SECTION I
INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION.

1-2.   Interface Kit 12531B provides for bit-parallel transfer of data between the Computer and interface card, while transfer between the interface card and the Teleprinter is bit-serial. This is a single address I/O card, simultaneous input and output is not possible. The kit consists of the following:

a.   Buffered Teleprinter Interface Card (HP Part No. 12531-6001 or 02116-6168).

b.   BCS Teleprinter Driver Tape (HP Accessory No. 20017).

c.   SIO 4K Teleprinter Driver Tape (HP Accessory No. 20322) or SIO 8K Teleprinter Driver Tape (HP Accessory No. 20323).

d.   HP 2116 Buffered Teleprinter Test-Binary Tape (HP Accessory No. 20417).

e.   HP 2115/2114 Buffered Teleprinter Test-Binary Tape (HP Accessory No. 20420).

NOTE

Each tape has a suffix letter after the HP Accessory Number. This suffix letter is subject to change depending on the supplied version of the tape.

1-3.   Sections II through IV provide installation, programming, and theory of operation for the Buffered Teleprinter Interface Card and Teleprinter operation information. A supplement to this manual contains a description of the diagnostic program contained on the Buffered Teleprinter Test-Binary Tape.

1-4.   DESCRIPTION.

1-5.   The Buffered Teleprinter Interface Card plugs into any of the interface-card I/O slots of the Computer. The card contains control and interrupt logic for both input and output Computer functions, and eight flip-flops for temporary storage of data. This data is entered into the Computer or transferred to the Teleprinter through the Buffered Teleprinter Interface Card. Eight data bits are transferred between the Computer and interface card in parallel and converted by the card to 11-bit ASCII for transfer between the Teleprinter and interface card in bit-serial (one bit at a time). The least-significant 8-bits of the A or B Register are sent via the I/O Bus Out (IOBO) to the interface card and then to the Teleprinter during output operations. During input operations, a character from the Teleprinter enters the Buffered Teleprinter Card in bit-serial and from the card to the Computer in parallel (8-bits at a time). During output operations 8-bits are transferred from the Computer to the interface card in parallel and from the interface card to the Teleprinter in bit-serial. This card can provide automatic readback from keyboard or paper tape to the Teleprinter without Computer intervention.

1-6.   TELEPRINTER DRIVER TAPES.

1-7.   BCS TELEPRINTER DRIVER TAPE. The BCS (Basic Control System) Teleprinter Driver Tape is a flexible Input/Output routine which permits transfer of data between the Computer and the Teleprinter. The driver is accessed through the BCS I/O Control subroutine (.IOC.) by a 5-word calling sequence. The driver is made part of the Basic Control System through the use of the Prepare Control System routine which is furnished with each Computer. Refer to Chapter 1 of the HP Computer Basic Control System manual for information on Input/Output programming and to Chapter 4 for information on the processing of the BCS Teleprinter Driver Tape.

1-8.   SIO TELEPRINTER DRIVER. The SIO (System Input/Output) Teleprinter Driver (4K or 8K, depending on Computer memory size) is a simple, unbuffered Input/Output routine used by standard software systems (FORTRAN, Assembler, etc.) to permit transfer of data between the Computer and the Teleprinter. The driver is incorporated into the system through the use of the SIO Dump Routine furnished with each Computer. The driver may also be accessed directly by a 3-word calling sequence in the user's program. Refer to Appendix F of the HP Computer Assembler manual for detailed programming and use information for the SIO Teleprinter Driver Tape.

1-9. HP 2752A TELEPRINTER.

1-10. The HP 2752A Teleprinter (Figure 1-1) is an HP-modified Teletype Model ASR33-TC Teletypewriter set and is recommended for applications requiring operation which does not exceed five hours per day or 30 hours per week. The unit is made up of a typewriter, a tape punch, and a tape reader as a single unit. It is furnished with its own floor stand and is usually placed in a location adjacent to the Computer. The following specifications apply to the HP 2752A Teleprinter:

a. Reading and Punching Speed: 10 characters per second.

b. Typing Speed: 100 words per minute.

c. Data Transfer: bit-serial, 8-bit code.

d. Ambient Temperature: 10°C to 40°C (50°F to 104°F).

e. Relative Humidity: 20% to 80%.

f. Power Requirements: 115 vac ±10 percent, 60 ±0.45 Hz or 50 ±0.12 Hz, single phase, 230 watts.
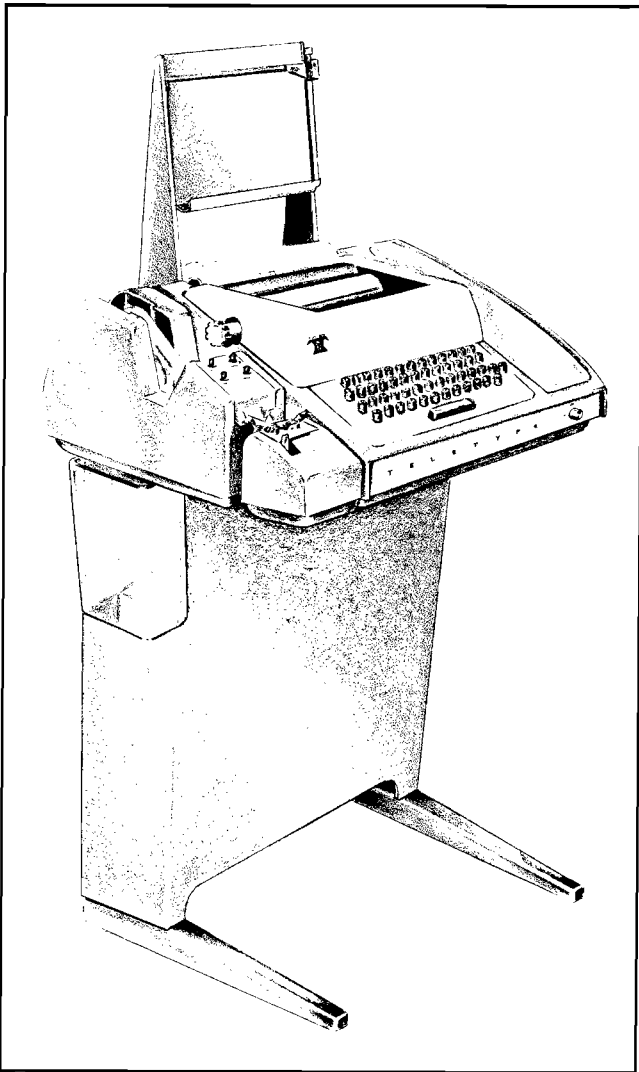

Figure 1-1. HP 2752A Teleprinter

g. Tape Handling Capabilities: 8-channel, 1-inch wide paper tape.

h. Dimensions and Weight (including stand):

Height: 33 inches (838 mm)
Width: 25-1/2 inches (648 mm)
Depth: 18-1/2 inches (470 mm)
Weight: 77 pounds (34,7 kg)

1-11. HP 2754A/B TELEPRINTER.

1-12. The HP 2754A/B Teleprinter (Figure 1-2) is an HP-modified Teletype Model ASR35-AR Teletypewriter Set and is recommended for heavy-use applications where operation exceeds five hours per day or 30 hours per week. It is made up of a typewriter, a tape punch, and a tape reader as a single unit. It is furnished with its own floor stand and is usually placed in a location adjacent to the Computer. The following specifications apply to the HP 2754A/B Teleprinter:

a. Reading and Punching Speed: 10 characters per second.

b. Typing Speed: 100 words per minute.

c. Data Transfer: bit-serial, 8-bit code.

d. Ambient Temperature: 10°C to 40°C (50°F to 104°F).

e. Relative Humidity: 20% to 80%.

f. Power Requirements: 115 vac ±10 percent, 60 ±0.5 Hz, single phase, 350 watts. (Consult factory if 50 Hz operation is desired.)

g. Tape Handling Capabilities: 8-channel, 1-inch wide paper tape.

h. Dimensions and Weight (including stand):

Height: 33-1/2 inches (851 mm)
Width: 40 inches (1016 mm)
Depth: 24 inches (610 mm)
Weight: 225 pounds (102 kg)

NOTE

When using the 2754A/B Teleprinter, the computer program can individually select the teleprinter tape punch, printer or both output devices simultaneously.

1-13. DATA PHONE.

1-14. This board used in this kit may also be used as an I/O Data Phone Interface card, providing ASCII formatted characters are to be used. When using a Data Phone, make the following connections on the 48-pin connector plug:

a. Connect pin Y to pins 4 and D.

b. Connect pin V to pins 16 and T.

1-15. Refer to the Data Phone Interface manual 12563A for a more detailed description.

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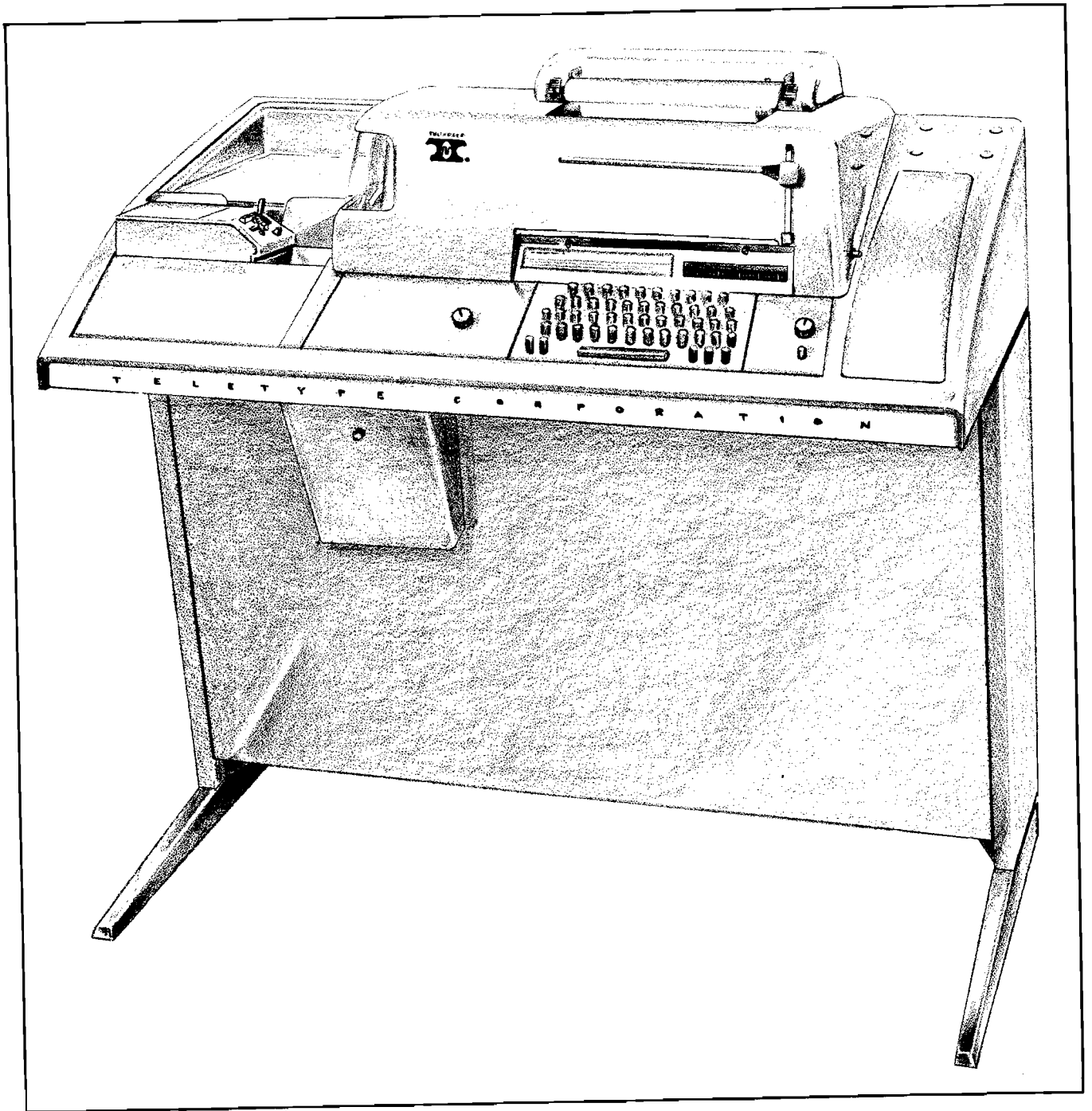**For research and education purposes only.**

Figure 1-2. HP 2754A/B Teleprinter

SECTION II
INSTALLATION AND PROGRAMMING

2-1. INSTALLATION.

