330         1226   RETX      DC        AL2(C55)    RETURN ADDRESS
                        1227   ***GET A BYTE****
                        1228   ***        GETS THE BYTE,CONVERTS,AND ADDS TO CHK SUM
      857B 08           1229   BYTE      LR         K,P        SAVE PC1
      857C 72           1230             LIS        2
      857D 58           1231             LR         HFLG,A     SET THE HALF FLAG
      857E 4B           1232   AGAN      LR         A,CHR1
      857F 15           1233             SL         4
      8580 5B           1234             LR         CHR1,A
      8581 2885A2 85A2  1235             PI         CHAR
      8584 213F         1236             NI         H'3F'      MASK TO 6 BITS
      8586 24D0         1237             AI         H'D0'      ASCII CONVERT-- FIRST 0-9
      8588 8203    858C 1238             BC         *+4
      858A 2439         1239             AI         H'39'      NEXT CLEAN UP A-F
      858C CB           1240             AS         CHR1
      858D 5B           1241             LR         CHR1,A     TEMP STORE
      858E 46           1242             LR         A,XFLG
      858F F6           1243             NS         XFLG       TEST FOR NEGATIVE
      8590 9104    8595 1244             BM         AEND       NEGATIVE=FORMULATOR
      8592 4B           1245             LR         A,CHR1
      8593 C7           1246             AS         CKSM       ADD NEW CHAR TO CHK SUM
      8594 57           1247             LR         CKSM,A
      8595 38           1248   AEND      DS         HFLG       DECREMENT HALF COUNT
      8596 94E7    857E 1249             BNZ        AGAN       GET 2ND HALF
      8598 46           1250             LR         A,XFLG
      8599 F6           1251             NS         XFLG
      859A 8104    859F 1252             BP         ADON       IF FORMULATOR
      859C 47           1253             LR         A,CKSM
      859D CB           1254             AS         CHR1
      859E 57           1255             LR         CKSM,A
      859F 4B           1256   ADON      LR         A,CHR1     ONLY HAVE UPPER HALF-GO BACK
      85A0 09           1257             LR         P,K        RESTORE PC1
      85A1 1C           1258             POP
                        1259   ********      PARALLEL AND SERIAL INPUT ROUTINES    ********
                        1260   **       COMMON CALL IS A PUSH TO CHAR
                        1261   **       CHAR USES Q TO JUMP TO APPROPRIATE ROUTINE
      85A2 0D           1262   CHAR      LR        P0,Q        JUMP TO INPUT ROUTINE INDIRECTLY THRU Q REG
                        1263   **    PINP:  GET A CHARACTER FROM PORT 4
                        1264   **     TYPICALLY USED WITH TAPE READER, BUT HAS A HANDSHAKING
                        1265   **     DISCIPLINE THAT IS APPLICABLE TO OTHER DEVICES SUCH AS FIFOS
                        1266   **     LOOKS FOR A CHARACTER READY INPUT, AND THEN GETS THE
                        1267   **     CHARACTER. NEXT CPU GIVES AN ADVANCE PULSE THAT IS REMOVED
                        1268   **     AFTER THE DEVICE READY INPUT GOES NOT READY.
      85A3 2628         1269   PINP      IN         PSTS       GET A CHAR FROM 300CPS READER
      85A5 13           1270             SL         1
      85A6 91FC    85A3 1271             BM         PINP       LOOK FOR SPOCKET= HIGH
      85A8 7F           1272             LIS        H'0F'      100 US DELAY AFTER SEEING SPOCKET
      85A9 18           1273             COM
      85AA 1F           1274   PDLY      INC
      85AB 94FE    85AA 1275             BNZ        PDLY
      85AD 2629         1276             IN         PPRT       AND NOW GET DATA BYTE
      85AF 18           1277             COM
      85B0 51           1278             LR         CHRS,A     TEMP STORE CNEW CHAR
      85B1 79           1279             LIS        9          ADVANCE READER TO NEXT CHAR
      85B2 2728         1280             OUT        PSTS
      85B4 2628         1281   NOSP      IN         PSTS       GET READER STATUS
```

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     85B6 13          1282          SL       1
     85B7 81FC   85B4 1283          BP       NOSP             AND LOOK FOR MOVING OFF SPOCKET
     85B9 71          1284          LIS      1
     85BA 2728        1285          OUT      PSTS      REMOVE DRIVE PULSE NOW THAT IT IS MOVING
     85BC 41          1286          LR       A,CHRS    PICK BACK UP THE NEW CHARACTER
     85BD 1C          1287          POP
                      1288 ***TTYI: SERIAL I/P          CHARACTER RETURNED IN ACC AND REG 1
                      1289 **   REG BCNT HOLDS BIT COUNT   REG CHRS HOLDS CHARACTER
     85BE 2628        1290 TTYI     IN       IPOR
     85C0 2120        1291          NI       H'20'
     85C2 8404   85C7 1292          BZ       TTX
     85C4 298636 8636 1293          JMP      SCAN