2-2. Refer to the HP 2752A, HP 2754A, or HP 2754B Teleprinter manuals for unpacking, installation, and checkout instructions of the applicable Teleprinter unit. To connect the Teleprinter to the Buffered Teleprinter Interface Card using the cable which is an integral part of the Teleprinter, perform the following:

a. Turn power off.

b. Open the Computer for access to the I/O cards.

c. Plug the Buffered Teleprinter Interface Card into the I/O slot assigned for the particular Computer System.

d. Pass the cable connector from the Teleprinter, marked TELEPRINTER, through the computer opening and to the front of the card. Slide the connector onto the Buffered Teleprinter Interface Card.

e. Close the cover of the Computer.

2-3. After the Teleprinter has been connected to the Computer, run the Teleprinter diagnostic program described in supplement. If the diagnostic program is completed without error, the system operates properly. Refer to Tables 2-1 and 2-2 for leadwire connections between the interface card and the HP 2752A and 2754A/B Teleprinters, respectively.

2-4. TELEPRINTER OPERATION.

2-5. MAIN CONTROL.

2-6. Plug the Teleprinter power cable into the appropriate power source. Operation of the Teleprinter is started and stopped by the LINE/OFF/LOCAL switch on the front panel of the HP 2752A Teleprinter, and by the ON LINE/OFF/LOC. switch on the front panel of the HP 2754A/B Teleprinter. Operation of these switches are as follows:

a. In the OFF position, the motor in the Teleprinter is turned off, preventing its operation.

b. In the LINE position (2752A) or ON LINE position (2754A/B) the Teleprinter is in a full-duplex configuration. This configuration, and the Computer programming subroutines, permit the following types of operation:

    1. Transmit data to the Computer manually from the typewriter keyboard while making a printed-page copy. The data can also be punched into tape simultaneously.

    2. Receive data from the Computer and provide a printed-page copy. The data can also be punched into tape simultaneously.

    3. Transmit data to the Computer from the tape reader while making a printed-page copy. The data transmitted can also be punched into tape simultaneously.

c. In the LOCAL position (2752A) or LOC. position (2754A/B) data cannot be entered into the Computer from the Teleprinter but the following types of operation can be performed:

    1. Punch data into tape from the typewriter keyboard while making a printed-page copy.

    2. Punch data into tape from the tape reader while making a printed-page copy.

    3. Make a printed-page copy of data from the tape reader or the keyboard.

2-7. TAPE READER.

2-8. The tape reader START/STOP/FREE switch performs the following functions:

a. Pressing the START switch when the HP 2752A Teleprinter LINE/OFF/LOCAL switch or HP 2754A/B ON LINE/OFF/LOC. switch is in the LOCAL or LOC. position energizes the tape reader trip coil and the tape reader starts reading the tape. If the switch is in the LINE or ON LINE position, the tape reader trip coil will not energize until a Read Command is issued by the Computer program. When it is issued, the coil energizes and the tape reader starts reading tape. (See Figure 2-1 for a simplified diagram of the switching circuits.)

b. Pressing the STOP switch prevents the tape reader from reading tape.

c. Pressing the FREE switch releases the feed ratchet of the tape reader permitting the tape under the plastic tape lid to move easily for positioning purposes.

2-9. TAPE PUNCH (HP 2752A TELEPRINTER ONLY.

2-10. The tape punch ON/OFF/REL./B.SP. switch on the 2752A Teleprinter performs the following functions:

a. Pressing the ON switch engages the drive mechanism in the punch through mechanical action. This permits a punching operation on receipt of data from the Computer or the typewriter keyboard.

b. Pressing the OFF switch releases the drive mechanism in the punch, preventing its operation.

c. Pressing the REL. (Release) switch disengages the tape-guide assembly from the feed wheel in the punch, allowing easy removal of tape.

d. Pressing the B.SP. (Back space) switch backspaces the tape one feed hole each time it is pressed.

Table 2-1. Interface Card-to-2752A Teleprinter Leadwire Connections

INTERFACE CARD CONNECTOR PIN	LEADWIRE COLOR CODE	TELEPRINTER CONNECTION	SIGNAL
4, D	Black	Pin 3 of Teleprinter rear connector	Input Data Bit
12, N	Red	+12-volt input on *Card Assy (one end of resistor R1)	+12 volts
14, R	White-Brown	-12-volt input on Card Assy (one end of resistor R3)	-12 volts
16, T	Green-Orange	Pin 7 of Teleprinter rear connector	Output Data Bit
13, P	Yellow	Input to Card Assy (junction of resistors R1 and R2)	Read Command
24, BB	Cable Shield	Gnd connection on Card Assy (emitter of transistor Q2)	Ground

NOTES:

1. Pins 4 & D, 12 & N, 13 & P, 14 & R, 16 & T, and 24 & BB are connected together on Interface Card Connector.

* Card Assy refers to the Printed Circuit Card Assembly added during modification of the Teletype Model ASR33. Refer to the Schematic Diagram in the HP 2752A Teleprinter manual for components specified in this Table.

Table 2-2. Interface Card-to-2754A/B Teleprinter Leadwire Connections

INTERFACE CARD CONNECTOR PIN	LEADWIRE COLOR CODE	TELEPRINTER CONNECTION	SIGNAL
4, D	Black	Terminal T6	Input Data Bit
12, N	Red	+12-volt input on *Card Assy (one end of resistor R1)	+12 volts
14, R	Brown	-12-volt input on Card Assy (one end of resistor R3)	-12 volts
16, T	White	Terminal T7	Output Data Bit
13, P	Yellow	Input to Card Assy (junction of resistors R1 and R2)	Read Command Signal
24, BB	White Black and Cable Shield	Gnd connection on Card Assy (emitter of transistor Q2)	Ground
6, F	Orange	Terminal T8	Punch Control
8, J	Green	Terminal T4	Print Control

NOTES:

1. Pins 4 & D, 12 & N, 13 & P, 14 & R, 16 & T, and 24 & BB are connected together on the Interface Card Connector.

* Card Assy refers to the Printed Circuit Card Assembly added during modification of the Teletype Model ASR35. Refer to the Schematic Diagram in the HP 2754A/B Teleprinter manual for components specified in this Table.
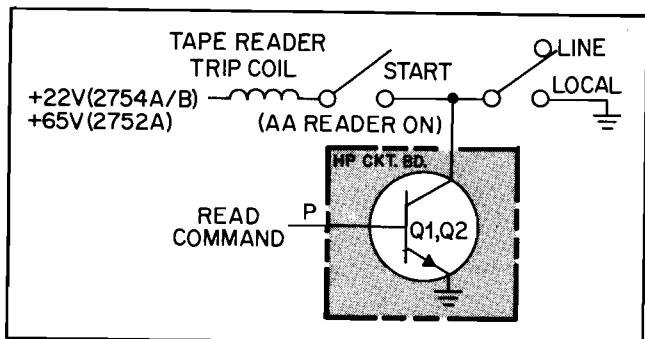
5

Figure 2-1. Teleprinter Tape Reader Switching
Circuit, Simplified Diagram

2-11. **MODE SWITCH (HP 2754A/B TELEPRINTER ONLY.**

2-12. Although the MODE switch on the 2754A/B Teleprinter contains positions K, KT, T, TTS, and TTR, only positions K, KT, and T can be used. Positions TTS and TTR are mechanically locked out. When the Teleprinter ON LINE/OFF/LOC. switch is in the LOC. position, the K, KT, and T positions of the MODE switch perform the following functions:

a. In the K and KT positions, printed-page copy is typed from either the typewriter keyboard or the tape reader.

b. In the T position, data is punched into tape from either the typewriter keyboard or the tape reader while a printed-page copy is being typed.

2-13. During output operations, with the Teleprinter ON LINE/OFF/LOC. switch in the ON LINE position, the K, KT, and T positions of the MODE switch perform the following functions:

a. In the K position, a printed-page copy of the Computer ASCII output is generated. The tape punch if off, therefore no punch output can take place even if punch is programmed.

b. In the KT position, a printed-page copy of the Computer ASCII output or a punched tape of the Computer binary output is generated. Standard BCS/IOC software restricts the output to one function. Both functions cannot be performed simultaneously. The user may write his own driver software that will do both.

c. In the T position all output data is printed and punched without regard to format content.

2-14. During input operations, with the Teleprinter ON LINE/OFF/LOC. switch in the ON LINE position, the K, KT, and T positions of the MODE switch perform the same functions as output operations if simultaneous output is programmed as in the keyboard function. The keyboard function can be accomplished from the tape reader if the tape is inserted in the reader and the switch set to RUN.

2-15. PROGRAMMING.

2-16. The HP standard software facilities may be used to input data using the 2752A or 2754A/B Teleprinter. The Basic Control System (BCS) includes an Input/Output control subroutine which requires only a simple calling sequence to transfer data between the Computer and the Teleprinter. Refer to Section I, Paragraphs 1-6, 1-7, and 1-8, for programming information using BCS.

2-17. A subroutine may be programmed to perform all necessary operations to input data from the Teleprinter and output data to the Teleprinter. Tables 2-3 through 2-7 illustrate the operations required to input and output data. The Wait for Flag Method (Skip on Flag Set) is used to signal the Computer that a character is available to the Computer or that a character was sent to the Teleprinter.

2-18. The programmer must output a function select code to the Buffered Teleprinter Interface Card before any I/O operation is started. The coding shown in Table 2-3 is the minimum required to input or output one character.

Table 2-3. Program Constants

LABEL	OP CODE	OPERAND	REMARKS
TTY	EQU	nn	WHERE nn IS THE SELECT CODE
DOPU	OCT	110000	DATA OUT PUNCH ONLY
DOPR	OCT	120000	DATA OUT PRINT ONLY
DOPP	OCT	130000	*DATA OUT PRINT AND PUNCH
DINP	OCT	140000	DATA IN, NO PRINT, NO PUNCH
DINPU	OCT	150000	*DATA IN AND PUNCH
DINPR	OCT	160000	DATA IN AND PRINT
DINPP	OCT	170000	*DATA IN, PRINT AND PUNCH
CHAR1	OCT	000000	TEMPORARY DATA
CHAR2	OCT	000000	STORAGE LOCATIONS
*FUNCTIONS NOT USED IN HP STANDARD SOFTWARE.			

2-19. **SAMPLE PROGRAMS.**

2-20. Refer to the following tables for sample programs:

a. Table 2-4, Status Check
b. Table 2-5, Input Program
c. Table 2-6, Input Subroutine
d. Table 2-7, Output Program
e. Table 2-8, Output Subroutine

Table 2-4. Status Check

OP CODE	OPERAND	REMARKS
LIA	SC	PUT BUFFERED DATA INTO A REG
SSA		BUSY?
JMP	*-2	YES, REPEAT LOOP
--		NO, PROGRAM CONTINUATION

Table 2-5. Input Program

OP CODE	OPERAND	REMARKS
CLF	0	INHIBIT INTERRUPT
LDA	DXXXX	LOAD "A" WITH I/O FUNCTION
OTA	TTY	OUTPUT A READ (DATA IN) FUNCTION TO I/O BOARD
JSB	CHRIN	GET A CHARACTER
STA	CHAR1	RETURN WITH CHARACTER IN "A" REGISTER
·	·	
·	·	
·	·	
JSB	CHR IN	GET A CHARACTER
STA	CHAR2	RETURN WITH CHARACTER IN REGISTER "A"
·	·	
·	·	
·	·	

Table 2-7. Output Program

OP CODE	OPERAND	REMARKS
LDA	DXXXX	LOAD "A" WITH I/O FUNCTION
OTA	TTY	OUTPUT A WRITE (DATA OUT) FUNCTION TO I/O BOARD
LDA	CHAR1	LOAD "A" WITH CHARACTER TO BE OUTPUT
JSB	CHROT	OUTPUT A CHARACTER
·	·	
·	·	
LDA	CHAR2	LOAD "A" WITH CHARACTER TO BE OUTPUT
JSB	CHROT	OUTPUT A CHARACTER
·	·	
·	·	

Table 2-6. Input Subroutine

LABEL	OP CODE	OPERAND	REMARKS
†CHRIN	NOP		
	STC	TTY,C	START THE TTY
	SFS	TTY	IS THE FLAG SET ?
	JMP	*-1	NO, STAY IN LOOP
	LIA	TTY	YES, GET CHARACTER
	JMP	CHRIN,I	AND EXIT

†CHARACTER INPUT SUBROUTINE WILL READ AND EXIT WITH ONE CHARACTER IN "A"

Table 2-8. Output Subroutine

LABEL	OP CODE	OPERAND	REMARKS
†CHROT	NOP		
	AND	M377	STRIP OFF ANY EXTRANEOUS BITS
	OTA	TTY	OUTPUT DATA
	STC	TTY,C	START THE TTY
	SFS	TTY	IS THE FLAG SET ?
	JMP	*-1	NO, STAY IN LOOP
	JMP	CHROT,I	YES, EXIT
M377	OCT	377	

†CHARACTER OUTPUT SUBROUTINE WILL OUTPUT ONE CHARACTER FROM THE 8 LEAST SIGNIFICANT BITS OF REGISTER "A" AND EXIT

SECTION III
THEORY OF OPERATION

3-1. GENERAL THEORY OF OPERATION.

3-2. DATA CODES.

3-3.   The typewriter portion of the Teleprinter must receive data in ASCII (American Standard Code for Information Interchange) code for it to type readable information. The tape punch will punch whichever code (binary, ASCII, etc.) the Teleprinter receives. However, if the punch is punching data received in a code other than ASCII, the typed copy from the typewriter (which may be typing simultaneously) will not be readable. Refer to the Operating Manual, HP Character Set for the ASCII-code character set. Note that only s e v e n bits are shown used in the code. Whether bit 8 is a logic "one" or "zero" during input operations depends on the parity functions of the particular Teleprinter being used. When reading ASCII coded tapes, programming masks the eighth bit before placing the data in memory so the logic level of the eighth bit is immaterial. During output operations using ASCII code, standard HP software supplied with the Computer automatically sets bit 8 to a logic "one".

3-4. CHARACTER LENGTH.

3-5.   Teleprinter design requires that a total of 11 bits of information be transferred between the Computer and the Teleprinter for each character transferred. The bits are transferred one at a time so the basic data unit is a bit. Figure 3-1 depicts a simplified block diagram of data transfer. Of the 11 bits, eight are character bits and three are start and stop bits. These bits are shown as follows:

Bit Transferred   0   1 2 3 4 5 6 7 8   9 10

                  Start   Character   Stop
                   Bit   Bits   Bits
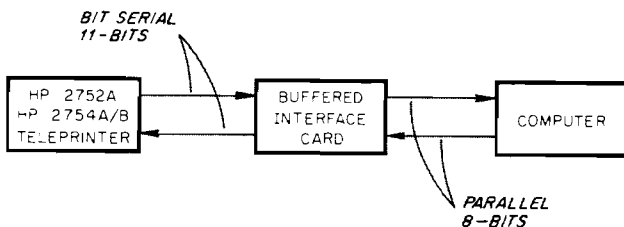
Figure 3-1.   Data Transfer Simplified
Block Diagram

3-6. INPUT OPERATIONS.

3-7.   With the Teleprinter LINE/OFF/LOCAL switch in the LINE position, an input operation can be provided from the Teleprinter in one of two ways.

a.   The input can be provided manually from the Teleprinter keyboard.

b.   The input can be provided from the tape reader of the Teleprinter.

3-8.   When a typewriter key is pressed or the tape reader starts reading tape, a Teleprinter timing cycle is started. This timing cycle establishes a bit transfer rate of 110 bits per second or a maximum character transfer rate of 10 characters (including start and stop bits) per second. Thus, a bit is transferred to the Interface card every 9.09 milliseconds. The first bit from the Teleprinter (the start bit) initiates the interface card timing circuits so that Computer and Teleprinter timing is in synchronization. After a character is transferred to the interface card, Teleprinter timing stops and must be reinitiated to transfer another character. Refer to Figure 3-2 for the signals sent to the Computer for the letter "M" from the tape reader or the typewriter keyboard. In TTY terminology a "1" is a mark and a "0" is a space.
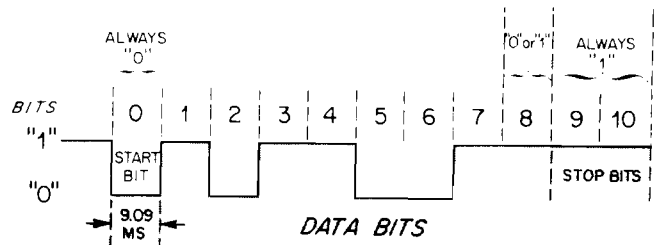
Figure 3-2.   Data Bits for Transfer of
Letter "M"

3-9.   An input operation is enabled by transferring bits 14 and 15 true to the Interface card which sets the IN/OUT flip-flop to the IN state. If printing data as it is input is desired, bit 13 of the control word will also have to be set. Pressing the PRESET pushbutton does the same thing. An input operation is initiated by a Set Control, Clear Flag (STCm,C) instruction to the interface card for inputs from either the Teleprinter tyepwriter keyboard or tape reader. The STC portion of the instruction causes a Read Command signal to be issued to the Teleprinter when the tape reader is to provide input data. If the typewriter is to be used to input data to the Computer, the tape reader STOP switch is engaged, and the Read Command signal has no effect on the Tape Reader. The STC portion of the instruction also sets the interface card Control Flip-Flop which enables incoming data bits and Flag signals. The CLF portion of the instruction resets the Flag Buffer and Flag Flip-Flops on the interface card to prevent an interrupt signal from being sent to the Computer before data is received from the Teleprinter.

3-10.   An LIA or LIB instruction generates an IOI signal to enable parallel transfer of the eight possible data bits representing the character read to the eight least-significant bit positions (bits 0-7) of the A or B

register. To put two characters in the A or B register, and then into a memory location, rotate instructions, ALF or BLF, are used (twice) to rotate the first eight bits into the most-significant bit positions (8 through 15) of the register. An MIA or MIB instruction is then used to transfer the second eight bits from the interface card to the A or B register. An LIA or LIB instruction cannot be used for second-character transfer since these instructions destroy the contents of the register prior to entering data.

3-11.   The set or reset condition of the Flag flip-flop may be tested with a Skip on Flag Set (SFS) or a Skip on Flag Clear (SFC) instruction to determine when a character is available to the Computer from the Teleprinter. When using this method, the Interrupt System Enable flip-flop on the I/O Control card must be reset with a Clear Flag (CLF) instruction and a Select Code of 00 (octal).

3-12.   OUTPUT OPERATIONS.

3-13.   An output operation is enabled by transferring the desired command bits 12, 13 and 15 to the Interface card. This clears the IN/OUT flip-flop and sets the print or punch functions. An output from A (OTA) or an output from B (OTB) instruction must be issued by the Computer program to output 8-bits of data from the eight least-significant bit positions (0-7) of the A or B register to the interface card. The IOO signal which resulted from the OTA/B instruction enables the bits from the A or B register to set the applicable Bit 1 through Bit 8 flip-flops on the interface card.

3-14.   Before data transfer to the Teleprinter, the buffered interface card maintains a positive voltage on the input to the Teleprinter. The Computer program initiates an output operation with a STC nn, C command and the first bit to the Teleprinter must be a logic "zero" signal (the start bit). This bit initiates the Teleprinter timing cycle which requires a bit from the Interface card every 9.09 milliseconds until the 11 bits representing the character (including start and stop bits) are received. The timing circuit on the interface card is also initiated to maintain Computer-Teleprinter timing synchronization. After a character is transferred, Teleprinter timing stops and the Interface card must be reinitiated by another STC nn, C command from the Computer for the next character transfer.

3-15.   DETAILED THEORY OF OPERATION.

3-16.   GENERAL.

3-17.   Figure 3-5 depicts the logic diagram for the Buffered Teleprinter Interface Card. For leadwire connections between the interface card and applicable Teleprinter, refer to Figure 3-5 and Tables 2-1 or 2-2. Figure 3-6 depicts the parts location of the Buffered Teleprinter Card.

3-18.   Logic diagram reference designations preceded by MC are identified by part number in Section IV and the logic diagram for each Microcircuit Package is shown in Figure 3-7.

3-19.   COMPUTER POWER ON.

3-20.   When power is initially applied by the POWER switch, on the front panel of the Computer, the POPIO and CRS signals are received simultaneously by the interface card from the I/O Control card. These signals establish initial conditions for operation of the interface card. The POPIO signal is applied to "nand" gate MC16A. All inputs to the "nand" gate are then true and its false output sets the Flag Buffer Flip-Flop (the input to the flip-flop is inverted). At time T2, the ENF signal from the I/O Control card enables "nand" gate MC56B. The output from gate MC56B resets the IRQ flip-flop. The output from gate MC56B is also transferred through "nand" gate MC56D and with the output of the Flag Buffer flip-flop, sets the Flag flip-flop and changes the state of the Counter Reset flip-flop.

3-21.   When power is first applied, the positive pulse of the Control Reset (CRS) signal is received at pin 13 and inverted by "nand" gate MC66A. The output from this gate resets the Control flip-flop, Clock Enable flip-flop and Read flip-flop. This signal also directly resets the Print flip-flop, Punch flip-flop, directly sets the IN/OUT flip-flop to IN, and resets the Divider network through "nand" gates MC94D and MC84A. Therefore the card is always in the Input state after turn on or whenever PRESET is pressed.

3-22.   OUTPUT LOGIC.

3-23.   INITIAL CONDITIONS. To output data from the Buffered Teleprinter Card the following assumptions are made:

   a.   The Teleprinter used is an HP 2754A/B Teleprinter. This model is identical to the HP 2752A Teleprinter with the following exceptions:

   1.   Computer control of punching and printing is not available with the HP 2752A Teleprinter.

   2.   Manual control of punching output data and printing of all output to the HP 2752A Teleprinter.

   b.   The Flag Buffer and Flag flip-flops are set by the POPIO pulse when power is initially applied to the Computer or when PRESET is pressed.

   c.   The IRQ and Control flip-flops are in the reset state.

   d.   A positive voltage is supplied through pins 16 and T of the interface card to the data line of the Teleprinter.

   e.   The Teleprinter control switch is ON LINE.

   f.   The Teleprinter MODE switch is in the KT position for Computer control of output data formatting.

3-24.   PROGRAM CONTROL OF PUNCH AND PRINT. Before data is output to the Buffered Teleprinter Card, a control word must be output to select the punch or print or both. When bit 13 of the control word is true, the Teleprinter will print. When bit 12 of the control word is true, the Teleprinter will punch output data. Bit 15 is set true to inform the card that the word is a control word and not a data word.

3-25. To print but not punch data, the control word would be 120000. An OTA or OTB instruction with the select code of the interface card location will output the word. When this instruction is executed, IOO comes true at time T3, T4. This signal is input to "nand" gate MC36C and with the output from the Select Code gate MC46A pin 3, enables "nand" gate MC54A. The IOBO 15 signal is input through pin 74 (86-pin connector) to pin 10 of "nand" gate MC55D. The other input to this "nand" gate is the T3 Buffered signal. Gate MC55D is enabled generating a clock pulse at output pin 8. This clock strobes the In/Out flip-flop, MC124A, to a false state since IOBO 14 is false. The clock pulse also strobes the Print flip-flop, MC114B, to the true state since IOBO 13 is true, and strobes the Punch flip-flop MC114A to the false state because IOBO 12 is false. The In/Out flip-flop, MC124A, is now in the reset condition or output state. Print flip-flop, MC114B, is set true which turns transistor Q6 off. (This transistor shorts the print circuit in the Teleprinter when it is on.) Punch flip-flop MC114A is false, which turns transistor Q7 on shorting the punch circuit in the Teleprinter. Therefore, the Teleprinter will print the output data but will not punch it.