     85C7 2628        1294 TTX      IN       IPOR
     85C9 91FD   85C7 1295          BM       TTX      LOOK FOR START BIT
     85CB 40          1296          LR       A,BAUD    GET DELAY COUNT
     85CC 9001   85CE 1297 DLY3     BR       *+2       SILLY BRANCH FOR DELAY
     85CE 2401        1298          AI       H'01'
     85D0 94FB   85CC 1299          BNZ      DLY3      THIS LOOP IS HALF AS MUCH DELAY
     85D2 2628        1300          IN       IPOR      CHECK START BIT VALIDITY
     85D4 91E9   85BE 1301          BM       TTYI
     85D6 79          1302          LIS      9
     85D7 52          1303          LR       BCNT,A     SET BIT COUNT,9DATA+1 STOP
     85D8 2180        1304 LOOP     NI       H'80'     NASK TO GET INPUT BIT ONLY
     85DA C1          1305          AS       CHRS      (LD'G START BIT WILL CLR GARBAGE)
     85DB 32          1306          DS       BCNT      DROP BIT CNT: 0 IF LAST DATA,NEG IF STOP
     85DC 9114   85F1 1307          BM       STOP      NEG IF LOOKING FOR STOP BIT
     85DE 8402   85E1 1308          BZ       LOP2      IF LAST BIT, DO NOT SHIFT
     85E0 12          1309          SR       1         SHIFT ASSEMBLED CHARACTER TO MAKE ROOM
     85E1 51          1310 LOP2     LR       CHRS,A    STORE ASSEMBLED CHARACTER
     85E2 40          1311          LR       A,BAUD    START OF FULL BIT TIME DELAY
     85E3 27EB        1312 DLY4     OUT      NUSE      NOP FOR DELAY
     85E5 27EB        1313          OUT      NUSE
     85E7 27EB        1314          OUT      NUSE
     85E9 2401        1315          AI       H'01'     INCR WITH A 5US INST
     85EB 94F7   85E3 1316          BNZ      DLY4
     85ED 2628        1317          IN       IPOR      GET NEW BIT
     85EF 90E8   85D8 1318          BR       LOOP
     85F1 1C          1319 STOP     POP
                      1320 ******* SERIAL OUTPUT ROUTINE  ***********
                      1321 **  HAS 1 START, 8 DATA, 2 STOP. USES PORT 0, BITS 0 AND 7
                      1322 **  BAUD RATE IS SET BY A DELAY COUNT IN REG BAUD
                      1323 **   CALL BY PUTTING CHAR IN REG CHRS, AND SETTING DELAY IN BAUD
                      1324 **   ROUTINE RETURNS WITH ALL 1'S IN REG CHRS, REG BAUD INTACT
     85F2 2628        1325 TTCR     IN      IPOR
     85F4 2120        1326          NI      H'20'
     85F6 8402   85F9 1327          BZ      TCRX
     85F8 1C          1328          POP
     85F9 08          1329 TCRX     LR       K,P
     85FA 7D          1330          LIS      CR
     85FB 51          1331          LR       CHRS,A
     85FC 288610 8610 1332          PI       TTYO
     85FF 7A          1333          LIS      LF
     8600 51          1334          LR       CHRS,A
     8601 288610 8610 1335          PI       TTYO
     8604 2062        1336          LI       98
     8606 51          1337          LR       1,A
     8607 70          1338          LIS      0
     8608 52          1339          LR       2,A
     8609 32          1340 PIX      DS       2
     860A 94FE   8609 1341          BNZ      PIX
     860C 31          1342          DS       1
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APPENDIX H (continued)

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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     860D 94FB   8609 1343          BNZ       PIX
     860F 0C          1344          PK                  RETURN
     8610 2628        1345  TTYO    IN        IPOR
     8612 2120        1346          NI        H'20'     KEYBOARD BIT
     8614 8402   8617 1347          BZ        TTYX
     8616 1C          1348          POP                NO OUTPUT TO TTY
     8617 7B          1349  TTYX    LIS       H'0B'
     8618 52          1350          LR        BCNT,A    SET BIT COUNT FOR 11 BITS
     8619 70          1351          LIS       0
     861A 2728        1352          OUT       OPOR      OUTPUT START BIT
                      1353  ***   DELAY ROUTINE-- 3.3MS FOR 300 BAUD, 9 MS FOR 110 BAUD
     861C 40          1354  DLY1    LR        A,BAUD    GET DELAY COUNT
     861D 27EB        1355  DLY2    OUT       NUSE      NOP FOR DELAY
     861F 27EB        1356          OUT       NUSE
     8621 27EB        1357          OUT       NUSE
     8623 2401        1358          AI        H'01'     INCR WITH A 5 US INST
     8625 94F7   861D 1359          BNZ       DLY2
     8627 32          1360          DS        BCNT
     8628 9402   862B 1361          BNZ       DLY5
     862A 1C          1362          POP
     862B 71          1363  DLY5    LIS       1
     862C F1          1364          NS        CHRS
     862D 2728        1365          OUT       OPOR
     862F 41          1366          LR        A,CHRS
     8630 12          1367          SR        1
     8631 2480        1368          AI        H'80'
     8633 51          1369          LR        CHRS,A
     8634 90E7   861C 1370          BR        DLY1      NOW DELAY,TNEN NEXT BIT?
                      1371  * SCAN KEYBOARD SUBROUTINE
     8636 0A          1372  SCAN LR    A,IS
     8637 65          1373       LISU 5
     8638 6F          1374       LISL 7
     8639 5E          1375       LR   D,A
                      1376  * LOAD KEY CODE
     863A 65          1377  A39  LISU   5
     863B 6E          1378       LISL   6
     863C 2017        1379       LI   H'17'
     863E 52          1380       LR   2,A
                      1381  * LOAD FIRST STROBE
     863F 20FE        1382       LI   H'FE'
     8641 5C          1383       LR   S,A
                      1384  * OUTPUT STROBE
     8642 7F          1385  A40  LIS  15    BLANK DISPLAY
     8643 2721        1386       OUT  P9
     8645 20C0        1387       LI   H'C0'
     8647 2720        1388       OUT  P8
     8649 4E          1389       LR   A,D
     864A 2720        1390       OUT  P8
                      1391  * READ KEYS
     864C 74          1392       LIS  4
     864D 5C          1393       LR   S,A
     864E 2621        1394       IN   P9
     8650 14          1395       SR   4
     8651 8417   8669 1396       BZ   A43   BRANCH IF NO KEY IN THIS COLUMN
     8653 15          1397       SL   4
     8654 9108   865D 1398  A41  BM   A42   BRANCH IF KEY IS IN THIS ROW
                      1399  * GO TO NEXT ROW IF NOT LAST ROW
     8656 32          1400       DS   2
     8657 3C          1401       DS   S
     8658 8414   866D 1402       BZ   A44   BRANCH IF LAST ROW IN THIS COLUMN
     865A 13          1403       SL   1
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ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

      865B 90F8   8654           BR   A41
                            * IS THIS FIRST SCAN
      865D 6C               A42  LISL 4
      865E 71                    LIS  1
      865F EC                    XS   S
      8660 941D   867E           BNZ  A48    BRANCH IF KBD FLAG NOT SET
                            * RESET KBD FLAG
      8662 5E                    LR   D,A
                            * COMPARE TWO SCANS
      8663 4C                    LR   A,S
      8664 E2                    XS   2
      8665 8431   8697           BZ   A46    BRANCH IF SCANS ARE THE SAME
      8667 900E   8676           BR   A45
                            * CHANGE KEY CODE FOR NEXT COLUMN
      8669 20FC             A43  LI   H'FC'
      866B C2                    AS   2
      866C 52                    LR   2,A
                            * SHIFT STROBE ONE POSITION
      866D 6E               A44  LISL 6
      866E 4C                    LR   A,S
      866F 13                    SL   1
      8670 1F                    INC
      8671 5C                    LR   S,A
                            * HAS LAST COLUMN BEEN SCANNED ALREADY
      8672 2140                  NI   H'40'
      8674 94CD   8642           BNZ  A40    BRANCH IF NOT LAST STROBE
                            * STORE 'FF' IN KEY CODE REGISTER
      8676 20FF             A45  LI   H'FF'
      8678 52                    LR   2,A
                            * RESET KBD FLAG
      8679 6C                    LISL 4
      867A 70                    LIS  0
      867B 5C                    LR   S,A
      867C 9004   8681           BR   A51
                            * GO TO NEXT ROW
                            * SET KBD FLAG
      867E 5E               A48  LR   D,A
                            * STORE KEY CODE OF FIRST SCAN
      867F 42                    LR   A,2
      8680 5E                    LR   D,A
                            * LOAD COUNTERS FOR BOUNCE TIME OF 28MS
      8681 298724 8724      A51  JMP  DISP
      8684 65               A53  LISU 5
      8685 6A                    LISL 2
      8686 7B                    LIS  11
      8687 5C                    LR   S,A
      8688 70               A49  LIS  0
      8689 51                    LR   1,A
      868A 31               A50  DS   1
      868B 94FE   868A           BNZ  A50    BRANCH IF COUNTER 1 NOT ZERO
      868D 3C                    DS   S
      868E 94F9   8688           BNZ  A49    BRANCH IF COUNTER 2 NOT ZERO
      8690 6C                    LISL 4
      8691 71                    LIS  1
      8692 FC                    NS   S
      8693 8403   8697           BZ   A46    BRANCH IF NOT KBD FLAG
      8695 90A4   863A           BR   A39
                            *STILL SAME KEY?
      8697 62               A46  LISU   2
      8698 68                    LISL   0
      8699 4C                    LR     A,S
```

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     869A E2          1465       XS     2
     869B 849E   863A 1466          BZ    A39    NOT DIFFERENT
     869D 42          1467          LR    A,2
     869E 5C          1468          LR    S,A
     869F 25FF        1469          CI    H'FF'
     86A1 8498   863A 1470          BZ    A39
     86A3 66          1471          LISU  6
     86A4 6F          1472          LISL  7
     86A5 14          1473          SR    4
     86A6 841D   86C4 1474          BZ    A1A      MULTI FUNCTION KEY
     86A8 42          1475          LR    A,2
     86A9 2515        1476          CI    H'15'    KILL
     86AB 8440   86EC 1477          BZ    B1A
     86AD 2514        1478          CI    H'14'    C/R
     86AF 8435   86E5 1479          BZ    C1A
     86B1 2513        1480          CI    H'13'  MINUS
     86B3 8425   86D9 1481          BZ    E1A
     86B5 2517        1482          CI    H'17'  PLUS
     86B7 8421   86D9 1483          BZ    E1A