3-26. The data character to be printed on the Teleprinter is output to the interface card from the eight least-significant bits of the A or B Register. This is accomplished by using the OTA or OTB instruction with the select code of the interface card location. The eight most-significant bits must be zero. The IOO signal comes true at time T3, T4. This signal is input to "nand" gate MC36C and with the output from the Select Code gate MC46A pin 3, enables "nand" gate MC54A. The positive-going output from this gate is transferred as one input to "nand" gates MC86A, MC86B, MC86C, MC86D, MC76A, MC76B, MC76C, and MC76D. The Data Register is reset by the output signal from MC54B pin 8, except flip-flop MC124B which is directly set by the signal at time T3. The condition of the IOBO lines 0 through 7 are now directly set into the 8-bit Data Register flip-flops MC95A, MC95B, MC105A, MC105B, MC115A, MC115B, MC 125A, and MC125B. Data is stored in the register flip-flops during time T4. Flip-flop MC85A is held in the 0 (false) state and flip-flop MC85B is held in the 1 (true) state by the false Clock Enable signal.

3-27. The Data Register consists of 11 flip-flops. These flip-flops store input data on the positive-going edge of the clock signal and can be directly set or reset. Now that the character is stored in the Data Register, a STC, C instruction is issued to the interface card with the select code of the location of the card.

3-28. The STC signal is input on pin 22 and transferred through "nand" gate MC36B (see Figure 3-3). The output signal on pin 6 of MC36B sets the Control flip-flop. With the use of the skip flag set method of input/output control, the Control flip-flop has no effect as the signal is only used to enable the interrupt circuits on the card. The interrupt system should have been turned off by a CLF instruction to I/O location 00. The STC signal is also sent to "nand" gate MC104B. Since the In/Out flip-flop is in the Out state, "nand" gate MC34D is enabled. The output from this

gate sets the Clock Enable flip-flop. The Clock Enable flip-flop had been reset by the CRS signal (from power turn-on or PRESET) or had been reset at the end of the last character, and has held the Data Register flip-flop MC85A in the reset state and flip-flop MC85B in the set state. Flip-flop MC85B kept "nand" gate MC24C at a state such that transistor Q4 has been held in the off position. When Q4 is in the off position, +12 volts is applied to the Teleprinter through R12 and CR1 keeping the Teleprinter in a true or mark state (normally on, dormant condition). Once the Clock Enable flip-flop has been set, "nand" gate MC55A is enabled and the 872 Hz oscillator pulses are transferred through "nand" gate MC55C to the A, B, C divider network flip-flop MC64A. This network divides the 872 Hz signal down to 109 Hz (slightly lower than the maximum rate of the Teleprinter). The period of 109 Hz is 9.09 milliseconds. The CLF signal enters through "nand" gate MC16C resetting the Flag Buffer flip-flop and Flag flip-flop.

3-29. Pin 9 of the C flip-flop (MC74B) goes false and pin 8 goes true 9.09 milliseconds after the Clock Enable flip-flop was set. For this period of one pulse, the true signal (mark condition) has been held on by the Teleprinter. Since the In line to "nand" gate MC94C is false, the output on pin 11 is true enabling "nand" gate MC84B. Therefore, the output pin 8 of MC84B is false. At the end of the 9.09 millisecond period, pin 8 of MC84B goes true transferring a clock pulse to the Data Register. This clock pulse shifts the Data Register downward one bit. Since flip-flop MC85A was reset to a false state and the bit shifted to flip-flop MC85B, transistor Q4 is turned on. When Q4 is on, a space condition (false) is sent to the Teleprinter. This is the start bit (false bit) which starts all ASCII characters. At the same time, the Divide by 11 divider is incremented by one count by the negative-going edge of the C flip-flop, MC74B pin 9, setting the D flip-flop true. Another 9.09 milliseconds later, the next pulse from the C flip-flop (in the Divide by 8 divider) causes the next bit in the Data Register to shift to flip-flop MC85B and out to the Teleprinter. This procedure is repeated 11 times until bit 11 has been shifted into flip-flop MC85B. Bits 10 and 11 come from flip-flop MC124B which was set true when the Data Register was reset prior to storing the output characters. The output from "nand" gate MC104C has always been high, therefore the Data Register is now all true. On the leading edge of bit 11, divider flip-flops D, E, and G are true and F is false. Since this is an output operation, "nand" gate MC55B is enabled. At T3 of the next machine cycle after the eleventh shift of the Data Register, the output of "nand" gate MC66B goes false, directly resetting the Counter Reset flip-flop MC64B. At T5 of the same machine cycle, SIR (pin 32 of 86-pin connector) enables "nand" gate MC94B. The false output from pin 6 of MC94B enables "nand" gate MC94D. Since $\overline{CRS}$ is true, the true output from pin 8 of MC94D enables "nand" gate MC84A. The false output from pin 6 of MC84A resets both Dividers, the Clock Enable flip-flop and sets the Flag Buffer flip-flop. This signal remains true only for period T5. At T2 of the next machine cycle, the ENF signal sets the Counter Reset flip-flop to its set state preventing the second Flag pulse. Also at the same time, the Flag flip-flop is set and a request for
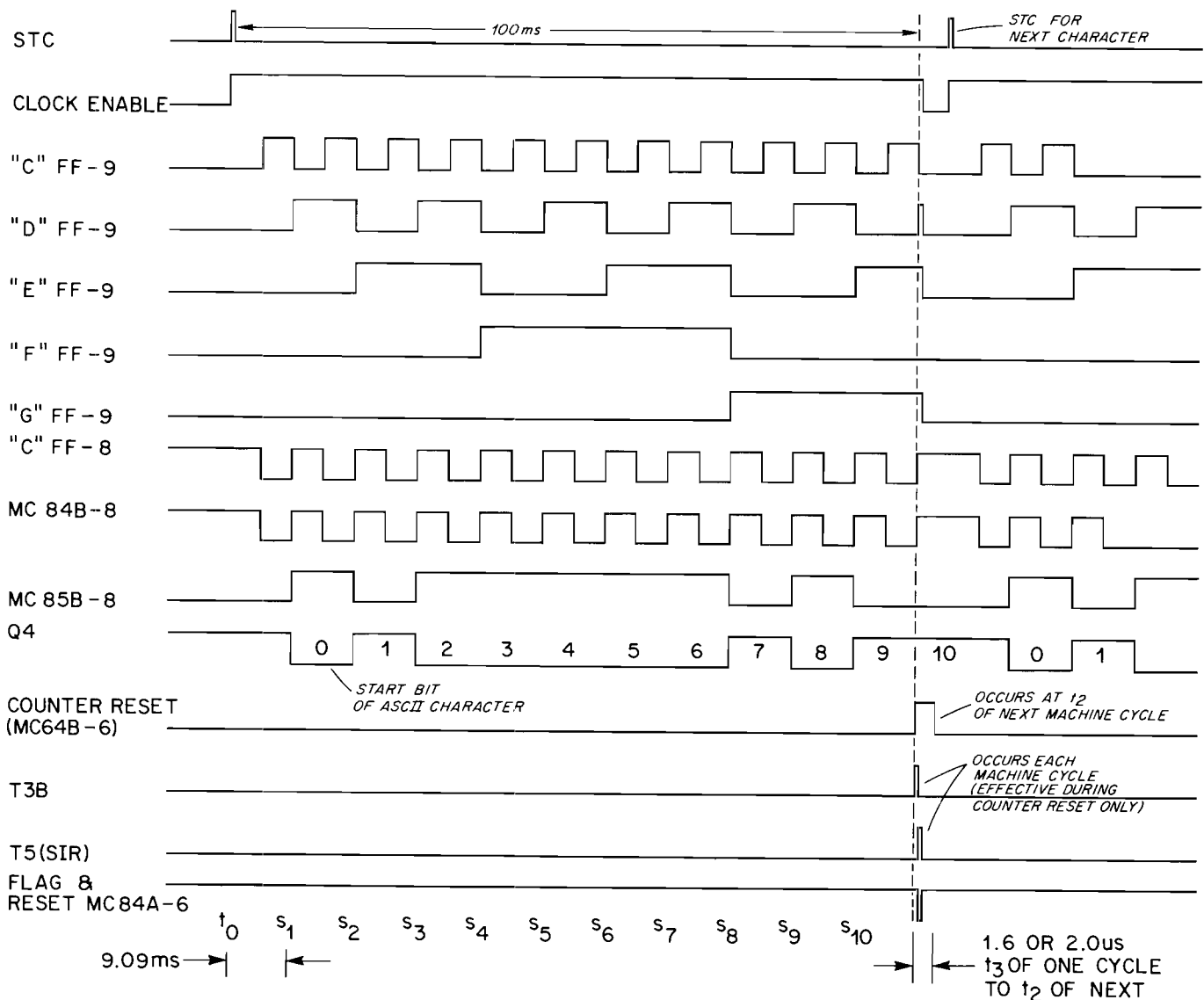
Figure 3-3. Output Timing Diagram

SFS or SFC forces the SKF output to go true. This informs the Computer that the operation is completed and it can now process the next character to the Teleprinter.

3-30. Since the first bit from the interface card is always true (logic 1) it is not necessary to wait until the end of the eleventh bit before issuing a Flag signal to the Computer. Since the Clock Enable flip-flop is turned off, the Teleprinter is resynchronized to the 872 Hz oscillator at the start of each character. Therefore, the maximum speed of the Teleprinter is always available without losing sync with the mechanical mechanism of the Teleprinter. To punch data, rather than print it, bit 12 of the control word is true and bit 13 is false. If printing and punching are desired, bits 12 and 13 are set true. When using an HP 2752A Teleprinter, either bit 12 or bit 13 set true will produce an output, but for any output to occur, one of the bits must be true.

3-31. READ OPERATION.

3-32. The CRS input signal is transferred through pin 13 (86-pin connector) to the input of "nand" gate MC66A. The output of this gate directly sets the In/Out flip-flop, MC124A, to the Input condition, resets the Print flip-flop MC114B, resets the Punch flip-flop MC114A, and resets the Read flip-flop MC24A, MC34B. This turns off the Read Command signal to the Teleprinter through transistor Q5. To generate a read sequence from the Teleprinter, a control word must be output to the interface card. Bit 15 must be set in the control word as it informs the card that the output is a control word. To input data from the Teleprinter, bit 14 must be true. Bit 14 is used to generate the input condition on the interface card. This is accomplished by an OTA or OTB to the Select Code of I/O location of the Buffered Teleprinter Card after the control word has been loaded in the appropriate register. If it is desired to print the data as it is entered, bit 13 of the control word should also be set.

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3-33. To read from the Teleprinter tape reader, and print the data on the Teleprinter as it is read in, the control word to be output would be 160000. When the OTA or OTB instruction is implemented, the Select Code for the board location comes true. Since bits 13 and 14 are true, the In/Out flip-flop is set to the In state and the Print flip-flop is set true. Since IOBI 12 is false, the punch flip-flop is set false. At T3B, during the first half of the T3T4 IOO signal, a true signal, through "nand" gates MC46B, MC46D, and MC54B directly resets the Data Register except flip-flop MC124B which is directly set. The true state of the Print flip-flop, MC114B, results in pin 8 going false and the output of "nand" gate MC44B pin 6, true. Since the In/Out flip-flop is in the Input state, two of the three inputs of "nand" gate MC24B are true. The pin 3 input to this gate comes from the Data signal of the Teleprinter through pins 4 and D (48-pin connector), Schmitt-trigger Q1 and Q2, driver Q3 to "nand" gate MC104C. The output of MC104C, pin 11, is inverted through MC104A to pin 3 of MC24B causing

MC104D to operate transistor Q4. This outputs data that comes in from the Teleprinter input circuit to its separate output circuit. Since Print inhibit transistor Q6 is off, the data is printed.