     86B9 2516        1484          CI    H'16'    CHANGE
     86BB 9418   86D4 1485          BNZ   F1A
     86BD 72          1486          LIS   2
     86BE 5E          1487          LR    D,A      CHANGE CODE=2
     86BF 2040        1488          LI    H'40'
     86C1 5C          1489          LR    S,A      STORE MODE ON
     86C2 9016   86D9 1490          BR    E1A
     86C4 6E          1491 A1A      LISL  6
     86C5 CC          1492          AS    S
     86C6 812C   86F3 1493          BP    G1A      NOT FUNCTION
     86C8 71          1494          LIS   1
     86C9 E2          1495          XS    2
     86CA 847A   8745 1496          BZ    E70
     86CC 72          1497          LIS   2
     86CD E2          1498          XS    2
     86CE 8472   8741 1499          BZ    F2716
     86D0 42          1500          LR    A,2
     86D1 2418        1501          AI    24       SHIFT IN TABLE LOOKUP
     86D3 52          1502          LR    2,A
     86D4 6E          1503 F1A      LISL  6
     86D5 4C          1504          LR    A,S
     86D6 13          1505          SL    1
     86D7 12          1506          SR    1
     86D8 5C          1507          LR    S,A      FUNCTION OFF
     86D9 65          1508 E1A      LISU  5
     86DA 6F          1509          LISL  7
     86DB 4C          1510          LR    A,S
     86DC 0B          1511          LR    IS,A     ISAR RESTORED
     86DD 2A86FC 86FC 1512          DCI   KTAB
     86E0 42          1513          LR    A,2
     86E1 8E          1514          ADC
     86E2 16          1515          LM
     86E3 51          1516          LR    1,A      ASC CODE FOR KEY IN
     86E4 1C          1517          POP            RETURN
                      1518 *ENTRY FOR C/R
     86E5 70          1519 C1A      LIS   0
     86E6 CC          1520          AS    S
     86E7 8404   86EC 1521          BZ    B1A      CHANGE CODE=0
     86E9 3C          1522          DS    S        CHANGE CODE -1
     86EA 94EE   86D9 1523          BNZ   E1A      STILL EXPECT C/R
                      1524 * ENTRY FOR KILL
     86EC 70          1525 B1A      LIS   0
```

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

      86ED 5E          1526          LR    D,A       R67=0
      86EE 2080        1527          LI    H'80'
      86F0 5C          1528          LR    S,A       FUNCTION NEXT
      86F1 90E7   86D9 1529          BR    E1A
                       1530 *NUMERIC KEY IN
      86F3 6F          1531 G1A      LISL  7
      86F4 70          1532          LIS   0
      86F5 CC          1533          AS    S
      86F6 8402   86F9 1534          BZ    G2A       CHANGE CODE=0
      86F8 72          1535          LIS   2         CHANGE CODE =2
      86F9 5E          1536 G2A      LR    D,A
      86FA 90D9   86D4 1537          BR    F1A
                       1538 *TRANSLATE KEY PAD TO ASC CHARACTER
      86FC 30          1539 KTAB     DC    C'0'
      86FD 34          1540          DC    C'4'
      86FE 38          1541          DC    C'8'
      86FF 43          1542          DC    C'C'
      8700 31          1543          DC    C'1'
      8701 35          1544          DC    C'5'
      8702 39          1545          DC    C'9'
      8703 44          1546          DC    C'D'
      8704 32          1547          DC    C'2'
      8705 36          1548          DC    C'6'
      8706 41          1549          DC    C'A'
      8707 45          1550          DC    C'E'
      8708 33          1551          DC    C'3'
      8709 37          1552          DC    C'7'
      870A 42          1553          DC    C'B'
      870B 46          1554          DC    C'F'
                       1555 *SINGLE FUNCTION KEYS
      870C 4D          1556          DC    C'M'      MEMORY DISPLAY
      870D 52          1557          DC    C'R'      REGISTER
      870E 4F          1558          DC    C'O'      PORT
      870F 2D          1559          DC    C'-'      DELIMITER MINUS
      8710 0D          1560          DC    H'0D'     CARRIAGE RETURN
      8711 5B          1561          DC    H'5B'     KILL
      8712 43          1562          DC    C'C'      CHANGE
      8713 2B          1563          DC         C'+'  DELIMITER PLUS
                       1564 *SHIFT FUNCTION KEYS
      8714 50          1565          DC    C'P'      PC
      8715 00          1566          DC    0         GO TO 2716
      8716 00          1567          DC    0         GO TO E70
      8717 55          1568          DC    C'U'      BREAKPOINT
      8718 44          1569          DC    C'D'      DC
      8719 49          1570          DC    C'I'      ISAR
      871A 58          1571          DC    C'X'      HEX
      871B 54          1572          DC    C'T'      CLEAR BREAK
      871C 42          1573          DC    C'B'      BACK OR PREVIOUS
      871D 57          1574          DC    C'W'      STATUS
      871E 56          1575          DC    C'V'      MOVE
      871F 4C          1576          DC    C'L'      LOAD
      8720 4E          1577          DC    C'N'      NEXT
      8721 41          1578          DC    C'A'      ACCUMULATOR
      8722 4B          1579          DC    C'K'      FIND
      8723 47          1580          DC    C'G'      GO TO
                       1581 * DISPLAY SUBROUTINE
                       1582 *
      8724 66          1583 DISP LISU 6
      8725 6E          1584      LISL  6
      8726 71          1585      LIS  1
      8727 51          1586      LR   1,A
```

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8728 4E          1587       LR    A,D
     8729 57          1588       LR    7,A
     872A 47          1589  A52  LR   A,7
     872B 18          1590       COM
     872C 2720        1591       OUT  P8      LED'S ON, SELECT DIGIT OFF
     872E 4E          1592       LR   A,D
     872F 18          1593       COM
     8730 15          1594       SL   4
     8731 14          1595       SR   4
     8732 2721        1596       OUT  P9
     8734 2620        1597       IN   P8
     8736 E1          1598       XS   1
     8737 2720        1599       OUT  P8
     8739 41          1600       LR   A,1
     873A 13          1601       SL   1
     873B 51          1602       LR   1,A
     873C 8FED   872A 1603       BR7  A52
     873E 298684 8684 1604       JMP  A53     RETURN
                      1605  *
                      1606  *
                      1607  *  PEP BOARD 2716 AND 38E70 PROGRAMMING
                      1608  *
                      1609  *
                      1610  *    USER MUST INITIALIZE PROGRAM BY STORING IN
                      1611  *    RAM H'2BD8' THROUGH H'2BDE':
                      1612  *       MEMORY START ADDRESS HI BYTE
                      1613  *       MEMORY START ADDRESS LOW BYTE
                      1614  *       PROM START ADDRESS HI BYTE
                      1615  *       PROM START ADDRESS LOW BYTE
                      1616  *       PROM END ADDRESS HI BYTE
                      1617  *       PROM END ADDRESS LOW BYTE
                      1618  *       BLANK CHECK FLAG
                      1619  *          0=>OMIT BLANK CHECK
                      1620  *          H'FF'=>PERFORM BLANK CHECK
                      1621  *
                      1622  *
                      1623  *       REGISTER USEAGE
                      1624  *
                      1625  *         R0=ERROR CODE
                      1626  *            0=>GOOD
                      1627  *            1=>BURN VERIFY ERROR
                      1628  *            2=>BLANK CHECK ERROR
                      1629  *         R1=DATA OUTPUT
                      1630  *         R3=BLANK CHECK FLAG
                      1631  *            0=>OMIT BLANK CHECK
                      1632  *            H'FF'=>PERFORM BLANK CHECK
                      1633  *         R4=PROM END ADDRESS HI BYTE
                      1634  *         R5=PROM END ADDRESS LO
                      1635  *         R7=MASK TO COMPLEMENT DATA OUT
                      1636  *            0=>38E70
                      1637  *            H'FF'=>2716
                      1638  *         R6=ADDRESS SCRAMBLE (SUB ADDR)
                      1639  *           =DELAY LOOP COUNTER
                      1640  *         R9=DELAY LOOP COUNTER
                      1641  *         H=PROM START ADDRESS
                      1642  *         Q=MEMORY START ADDRESS
                      1643  *
                      1644  *
                      1645  *
                      1646  *
     8741 20FF        1647  F2716    LI    H'FF'
```

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

      8743 9002   8746 1648         BR    F2111
      8745 70          1649  E70    LIS   0
      8746 2A0058 0058 1650  F2111  DCI   BRAM
      8749 57          1651         LR    7,A          =>R7
      874A 16          1652         LM                MEMORY START ADDRESS
      874B 06          1653         LR    QU,A         =>Q
      874C 16          1654         LM
      874D 07          1655         LR    QL,A
      874E 16          1656         LM                PROM START ADDRESS
      874F 5A          1657         LR    10,A         =>H
      8750 16          1658         LM
      8751 5B          1659         LR    11,A
      8752 16          1660         LM                PROM END ADDRESS
      8753 54          1661         LR    4,A           =>4,5
      8754 16          1662         LM
      8755 55          1663         LR    5,A
                       1664  *
                       1665  *      BLANK CHECK
                       1666  *
      8756 72          1667         LIS   2           SET ERROR FLAG
      8757 50          1668         LR    0,A
      8758 70          1669         CLR               OMIT BLANK CHECK IF FLAG SET
      8759 88          1670         AM
      875A 53          1671         LR     3,A
      875B 10          1672         LR     DC,H
      875C 2C          1673         XDC
      875D 10          1674         LR     DC,H
      875E 840B   876A 1675         BZ    CONTU
      8760 51          1676         LR    1,A
                       1677  *
      8761 2887B8 87B8 1678  AGN    PI    ADDR        OUTPUT ADDRESS
      8764 2887A2 87A2 1679         PI    REED        VERIFY BYTE IS BLANK
      8767 16          1680         LM                INCREMENT DATA COUNTER
      8768 94F8   8761 1681         BNZ   AGN         LOOP IF NOT FINISHED
                       1682  *
                       1683  *      BURN PROM
                       1684  *
      876A 30          1685  CONTU  DS    0           SET ERROR FLAG
      876B 0F          1686         LR    DC,Q        MEMORY START ADDRESS
      876C 2C          1687         XDC               RESTORE PROM START ADDRESS
      876D 11          1688         LR    H,DC
                       1689  *
      876E 2887B8 87B8 1690  BURN   PI    ADDR        OUTPUT ADDRESS
      8771 2C          1691         XDC               SWITCH TO MEM DC
      8772 16          1692         LM                GET BYTE OF DATA