3-34. The next instruction issued to the card is STC,C. The Flag is cleared in the normal manner and the STC signal is transferred through "nand" gates MC36B and MC104B (see Figure 3-4). The output of gate MC104B (pin 6) is transferred as a true input to "nand" gate MC34C. The other input from the true side of the In/Out flip-flop enables MC34C. These inputs cause MC34C, pin 11, to set the Read flip-flop. This turns transistor Q5 on, which starts the Teleprinter reader, if its FREE/START/STOP switch is in START. When the first space (false signal) from the Teleprinter causes the Schmitt-trigger to go to the false state, transistor Q3 turns off, setting the output of "nand" gate MC104C false and the output of "nand" gate MC104A true. This signal goes through "nand" gates MC24B and MC104D turning transistor Q4 on,
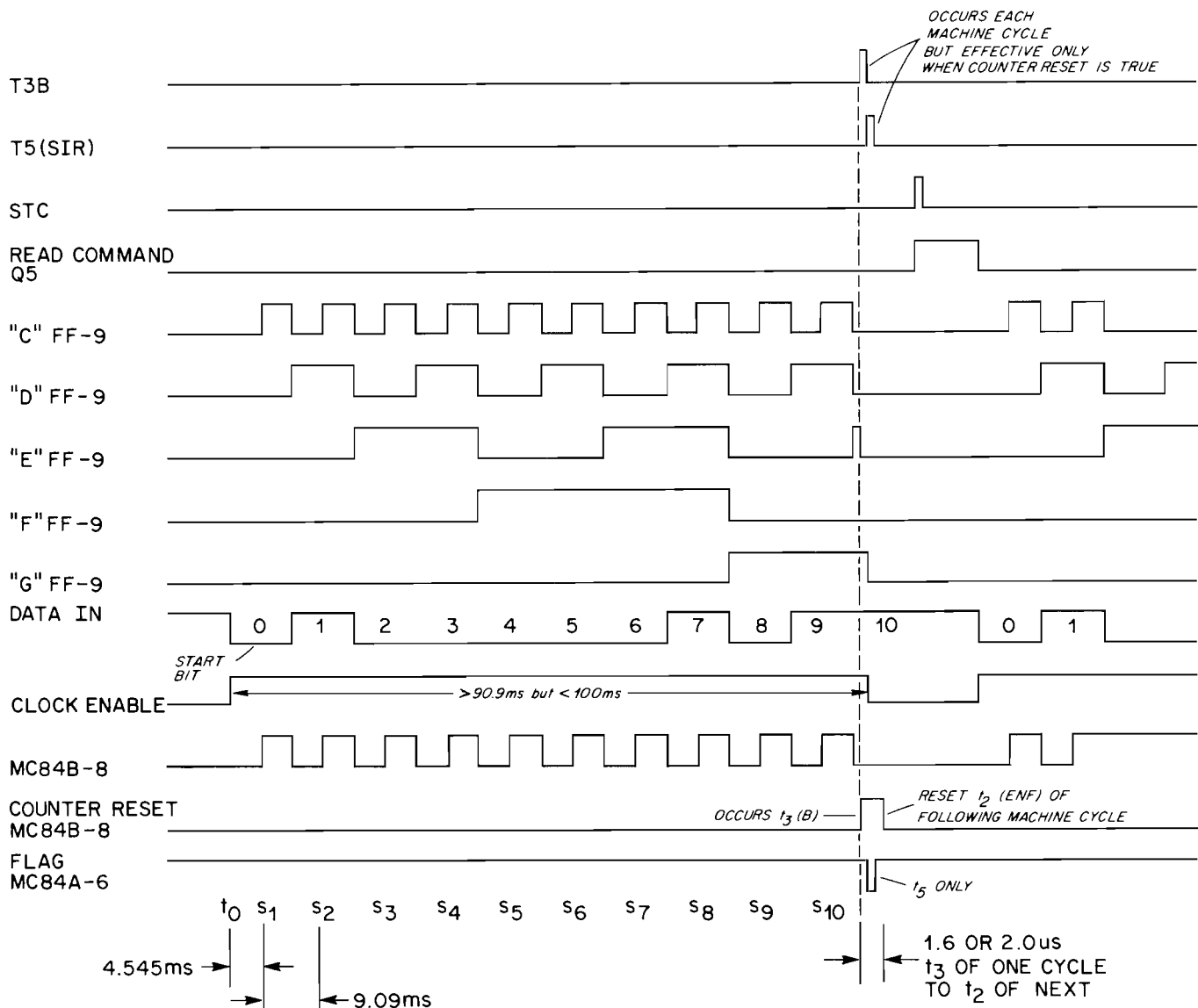
Figure 3-4. Input Timing Diagram
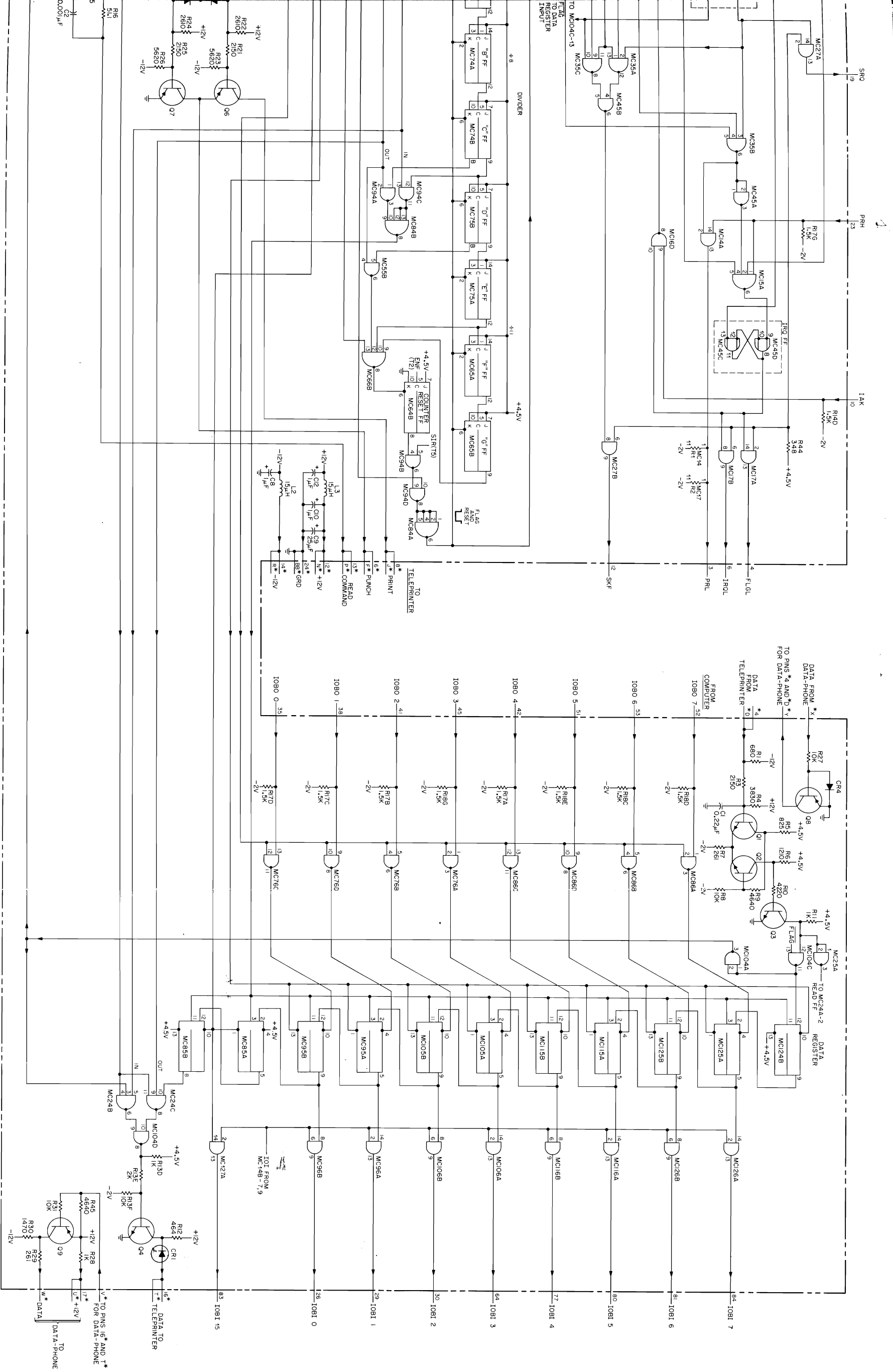
Figure 3-5. Buffered Teleprinter, Logic Diagram

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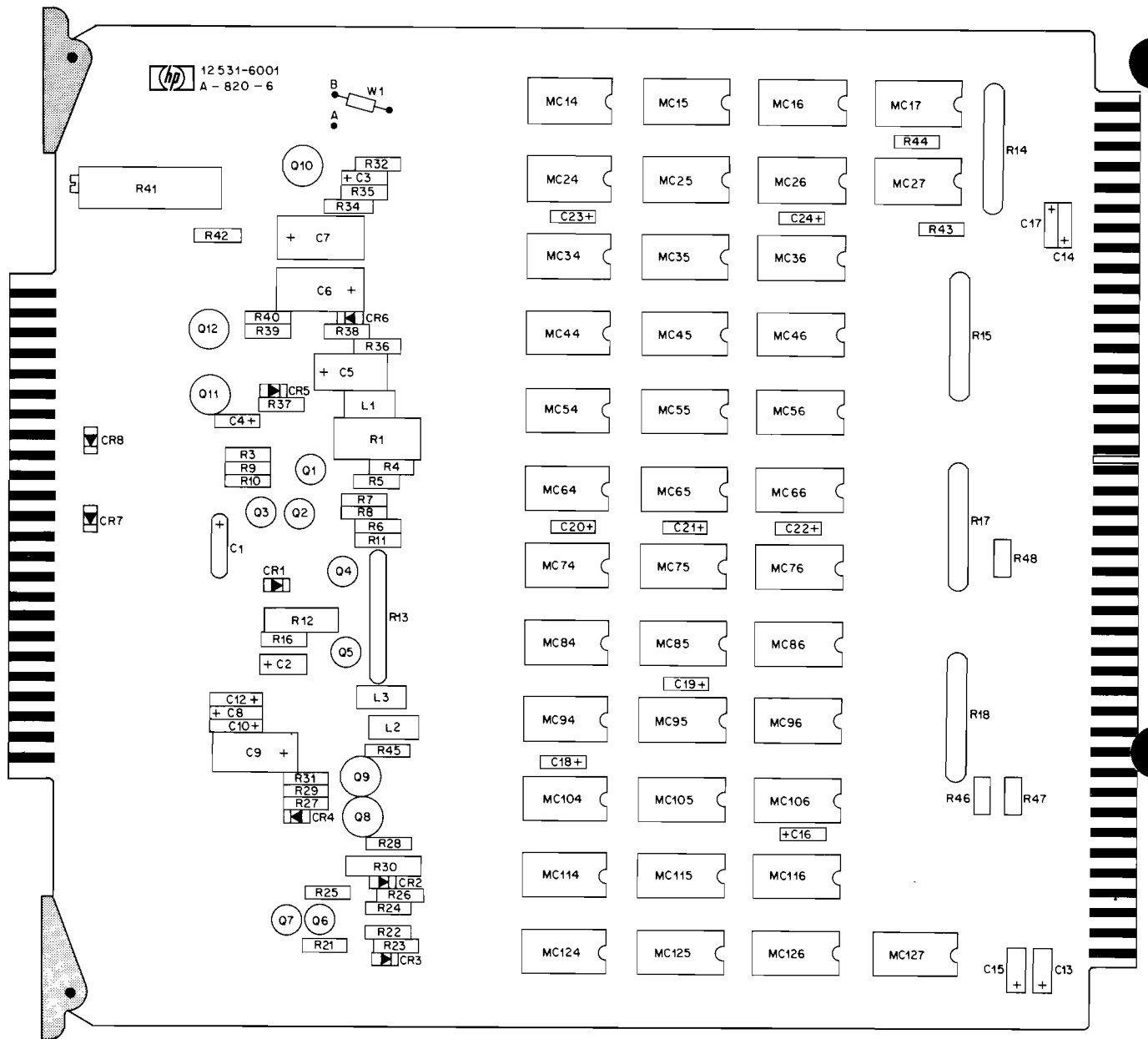
Figure 3-6. Buffered Teleprinter, Part Location Diagram
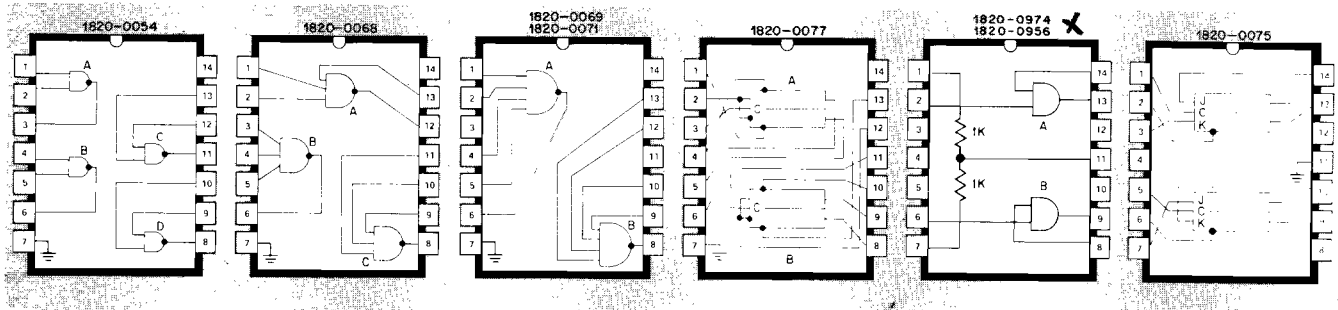
Figure 3-7. Microcircuit Packages, Top View

which transfers the start bit (first false signal) back to the Teleprinter output circuit. At the same time the Clock Enable flip-flop is set by the output of "nand" gate MC34A. The true signal from transistor Q3 is output through "nand" gate MC25A resetting the Read flip-flop. This stops the Teleprinter reader until the Computer is ready for the next character.