      8773 2C          1693         XDC               SWITCH BACK TO PROM DC
      8774 51          1694         LR    1,A         SAVE COPY OF DATA BYTE
      8775 E7          1695         XS    7           CPLEMENT IF 2716
      8776 B5          1696         OUTS  5           OUTPUT DATA
      8777 A0          1697         INS   0           TURN ON 2716 WRITE
      8778 13          1698         SL    1
      8779 12          1699         SR    1
      877A B0          1700         OUTS  0
      877B 21F7        1701         NI    H'F7'       TURN ON 2716 BURN
      877D B0          1702         OUTS  0
      877E A1          1703         INS   1           TURN ON 38E70 BURN
      877F 2440        1704         AI    H'40'
      8781 B1          1705         OUTS  1
                       1706  *
      8782 7B          1707         LIS   11           BEGIN DELAY
      8783 59          1708         LR    9,A
```

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

     8784 70           1709          LIS   0
     8785 56           1710          LR    6,A
     8786 A5           1711 WAIT     INS   5
     8787 36           1712          DS    6
     8788 94FD    8786 1713          BNZ   WAIT
     878A 39           1714          DS    9
     878B 94FA    8786 1715          BNZ   WAIT       END DELAY
     878D A1           1716          INS   1          TURN OFF 38E70 BURN
     878E 21BF         1717          NI    H'BF'
     8790 B1           1718          OUTS  1
     8791 A0           1719          INS   0          TURN OFF 2716 BURN
     8792 2408         1720          AI    8
     8794 B0           1721          OUTS  0
     8795 2480         1722          AI    H'80'      TURN OFF 2716 WRITE
     8797 B0           1723          OUTS  0
     8798 16           1724          LM               INCREMENT PROM DC
     8799 2887A2 87A2  1725          PI    REED       VERIFY DATA
     879C 94D1    876E 1726          BNZ   BURN
     879E 30           1727          DS    0          SUCCESSFUL BURN
     879F 288080 8080  1728 ERR      PI    SAVER    RETURN TO MONITOR
                       1729 *
                       1730 *********************************************
                       1731 *
                       1732 * ROUTINE TO READ DATA AND COMPARE W/ OUTPUT
                       1733 *
                       1734 *    R1=ORIGINAL DATA
                       1735 *    R7=DEVICE FLAG
                       1736 *
     87A2 70           1737 REED     CLR              CLEAR PORTS
     87A3 B4           1738          OUTS  4
     87A4 B5           1739          OUTS  5
     87A5 C7           1740          AS    7          IDENTIFY DEVICE
     87A6 9404    87AB 1741          BNZ   VER1
     87A8 A4           1742          INS   4          READ PORT 4 FOR 38E70
     87A9 9002    87AC 1743          BR    VER2
     87AB A5           1744 VER1     INS   5          READ PORT 5 FOR 2716
     87AC C1           1745 VER2     AS    1          COMPARE W/ OUTPUT
     87AD 1F           1746          INC
     87AE 94F0    879F 1747          BNZ   ERR
                       1748 *
     87B0 45           1749          LR    A,5        TEST FOR FINISH
     87B1 EB           1750          XS    11
     87B2 9403    87B6 1751          BNZ   RET
     87B4 44           1752          LR    A,4
     87B5 EA           1753          XS    10
     87B6 11           1754 RET      LR    H,DC       UPDATE H
     87B7 1C           1755          POP
                       1756 *
                       1757 *********************************************
                       1758 *
                       1759 *  ROUTINE TO TRANSLATE ADDRESS BITS AND OUTPUT THEM
                       1760 *
                       1761 *  ADDRESS IN H MUST BE OUTPUT TO PORTS 0 AND 1
                       1762 *        P0-0  ADDR BIT  6
                       1763 *        P0-1            5
                       1764 *        P0-4            2
                       1765 *        P0-5            3
                       1766 *        P0-6            4
                       1767 *        P1-0            7
                       1768 *        P1-1            8
                       1769 *        P1-2            9
```

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      1770  *       P1-3            10
                      1771  *       P1-4            1
                      1772  *       P1-5            0
                      1773  *
                      1774  *       P0-3  2716 PROGRAM STROBE--0=>BURN
                      1775  *       P0-7  2716 READ/WRITE--0=>WRITE
                      1776  *       P1-6  38E70 PROGRAM STROBE--1=>BURN
                      1777  *
                      1778  *       PORT 4--DATA FROM 38E70
                      1779  *       PORT 5--DATA TO 38E70
                      1780  *               DATA TO AND FROM 2716
                      1781  *
                      1782  *       TRUE DATA--OUTPUT TO 38E70
                      1783  *       FALSE DATA-OUTPUT TO 2716
                      1784  *                  ALL ADDRESSES
                      1785  *                  ALL INPUT
                      1786  *
                      1787  *       BURN AND R/W BITS ARE FORCED TO NOBURN AND
                      1788  *       TO READ; THEY WILL BE TOGGLED WITHIN MAIN
                      1789  *       PROGRAM AT APPROPRIATE TIMES.
                      1790  *
      87B8 77         1791  ADDR    LIS   7