3-35. The Clock Enable flip-flop now allows the 872 Hz oscillator signal to start through the A,B,C divider network. Since the input condition is set, "nand" gate MC94C is enabled and the outputs from MC94A and MC55B are always true. At the end of 4.545 milliseconds, the C flip-flop of the divider chain goes true which causes the output of "nand" gate MC94C to go false, and MC84B to go true. This causes the Data Register to shift one character and store the data of the bit of the ASCII word in flip-flop MC124B. This is a zero (false) for the first bit.

3-36. At the end of the other half of the 9.09 milliseconds, the C flip-flop goes false which forces the Divide by 11 divider to step one count. This process continues through the next 10 bits of the ASCII data string entering the card with the shift register storing and shifting the bits in the middle of each bit and incrementing the counter at the end of the bit. At the end of bit 10, the state of divider flip-flops D, E, F, and G become 0, 1, 0, 1, respectively. Because "nand" gate MC55B, pin 6, is true, the output of "nand" gate MC66B goes false after bit 10 at time T3 of the following machine cycle. This forces the Counter Reset

flip-flop to be reset which with T5 (through "nand" gate MC94B) resets the entire Divider string and the Clock Enable flip-flop, and sets the Flag flip-flop. Once the signal is detected by the skip flag condition, a LIA or LIB instruction will load the 8-bits of data into the least-significant bits of the A or B Register by enabling IOI, permitting data to pass from the Data Register into the IOBI 0 through 7 lines.

3-37. Since only 10-bits have been shifted, bit 0 is now stored in flip-flop MC85A and bit 10 stored in flip-flop MC124B. Since bit 11 is a known 1 (true), it does not have to be stored or shifted into the Data Register. If the Computer requests another character, another STC,C instruction is issued, energizing the reader, and the circuit then waits for the start bit (false signal) of the next character to restart the divider network and counter.

NOTE

The Buffered Interface Card, HP Part No. 02116-6168 is similar to the Buffered Interface Card, HP Part No. 12531-6001 (A-820-6). For re-order purposes, use the 12531-6001 number. The 02116-6168 card does not have the Status Bit capability.

3-38. If IOBI 15 of the status word is set, the card is currently in the process of inputting or outputting a character. The 8 least-significant bits are not effective in a status check.

SECTION IV
REPLACEABLE PARTS

4-1. INTRODUCTION.

4-2. This section contains information for ordering replacement parts for the Buffered Teleprinter Interface Card. Refer to Table 4-1 for a list of replaceable parts in alpha-numerical order of their reference designations, with a description and HP part number for each part. Table 4-2 lists parts alpha-numerically by their HP part numbers.

4-3. ORDERING INFORMATION.

4-4. To order a replacement part, address the order or inquiry to your local Hewlett-Packard field office. See the list at the rear of this manual for field-office addresses.

4-5. Specify the following information for each part when ordering:

    a. Hewlett-Packard part number.

    b. Circuit reference designation.

    c. Description.

4-6. To order a part not listed in Tables 4-1 and 4-2, give a complete description of the part and include its function and location.

Table 4-1. Reference Designation Index

Reference Designation	HP Part No.	Description
C1	0160-0263	C:FXD CER 0.22UF 20% 50VDCW
C2	0160-0153	C:FXD MY 1000 PF 10% 200VDCW
C3, 4, 8, 10, 12-24	0180-0291	C:FXD ELECT 1UF 10% 35VDCW
C5	0180-0228	C:FXD ELECT 22UF 10% 15VDCW
C6, 7	0160-0165	C:FXD MY 5600 PF 10%
C9	0180-0338	C:FXD ELECT 25UF +75-10% 25VDCW
CR1, 4, 5	1902-0022	DIODE BREAKDOWN: 2.67V
CR2, 3, 7, 8	1910-0030	DIODE: GERMANIUM 100 MA 0.65V
CR6	1901-0040	DIODE: SILICON 30MA 30WV
L1, 2, 3	9140-0082	COIL:FXD RF 15 UH
MC14, 17, 27	1820-0956	INTEGRATED CIRCUIT
MC15	1820-0069	INTEGRATED CIRCUIT
MC16, 25, 34, 36, 45, 46, 55, 56, 76, 86, 94, 104	1820-0054	INTEGRATED CIRCUIT
MC24, 26, 35, 44	1820-0068	INTEGRATED CIRCUIT
MC54, 66, 84	1820-0071	INTEGRATED CIRCUIT
MC64, 65, 74, 75	1820-0075	INTEGRATED CIRCUIT
MC85, 95, 105, 114, 115, 124, 125	1820-0077	INTEGRATED CIRCUIT
MC96, 106, 116, 126, 127	1820-0974	INTEGRATED CIRCUIT
MC106	1820-0974	INTEGRATED CIRCUIT
Q1, 2, 3	1854-0094	TRANSISTOR: SILICON NPN
Q4, 5	1854-0215	TRANSISTOR: SILICON NPN 2N3904
Q6, 7	1853-0036	TRANSISTOR: SILICON PNP
Q8, 9	1853-0058	TRANSISTOR: SILICON PNP
Q10, 11, 12	1854-0094	TRANSISTOR: SILICON NPN
R1	0698-3635	R: FXD MET OX 680 OHM 5% 2W
R3, R21, R25	0698-0084	R:FXD MET FLM 2.15K OHM 1% 1/8W
R4	0698-3153	R:FXD MET FLM 3.83K OHM 1% 1/8W
R5	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W
R6	0757-0274	R:FXD MET FLM 1.21K OHM 1% 1/8W
R7, 29	0698-3132	R:FXD MET FLM 261 OHM 1% 1/8W
R8, 27, 31, 42	0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W
R9, 34, 45	0698-3155	R:FXD MET FLM 4.64K OHM 1% 1/8W
R10	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W
R11, 28, 32, 39, 48	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W
R12	0698-0090	R:FXD MET FLM 464 OHM 1% 1/2W
R13	1810-0008	RESISTOR NETWORK: MET FLM (6 RES)
R14, 15, 17, 18	1810-0020	RESISTOR NETWORK: MET FLM (7 RES)
R16	0757-0394	R:FXD MET FLM 51.1 OHM 1% 1/8W
R22, 24	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W
R23, 26	0757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W
R30, 46, 47	0757-1078	R:FXD MET FLM 1.47K OHM 1% 1/2W
R35	0757-0199	R:FXD MET FLM 21.5K OHM 1% 1/8W
R36	0757-0465	R:FXD MET FLM 100K OHM 1% 1/8
R37	0757-0444	R:FXD MET FLM 12.1K OHM 1% 1/8W
R38, 40	0757-0278	R:FXD MET FLM 1.78K OHM 1% 1/8W
R41	2100-1660	R:VAR WW LIN 10K OHM 10% 1W
R43	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W
R44	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W
W1	8159-0005	JUMPER WIRE

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Table 4-2. Replaceable Parts

HP Part No.	Description	Mfr.	Mfr. Part No.	TQ
0160-0153	C:FXD MY 1000 PF 10% 200VDCW	28480	0160-0153	1
0160-0165	C:FXD MY 5600 PF 10%	28480	0160-0165	2
0160-0263	C:FXD CER 0.22UF 20% 50VDCW	56289	5C52B	1
0180-0228	C:FXD ELECT 22 UF 10% 15VDCW	28480	0180-0228	1
0180-0291	C:FXD ELECT 1UF 10% 35VDCW	56289	150D105X9035A2	17
0180-0338	C:FXD ELECT 25UF +75-10% 25VDCW	28480	0180-0338	1
0698-0084	R:FXD MET FLM 2.15K OHM 1% 1/8W	28480	0698-0084	3
0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085	2
0698-0090	R:FXD MET FLM 464 OHM 1% 1/2W	28480	0698-0090	1
0698-3132	R:FXD MET FLM 261 OHM 1% 1/8W	28480	0698-3132	2
0698-3153	R:FXD MET FLM 3.83K OHM 1% 1/8W	28480	0698-3153	1
0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	28480	0698-3154	1
0698-3155	R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155	3
0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440	1
0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	28480	0698-3445	1
0698-3635	R:FXD MET OX 680 OHM 5% 2W	28480	0698-3635	1
0757-0199	R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199	1
0757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200	2
0757-0274	R:FXD MET FLM 1.21K OHM 1% 1/8W	28480	0757-0274	1
0757-0278	R:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278	2
0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280	5
0757-0394	R:FXD MET FLM 51.1 OHM 1% 1/8W	28480	0757-0394	1
0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	28480	0757-0421	1
0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442	4
0757-0444	R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444	1
0757-0465	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465	1
0757-1078	R:FXD MET FLM 1.47K OHM 1% 1/2W	28480	0757-1078	3
1810-0008	RESISTOR NETWORK: MET FLM (6 RES)	28480	1810-0008	1
1810-0020	RESISTOR NETWORK: MET FLM (7 RES)	28480	1810-0020	4
1820-0054	INTEGRATED CIRCUIT	28480	1820-0054	12
1820-0068	INTEGRATED CIRCUIT	28480	1820-0068	4
1820-0069	INTEGRATED CIRCUIT	28480	1820-0069	1
1820-0071	INTEGRATED CIRCUIT	28480	1820-0071	3
1820-0075	INTEGRATED CIRCUIT	28480	1820-0075	4
1820-0077	INTEGRATED CIRCUIT	28480	1820-0077	7
1820-0956	INTEGRATED CIRCUIT	28480	1820-0956	3
1820-0974	INTEGRATED CIRCUIT	28480	1820-0974	5
1853-0036	TRANSISTOR: SILICON PNP	28480	1853-0036	2
1853-0058	TRANSISTOR: SILICON PNP	07263	2N3644	2
1854-0094	TRANSISTOR: SILICON NPN	28480	1854-0094	6
1854-0215	TRANSISTOR: SILICON NPN 2N3904	28480	1854-0215	2
1901-0040	DIODE: SILICON 30MA 30WV	28480	1901-0040	1
1902-0022	DIODE BREAKDOWN: 2.67V	28480	1902-0022	1
1910-0022	DIODE: GERMANIUM 5 WIV	28480	1910-0022	2
1910-0030	DIODE: GERMANIUM 100 MA 0.65V	28480	1910-0030	4
2100-1660	R: VAR WW LIN 10K OHM 10% 1W	28480	2100-1660	1
8159-0005	JUMPER WIRE	28480	8159-0005	1
9140-0082	COIL: FXD RF 15 UH	28480	9140-0082	3
12531-6001	BUFFERED TELEPRINTER	04404	12531-6001	1

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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

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HEWLETT hp PACKARD

DIAGNOSTIC TEST
for
BUFFERED TELEPRINTER
Computer Interface Kit

model
12531B

Manual Supplement 7 MAR 1969

CONTENTS

Diagnostic Operating Procedure

Diagnostic Program Listing HP 20420AL (for 2114A/15A Computers)
Diagnostic Program Listing HP 20417BL (for 2116A/B Computers)
Diagnostic Program Listing HP 20420BB (for 2114A/15A Computers)
Diagnostic Program Listing HP 20417CL (for 2116A/B Computers)

This Supplement applies to:

Diagnostic Tape HP 20420A (for 2114A/15A Computers)
Diagnostic Tape HP 20420B (for 2114A/15A Computers)
Diagnostic Tape HP 20417B (for 2116A/B Computers)
Diagnostic Tape HP 20417C (for 2116A/B Computers)

and

Interface Board HP Part No. 02116-6168
Interface Board HP Part No. 12531-6001

DIAGNOSTIC OPERATING PROCEDURE

1. **BUFFERED TELEPRINTER**

2. A Diagnostic Test Tape and Diagnostic Listing is furnished with each Buffered Teleprinter Interface Kit. The HP part number of the tape is on a label attached to the tape and/or container. Use this number and the system serial number for correspondence and re-ordering purposes.

3. This Diagnostic Program checks the Buffered Teleprinter Interface Card (HP 02116-6168 or 12531-6001) with an HP 2752A Teleprinter (ASR33) or an HP 2754A/B Teleprinter (ASR35).

4. The program consists of a background control program and four task routines. The first task routine inserts the address of the BUFFERED TELEPRINTER REGISTER into all I/O instructions. The second routine tests the flag, control, and interrupt circuitry and the data register on the Teleprinter Interface Card. The errors are stored, and at the end of the test, the program attempts to print out the errors. If it fails to print, or if bit 1 of the switch register is true, the program will halt where the errors are stored. Pressing DISPLAY MEMORY will show which errors occurred. The third routine tests the tape punch, tape reader, and printer parts of the Teleprinter. All combinations of eight bits are punched out, and this tape is read back while the computer checks the data. Errors are printed out and parts of the tape are also printed out as they are read. The fourth routine tests the printer and the keyboard parts of the Teleprinter. All sixty-four ASCII characters are printed out twice (see tables 1 and 2). The computer then waits for a character from the Teleprinter keyboard (or tape reader), reads in the character and then outputs it to the printer. The operator verifies accuracy.

5. The Buffered Teleprinter Interface Card must be in an unbroken interrupt priority string since the diagnostic tests the interrupt capability of the board.

6. **OPERATING PROCEDURE**

    a.   Buffered Teleprinter Interface Card

        1.   Place card in an I/O slot such that every slot of higher priority has either another I/O board or a priority jumper board in it.

2. Connect card to Teleprinter.

3. If 2754A/B Teleprinter, put MODE switch in KT position.

b. Buffered Teleprinter Diagnostic

1. Load diagnostic Test Tape into memory using Basic Binary Loader.

2. Put 000100 into Switch Register.

3. Push LOAD ADDRESS.

4. Put address of Buffered Teleprinter card into Switch Register. 313

5. Push RUN.

6. Computer will halt with A, B, and T Registers at 102001. This is the beginning of testing.

7. Clear Switch Register.

8. Push RUN (Computer will sit in Run Loop awaiting Switch Register option).

9. Operator must set Switch Register for desired program control option.

7. PROGRAM CONTROL

a. Put Switch 3 of Switch Register in up position. The Computer then performs the Basic Test task routine and halts if an error occurs or if Switch 1 is up. (When Switch 1 is up the Computer will halt at the top of the Error Codes for all basic tests.)

HLT55 - The T-Register 102055. The A and B Registers program address which called for the halt. This indicates a failure to print, (i.e., no Flag). Push DISPLAY MEMORY 16 times to display which errors occurred. (The T Register will show 000001 for E01, etc.) The 17th push displays all 1's. Push RUN to return to the main program. Clear Switch Register to terminate basic test.

ERROR CODES

CODE	MEANING
E01	SFC XX true after CLC 0, C instruction
E02	SFS XX false after CLC 0, C instruction
E03	SFC XX false after CLF xx instruction
E04	SFS XX true after CLF XX instruction
E05	SFC XX false after CLF XX and STC XX
E06	SFS XX true after CLF XX and STC XX
E07	No interrupt after STC XX, STF XX, STF 0
E10	SFC XX true after interrupt
E11	SFS XX false after interrupt
E12	Data Clock on Buffered Teleprinter Card too fast
E13	Data Clock on Buffered Teleprinter Card too slow
E14	Data buffer error
E15	Clock Enable flip-flop set
E16	Clock Enable flip-flop not set
E17	Illegal interrupt from teleprinter
IA	Program address at time of E17

NOTE

Only the first 15 error codes (E15) are valid with the
02116-6168 version of the Buffered Teleprinter card.
All error codes can occur on the 12531-6001 Buffered
Teleprinter card.

b. Put Switch 4 of Switch Register in up position. Program will
perform Punch and Read Task routine and Halt.

HLT 2 - A, B and T Registers 102002. This is the begin-
ning of the punch operation. Turn on punch (if HP 2752A)
and push RUN.

HLT 3 - A, B and T Registers 102003. This is the begin-
ning of the tape reader operation. Turn off the punch (HP
2752A), load tape into reader, turn on reader, and push RUN.
Since the Printer and Punch can be controlled independently
on the 2754A/B but not on the 2752A, the printed output be-
tween the two teleprinters will be different. Table 5-1 shows
the printout of 2752A Teleprinter and Table 5-2 shows the
printout of the 2754A/B Teleprinter.

Clear Switch Register to terminate the Punch and Read task
routine.

c.   Put Switch 5 of Switch Register in up position. Program will perform Print and Keyboard Task routine. At Teleprinter request, the operator must input data from the teleprinter. This same data is transferred through the computer and printed by the teleprinter. Clear Switch Register to terminate Print and Keyboard task routine.

d.   Put Switch 0 of Switch Register in up position. Computer will halt.

HLT 0 - T Register = 102000, A, B, M, and P Registers = 100. This is the beginning of the program. Put Teleprinter address in Switch Register and press RUN. (This permits the testing of multiple teleprinters.) Return to paragraph 6b, step 6.

e.   With Switch 2 of Switch Register in up position, teleprinter printout is suppressed.

Table 5-1. HP 2752A PRINTOUT

```
BEGIN BASIC TEST

END BASIC TEST

BEGIN PUNCH AND READ


  !"#$%&'()*+,-./0123456789:;<=>?                                         Printed
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑←@ABCDEFGHIJKLMNOPQRSTUVWXYZ[ )  While
                                                                          Punching
  !"#$%&'()*+,-./0123456789:;<=>?                                ) Tape
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑←@ABCDEFGHIJKLMNOPQRSTUVWXYZ[ )
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑←@ABCDEFGHIJKLMNOPQRSTUVWXYZ[ )  Printed
                                                                          While
  !"#$%&'()*+,-./0123456789:;<=>?                                         Reading
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑←@ABCDEFGHIJKLMNOPQRSTUVWXYZ[ )  Tape


END PUNCH AND READ

BEGIN PRINT AND KEYBOARD

@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑←
  !"#$%&'()*+,-./0123456789:;<=>?
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑←
  !"#$%&'()*+,-./0123456789:;<=>?

USE KEYBOARD SLOWLY (5 CHS./SEC.)

1234567890:-!"#$%&'()*=    )   Operator
QWERTYUIOP←0               )   Using
ASDFGHJKL;[\+             )   Keyboard
ZXCVBNM,./↑]<>?          )

END PRINT AND KEYBOARD
```