      87B9 FA         1792          NS    HII
      87BA 13         1793          SL    1         ADDR BITS 8-10
      87BB 1F         1794          INC             SET BIT 7
      87BC 56         1795          LR    6,A       SAVE
      87BD 4B         1796          LR    A,LO
      87BE FB         1797          NS    LO
      87BF 9102  87C2 1798          BM    *+3       BIT 7 SET?
      87C1 36         1799          DS    6         NO BIT 7
      87C2 73         1800          LIS   3
      87C3 FB         1801          NS    LO
      87C4 8406  87CB 1802          BZ    OK        ADDR BITS 0-1 ARE 0
      87C6 2303       1803          XI    3         INVERT
      87C8 9402  87CB 1804          BNZ   OK        WAS 10 OR 01
      87CA 73         1805          LIS   3         BOTH 1
      87CB 15         1806  OK      SL    4
      87CC C6         1807          AS    6
      87CD 2440       1808          AI    H'40'     FORCE E70 PGM STROBE OFF
      87CF 18         1809          COM
      87D0 B1         1810          OUTS  1         BITS 7-10 AND 0-1
                      1811  *
                      1812  *       NOW DO PORT 0
                      1813  *
      87D1 4B         1814          LR    A,LO
      87D2 13         1815          SL    1
      87D3 1E         1816          LR    J,W       SAVE BIT 6
      87D4 13         1817          SL    1
      87D5 8103  87D9 1818          BP    *+4       BIT 5 WAS 0
      87D7 1F         1819          INC
      87D8 1F         1820          INC
      87D9 1D         1821          LR    W,J
      87DA 8102  87DD 1822          BP    *+3       BIT 6 WAS 0
      87DC 1F         1823          INC             SET BIT 0 TO 1
      87DD 2173       1824          NI    H'73'     FORCE BITS 3,7 TO 1
      87DF 18         1825          COM             (2716 READ MODE)
      87E0 B0         1826          OUTS  0         ADDR BITS 2-6
      87E1 1C         1827          POP
                      1828  *
                      1829  *
                      1830  *
```

APPENDIX H (continued)

```
ERRS  LOC OBJECT ADDR LINE          SOURCE STATEMENT

                      1831  *
                      1832  *
                      1833  *
                      1834  *
                      1835  *SUBROUTINE TO DISPLAY WITHOUT KEYBOARD READ
                      1836  *
     87E2 66          1837  DISPX   LISU  6
     87E3 6E          1838          LISL  6
     87E4 71          1839          LIS   1
     87E5 51          1840          LR    1,A
     87E6 4E          1841          LR    A,D
     87E7 57          1842          LR    7,A
     87E8 47          1843  A52X    LR    A,7
     87E9 18          1844          COM
     87EA 2720        1845          OUT   P8
     87EC 4E          1846          LR    A,D
     87ED 18          1847          COM
     87EE 15          1848          SL    4
     87EF 14          1849          SR    4
     87F0 2721        1850          OUT   P9
     87F2 2620        1851          IN    P8
     87F4 E1          1852          XS    1
     87F5 2720        1853          OUT   P8
     87F7 41          1854          LR    A,1
     87F8 13          1855          SL    1
     87F9 51          1856          LR    1,A
     87FA 8FED   87E8 1857          BR7   A52X
     87FC 1C          1858          POP
                      1859  *
                      1860  *
                      1861  *
                      1862          END
00 ERRS
```

```
SYMBOL TYP  VAL  REFERENCES

A       L 82CB  0775  0537  0535  0377  0376  0375  0374  0373
                0372  0371  0369  0368  0367  0366  0365  0364  0363
                0362  0361  0360  0359  0358  0357  0356  0355  0354
A1      L 82F6  0354
A1A     L 86C4  1474
A39     L 863A  1470  1466  1460
A40     L 8642  1429
A41     L 8654  1404
A42     L 865D  1398
A43     L 8669  1396
A44     L 866D  1402
A45     L 8676  1416
A46     L 8697  1459  1415
A48     L 867E  1409
A49     L 8688  1455
A50     L 868A  1453
A51     L 8681  1437
A52     L 872A  1603
A52X    L 87E8  1857
A53     L 8684  1604
ADDR    L 87B8  1690  1678
ADON    L 859F  1252
AEND    L 8595  1244
AGAN    L 857E  1249
AGN     L 8761  1681
B1A     L 86EC  1521  1477
BAUD    A 0000  1354  1311  1296
BAUDT   L 80DD  0229
BCNT    A 0002  1360  1350  1306  1303
BLNK    L 8436  0944
BLP     L 82A2  0666
BOT1    L 84C6  1100
BRAK    L 8295  0743
BRAM    L 0058  1650
BURN    L 876E  1726
BXT     L 82F4  0746
BXX     L 8292  0736  0696  0678
B       L 837D  0355
BYTE    L 857B  1182  1178  1175  1172  1170  1166  1151  1149
                1129
C0      L 830A  0750
C1      L 8312  0754
C1A     L 86E5  1479
C2      L 8318  0753
C3      L 831F  0761
C5      L 8324  0780
C55     L 8330  1226
CCNT    A 0005  1180  1168  1167  1131  1127  0021
CC      A 000B  0505  0492  0490  0476  0449  0409
CHAR    L 85A2  1235  1133  1113
CHR1    A 000B  1256  1254  1245  1241  1240  1234  1232  1176
CHRS    A 0001  1369  1366  1364  1334  1331  1310  1305  1286
                1278  1160  1146  1143  1097  1080  1036  1027  1013
                1003  1000  0975  0942  0923  0919  0877  0773  0382
                0343  0128  0085  0082  0076  0067
CKSM    A 0007  1255  1253  1247  1246  1184  1183  1163  1138
                1125  1112  0350  0349  0108  0069  0066  0017
CONT    L 84E3  1132
CONTU   L 876A  1675
COR1    L 8202  0494
COR2    L 8209  0506
```

```
SYMBOL TYP  VAL  REFERENCES

COR3    L 820B  0509
COR4    L 820D  0504
COR5    L 820F  0493
COR6    L 8210  0491
COR7    L 821D  0481
COR8    L 8219  0519
CORN    L 81ED  0433  0431
CORT    L 81EE  0435  0427
CR      A 000D  1330  0518  0426
C       L 82FE  0775  0356
D0      L 0044  0255
D       L 8334  0357
DISP    L 8724  1445
DISPX   L 87E2
DLY1    L 861C  1370
DLY2    L 861D  1359
DLY3    L 85CC  1299
DLY4    L 85E3  1316
DLY5    L 862B  1361
E1A     L 86D9  1529  1523  1490  1483  1481
E70     L 8745  1496
EA      A 0005  1092
EAHI    A 0005  0121  0064  0062  0057  0055
EALO    A 0006  0118  0061  0058
EGHT    L 8498  1083
ENDX    L 8512  1121
ERR     L 879F  1747
EX      L 004A  0316
E       L 833A  0358
F1      L 836F  0844  0842
F1A     L 86D4  1537  1485
F2111   L 8746  1648
F2716   L 8741  1499
FA      L 818B  0482
FAA     L 8192  0418
FAX     L 81EB  0521
FB      L 8197  0479  0477  0450  0447  0442  0440
FCNT    A 0008  0908  0795  0745  0532  0525  0522  0516  0406
FCON    L 8024  0122  0073
FF      L 8236  0538
FHI     L 8134  0335
FINT    L 813D  0341
FLG     A 0009  0950  0921  0907  0874  0815  0789  0747
FLOP    L 804A  0106
FLP1    L 812D  0346
FMLP    L 8535  1181
FOK     L 81C9  0445
FOP1    L 812A  0966  0888  0879  0103
FOP2    L 812C  1068  0940  0933  0735  0728  0132  0114  0099
                0096  0093  0090
FORM    L 851B  1117
FPN1    L 8010  0071
FPUN    L 8003  0793  0136
F       L 8340  0537  0359
G       L 8343  0360
G1      L 834F  0796
G1A     L 86F3  1493
G2A     L 86F9  1534
HERE    L 806D  0134
HEX     L 82CC  0562  0007
HFLG    A 0008  1248  1231  1086  1032  1016  0345  0333  0331
```

APPENDIX H (continued)

```
SYMBOL TYP  VAL  REFERENCES

                 0135  0133  0131  0113  0105  0102  0088  0072
HIGH     L 84B8  0822
HII      A 000A  1792
HXX      L 815F
H        L 8361  0361
I1       L 8354  0904  0739
IDLE     L 84CA  1186  1177  1156  1154  1140  1123
INS      L 8492  1045
IPOR     A 0028  1345  1325  1317  1300  1294  1290  0223  0222
I        L 8352  0362
J        L 835E  0363
JMP      L 855C  1224
K        L 836D  0364
KTAB     L 86FC  1512
LF       A 000A  1333
LO       A 000B  1814  1801  1797  1796
L        L 8367  0365
LOAD     L 84AD  0827
LOOP     L 85D8  1318
LOP2     L 85E1  1308
MBGN     L 8252  0592
MBY2     L 825A  0579
MCOM     L 827F  0587
MEND     L 8260  0580
MLOP     L 8282  0643  0640
MM       A 000A  0829
MOVE     L 824A  0536
MXX      L 826B  0602
M        L 836A  0366
N1       L 8386  0845  0838  0791
N2       L 8384  0851
NOSP     L 85B4  1283
NUSE     A 00EB  1357  1356  1355  1314  1313  1312
N        L 8382  0367
OK       L 87CB  1804  1802
OO       A 000C  0951  0824  0749
OPOR     A 0028  1365  1352  0160
O        L 8364  0368
OUTS     L 856E  1194
P1       L 8395  0869  0786
P2       L 839A  0790
P3       L 83BB  0985  0909
P8       A 0020  1853  1851  1845  1599  1597  1591  1390  1388
P9       A 0021  1850  1596  1394  1386
PBLK     L 8455  1093
PDLY     L 85AA  1275
PINP     L 85A3  1271  1101
PIO      L 846C  0952
PIX      L 8609  1343  1341
PLP      L 8458  1030
PLUS     L 82DB  0701
PLXX     L 8466  1161
PORTA    A 0020  0313  0305  0190  0158
PORTB    A 0028  0311  0307  0213  0162
PORTC    A 0029  0215  0164
PORT     L 8546  0751
PP       A 000D  0873  0788  0752
PPA      L 844C  1094
PPC      L 8496  1085  1033
PPRT     A 0029  1276  1103
PPUN     L 8444  0818
```

APPENDIX H (continued)

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SYMBOL TYP  VAL  REFERENCES

PSTS     A 0028  1285  1281  1280  1269  1105  1104
P        L 838E  0369
PXA      L 848B  1055
PXX      L 847A  1072
PXXY     L 848D  1065
R1       L 83C4  0830  0825
R2       L 83CE  0995  0910
R22      L 83D1  0864
R23      L 83F2  0816
R4       L 83FA  1005  0998
R5       L 840D  0954
R77      L 8411  1069
R7       L 8428  0983
RA9      L 0009  0303  0210
RAM      L 0000  0269  0232  0167  0045  0040  0036  0035
REED     L 87A2  1725  1679
REST     L 80E3  0806
RETX     L 8579  1208
RET      L 87B6  1751
RPTC     L 8184  0777
RR       A 000F  0953  0906  0814
RTN1     L 823B  0540  0533
R        L 83C2  0371
SA       A 0003  1091  1088  1019
SAVER    L 8080  1728  0247  0048
SCAN     L 8636  1293
SETA     L 8507  1119
SIZE     A 0007  1090  1022  1018  1017
SLF1     L 84BC  1108
SLF2     L 84F9  1185
STB      L 8248  0551
STOP     L 85F1  1307
STPP     L 8515  1169  1148
STR1     L 8162  0437  0400  0393  0391
STRT     L 8160  0901  0644  0146
S        L 83BE  0376  0372
TBLS     L 8148  0395
TCRX     L 85F9  1327
TT       L 82B8  0741
TTCR     L 85F2  0917  0380  0115
TTLP     L 82C3  0695
TTX      L 85C7  1295  1292
TTYI     L 85BE  1301  1099  0423  0385
TTYO     L 8610  1335  1332  1147  1144  1098  1081  1037  1028
                 1014  1004  1001  0976  0943  0924  0920  0878  0774
                 0428  0387  0383  0344  0129  0086  0083  0077  0068
TTYX     L 8617  1347
TZE      L 8076  1038  0235  0226  0078
T        L 82FA  0373
U        L 82FC  0374
V        L 8361  0535  0375
VER1     L 87AB  1741
VER2     L 87AC  1743
WAIT     L 8786  1715  1713
XFLG     A 0006  1251  1250  1243  1242  1165  1155  1128  1110
                 1082  1077  1029  1025  0020
XX       L 8000
X        L 82CC  0377
ZA       L 80E8  0260
ZB       L 80F5  0276
ZC       L 809B  0188
ZD       L 80B2  0207
ZE       L 80DB
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Manufactured under one of the following U.S. Patents: 2981877, 3015048, 3064167, 3108359, 3117260; other patents pending.
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