2116A/B BUFFERED TELEPRINTER TEST

BINARY TAPE   - HP20417C

SOURCE TAPE   - HP20471C

SOURCE LISTING - HP20417CL

0001   ASMB,A,B,L
** NO ERRORS*

```
0001                     ASMB,A,B,L
0002*
0003*
0004*
0005*BUFFERED TELETYPE DIAGNOSTIC   2116   07/08/68
0006*
0007*
0008*
0009*STARTING OCTAL ADDRESS  =  100
0010****
0011*THE FOLLOWING SWITCH REGISTER SETTINGS
0012*ARE USED FOR PROGRAM CONTROL
0013*
0014*BIT   0 = 1   ->   HALT AT BEGINNING OF PROGRAM
0015*BIT   1 = 1   ->   HALT AT ERROR BUFFER
0016*BIT   2 = 1   ->   SUPPRESS MESSAGE PRINTOUT
0017*BIT   3 = 1   ->   PERFORM BASIC TEST ROUTINE
0018*BIT   4 = 1   ->   PERFORM PUNCH AND READ ROUTINE
0019*BIT   5 = 1   ->   PERFORM PRINT AND KEYBOARD ROUTINE
0020****
0021*
0022*
0023*MAIN PROGRAM
0024*
0025   00077                ORG 77B
0026   00077 102700  FND    HLT 0
0027   00100 107700         CLC 0,C          INITIALIZE, INTERRUPT OFF
0028   00101 102501         LIA 1            PUT TTY
0029   00102 010141         AND MSK0            ADDRESS
0030   00103 070303         STA BTA               INTO ALL I/O
0031   00104 014203         JSB INIT                 INSTRUCTIONS
0032   00105 064142         LDB M67          PREPARE
0033   00106 060143         LDA HIS             TRAP
0034   00107 070111         STA *+2               FOR
0035   00110 060144         LDA HI                 ILLEGAL
0036   00111 070010         STA 10B                   INTERRUPT
0037   00112 034111         ISZ *-1                      FROM
0038   00113 002004         INA                           ANOTHER
0039   00114 006006         INB,SZB                          DEVICE
0040   00115 024111         JMP *-4
0041   00116 060407         LDA IIJ          PREPARE ILLEGAL TTY
0042   00117 070000  STA1   STA 0              INTERRUPT TRAP
0043   00120 014752         JSB EOI          LINE FEED
0044   00121 060123         LDA *+2          HALT TO CHOOSE
0045   00122 064123         LDB *+1             SWITCH REGISTER
0046   00123 102001         HLT 1                 OPTIONS
0047   00124 014145  MP1    JSB MODE         CHECK SW. REG.
0048   00125 060177         LDA BIT3         PERFORM
0049   00126 000010         SLA                 BASIC TEST?
0050   00127 014344         JSB BT           YES.
0051   00130 014145         JSB MODE         NO.  CHECK SW. REG.
0052   00131 060200         LDA BIT4         PERFORM
0053   00132 000010         SLA                 PUNCH AND READ?
0054   00133 015056         JSB PAR          YES.
0055   00134 014145         JSB MODE         NO.  CHECK SW. REG.
0056   00135 060201         LDA BIT5         PERFORM
0057   00136 000010         SLA                 PRINT AND KEYBOARD?
```

```
0058   00137 015342          JSB PAK        YES.
0059   00140 024124          JMP MP1        NO.
0060   00141 000077  MSK0    OCT 77
0061   00142 177711  M67     OCT 177711
0062   00143 070010  HIS     STA 10B
0063   00144 102010  HI      HLT 10B
0064*
0065*SWITCH REGISTER MONITORED
0066*FOR CURRENT OPERATING MODE
0067*
0068   00145 000000  MODE    NOP            ENTER SUBROUTINE
0069   00146 070173          STA AS0        STORE A
0070   00147 102501          LIA 1          EACH BIT
0071   00150 070174          STA BIT0         FROM THE
0072   00151 001300          RAR              SWITCH REGISTER
0073   00152 070175          STA BIT1          IS ROTATED
0074   00153 001300          RAR              INTO THE
0075   00154 070176          STA BIT2           LEAST SIGNIFICANT
0076   00155 001300          RAR                POSITION AND
0077   00156 070177          STA BIT3            STORED IN THE
0078   00157 001300          RAR                 STORAGE LOCATION
0079   00160 070200          STA BIT4             BEARING ITS NAME
0080   00161 001300          RAR
0081   00162 070201          STA BIT5
0082   00163 060174          LDA BIT0       HALT AT BEGINNING
0083   00164 002011          SLA,RSS          OF PROGRAM?
0084   00165 024171          JMP *+4        NO.
0085   00166 060202          LDA HAD        YES.  LOAD A AND B
0086   00167 064202          LDB HAD          WITH 100
0087   00170 024077          JMP END            AND HALT
0088   00171 060173          LDA AS0        RESTORE A
0089   00172 124145          JMP MODE,I     EXIT SUBROUTINE
0090   00173 000000  AS0     OCT 0          TEMPORARY STORAGE
0091   00174 000000  BIT0    OCT 0
0092   00175 000000  BIT1    OCT 0
0093   00176 000000  BIT2    OCT 0
0094   00177 000000  BIT3    OCT 0
0095   00200 000000  BIT4    OCT 0
0096   00201 000000  BIT5    OCT 0
0097   00202 000100  HAD     OCT 100
0098*
0099*
0100*INITIALIZATION ROUTINE
0101*
0102*THIS ROUTINE ADDS THE BUFFERED TELETYPE ADDRESS TO
0103*ALL I/O INSTRUCTIONS.
0104*
0105*
0106   00203 000000  INIT    NOP            ENTER ROUTINE
0107   00204 107700          CLC 0,C        INITIALIZE, INTERRUPT OFF
0108   00205 014274          JSB ADIN       PUT TTY ADDRESS
0109   00206 102300          SFS 0            INTO SFS INSTRUCTIONS
0110   00207 070340          STA SFS1
0111   00210 070347          STA SFS2
0112   00211 070357          STA SFS3
0113   00212 070401          STA SFS4
0114   00213 070512          STA SFS5
```

```
0115   00214 014274        JSB ADIN       PUT TTY ADDRESS
0116   00215 102200        SFC 0            INTO SFC INSTRUCTIONS
0117   00216 070334        STA SFC1
0118   00217 070344        STA SFC2
0119   00220 070354        STA SFC3
0120   00221 070375        STA SFC4
0121   00222 014274        JSB ADIN       PUT TTY ADDRESS
0122   00223 102600        OTA 0            INTO OTA INSTRUCTIONS
0123   00224 070415        STA OTA1
0124   00225 070450        STA OTA2
0125   00226 070471        STA OTA3
0126   00227 070713        STA OTA4
0127   00230 070716        STA OTA5
0128   00231 071357        STA OTA6
0129   00232 014274        JSB ADIN       PUT TTY ADDRESS
0130   00233 103700        STC 0,C          INTO STC,C  INSTRUCTIONS
0131   00234 070417        STA STCC1
0132   00235 070717        STA STCC2
0133   00236 071361        STA STCC3
0134   00237 014274        JSB ADIN       PUT TTY ADDRESS
0135   00240 106700        CLC 0            INTO CLC INSTRUCTION
0136   00241 070420        STA CLC1
0137   00242 014274        JSB ADIN       PUT TTY ADDRESS
0138   00243 102700        STC 0            INTO STC INSTRUCTION
0139   00244 070353        STA STC1
0140   00245 070500        STA STC2
0141   00246 014274        JSB ADIN       PUT TTY ADDRESS
0142   00247 103100        CLF 0            INTO CLF INSTRUCTION
0143   00250 070343        STA CLF1
0144   00251 014274        JSB ADIN       PUT TTY ADDRESS
0145   00252 102100        STF 0            INTO STF INSTRUCTION
0146   00253 070366        STA STF1
0147   00254 014274        JSB ADIN       PUT TTY ADDRESS
0148   00255 106500        LIB 0            INTO LIB INSTRUCTIONS
0149   00256 070451        STA LIB1
0150   00257 070472        STA LIB2
0151   00260 070501        STA LIB3
0152   00261 071122        STA LIB4
0153   00262 071311        STA LIB5
0154   00263 071324        STA LIB6
0155   00264 071332        STA LIB7
0156   00265 071366        STA LIB8
0157   00266 014274        JSB ADIN       PUT TTY ADDRESS
0158   00267 070000        STA 0            INTO STA INSTRUCTIONS
0159   00270 070117        STA STA1
0160   00271 070364        STA STA2
0161   00272 070374        STA STA3
0162   00273 124203        JMP INIT,I   EXIT ROUTINE
0163*
0164*ADDRESS INCLUSION SUBROUTINE.
0165*THE BUFFERED TTY ADDRESS IS PUT INTO
0166*THE INSTRUCTION FOLLOWING JSB ADIN.
0167*
0168   00274 000000  ADIN NOP            ENTER SUBROUTINE
0169   00275 160274        LDA ADIN,I     BRING I/O INSTRUCTION INTO A
0170   00276 010302        AND MSK1       ADD TTY ADDRESS
0171   00277 030303        IOR BTA          TO INSTRUCTION
```

```
0172   00300 034274          ISZ ADIN        EXIT
0173   00301 124274          JMP ADIN,I        SUBROUTINE
0174   00302 177700  MSK1    OCT 177700
0175   00303 000000  BTA     OCT 0           TTY ADDRESS STORAGE
0176*
0177*
0178*
0179*BASIC TEST ROUTINE
0180*
0181*THE FOLLOWING TESTS THE FLAG, CONTROL,
0182*AND INTERRUPT CIRCUITRY
0183*
0184   00304 000000  BT      NOP
0185   00305 107700          CLC 0,C         INITIALIZE, INTERRUPT OFF
0186   00306 060730          LDA SOYN        RESTORE
0187   00307 070727          STA OYN           OUTPUT CODE
0188   00310 060653          LDA SI1         PRINT FIRST
0189   00311 014765          JSB SMPOC         BT MESSAGE
0190   00312 006400          CLB             CLEAR
0191   00313 074620          STB E1            ERROR
0192   00314 074621          STB E2              BUFFER
0193   00315 074622          STB E3
0194   00316 074623          STB E4
0195   00317 074624          STB E5
0196   00320 074625          STB E6
0197   00321 074626          STB E7
0198   00322 074627          STB E10
0199   00323 074630          STB E11
0200   00324 074631          STB E12
0201   00325 074632          STB E13
0202   00326 074633          STB E14
0203   00327 074634          STB E15
0204   00330 074635          STB E16
0205   00331 074636          STB E17
0206   00332 074637          STB IA
0207   00333 006004          INB             INCREMENT ERROR CODE
0208   00334 102200  SFC1    SFC 0           FLAG CLEAR?
0209   00335 024337          JMP *+2            NO.
0210   00336 074620          STB E1             YES.  ERROR 1
0211   00337 006004          INB               INCREMENT ERROR CODE
0212   00340 102300  SFS1    SFS 0           FLAG SET?
0213   00341 074621          STB E2             NO.  ERROR 2
0214   00342 006004          INB               YES.
0215   00343 103100  CLF1    CLF 0           CLEAR FLAG
0216   00344 102200  SFC2    SFC 0           FLAG CLEAR?
0217   00345 074622          STB E3             NO.  ERROR 3
0218   00346 006004          INB               YES.
0219   00347 102300  SFS2    SFS 0           FLAG SET?
0220   00350 024352          JMP *+2            NO.
0221   00351 074623          STB E4             YES.  ERROR 4
0222   00352 006004          INB
0223   00353 102700  STC1    STC 0           SET CONTROL
0224   00354 102200  SFC3    SFC 0           FLAG CLEAR?
0225   00355 074624          STB E5             NO.  ERROR 5
0226   00356 006004          INB               YES.
0227   00357 102300  SFS3    SFS 0           FLAG SET?
0228   00360 024362          JMP *+2            NO.
```

```
0229   00361 074625          STB E6       YES.   ERROR 6
0230   00362 006004          INB
0231   00363 068406          LDA IJ1      PREPARE TO TEST
0232   00364 070000   STA2   STA A          INTERRUPT SYSTEM
0233   00365 102100          STF P        TURN ON INTERRUPT SYSTEM
0234   00366 102100   STF1   STF P        SET FLAG
0235   00367 000000          NOP          WAIT FOR
0236   00370 000000          NOP            INTERRUPT
0237   00371 074626          STB E7       NO INTERRUPT - ERROR 7
0238   00372 006004   P1     INB          INTERRUPT ENTRY
0239   00373 068407          LDA IIJ      RENEW ILLEGAL
0240   00374 070000   STA3   STA P          INTERRUPT TRAP
0241   00375 102200   SFC4   SFC P        FLAG CLEAR?
0242   00376 024400          JMP *+2         NO.
0243   00377 074627          STB E10        YES.  ERROR 10
0244   00400 006004          INR
0245   00401 102300   SFS4   SFS P        FLAG SET?
0246   00402 074630          STB E11        NO.  ERROR 11
0247   00403 006004          INR            YES.
0248   00404 074410          STB ERNO     STORE ERROR CODE
0249   00405 024411          JMP TOUT
0250   00406 024372   IJ1    JMP P1
0251   00407 014533   IIJ    JSB ILINT
0252   00410 000000   ERNO   OCT P        ERROR CODE STORAGE
0253*
0254*THE FOLLOWING TESTS THE TIME FOR OUTPUTING ONE CHARACTER.
0255*
0256   00411 000000   TOUT   NOP
0257   00412 107700          CLC P,C      INITIALIZE, INTERRUPT OFF
0258   00413 102100          STF P        INTERRUPT ON
0259   00414 068440          LDA ONN      PUT INTO OUTPUT, NO
0260   00415 102600   OTA1   OTA P          PRINT, NO PUNCH MODE
0261   00416 064441          LDB TOC1     CHECK
0262   00417 103700   STCC1  STC P,C        LOWER
0263   00420 106700   CLC1   CLC P           TIME LIMIT
0264   00421 014511          JSB TOS      FLAG SET?
0265   00422 024424          JMP *+2      YES.  DATA CLOCK TOO FAST
0266   00423 024426          JMP *+3      NO.
0267   00424 064410          LDB ERNO     ERROR 12
0268   00425 074631          STB E12
0269   00426 034410          ISZ ERNO     INCREMENT ERROR CODE
0270   00427 000000          NOP          CHECK UPPER
0271   00430 064442          LDB TOC2       TIME LIMIT
0272   00431 014511          JSB TOS      FLAG SET?
0273   00432 024435          JMP *+3      YES.  TIMING OK
0274   00433 064410          LDB ERNO     NO.  DATA CLOCK TOO SLOW
0275   00434 074632          STB E13        ERROR 13
0276   00435 034410          ISZ ERNO     INCREMENT ERROR CODE
0277   00436 000000          NOP
0278   00437 024443          JMP DT
0279   00440 100000   ONN    OCT 100000   OUTPUT,NO PRINT, NO PUNCH
0280   00441 150000   TOC1   OCT 150000     TIMEOUT CONSTANT 1
0281   00442 177040   TOC2   OCT 177040     TIMEOUT CONSTANT 2
0282*
0283*THE FOLLOWING TESTS THE EIGHT BIT DATA BUFFER.
0284*
0285   00443 000000   DT     NOP
```

```
0286   00444 107700          CLC 0,C          INITIALIZE, INTERRUPT OFF
0287   00445 002400          CLA
0288   00446 070465    P2     STA CURWD        OUTPUT THE
0289   00447 010463          AND MSK2            CURRENT
0290   00450 102600    OTA2   OTA 0               WORD
0291   00451 106500    LIB1   LIB 0
0292   00452 050001          CPA 1            INPUT = OUTPUT ?
0293   00453 024456          JMP *+3          YES.
0294   00454 060410          LDA ERNO         NO.  ERROR 14
0295   00455 070633          STA E14
0296   00456 060465          LDA CURWD        INCREMENT
0297   00457 002006          INA,SZA            CURRENT WORD
0298   00460 024446          JMP P2
0299   00461 034410          ISZ ERNO         INCREMENT ERROR CODE
0300   00462 024467          JMP CET
0301   00463 000377    MSK2   OCT 377
0302   00464 000200    MSK3   OCT 200
0303   00465 000000    CURWD  OCT 0
0304   00466 000000    NBE    OCT 0
0305*
0306*THE FOLLOWING TESTS THE CLOCK ENABLE FLIP-FLOP
0307*
0308   00467 107700    CET    CLC 0,C          INITIALIZE, INTERRUPT OFF
0309   00470 060440          LDA ONN          PUT BUFFER INTO "OUTPUT, NO
0310   00471 102600    OTA3   OTA 0               PRINT, NO PUNCH" STATE
0311   00472 106500    LIB2   LIB 0            FLIP-FLOP
0312   00473 006021          SSB,RSS            SET?
0313   00474 024477          JMP *+3          NO.
0314   00475 060410          LDA ERNO         YES.  ERROR 15
0315   00476 070634          STA E15
0316   00477 034410          ISZ ERNO         INCREMENT ERROR CODE
0317   00500 102700    STC2   STC 0            SET FLIP-FLOP
0318   00501 106500    LIB3   LIB 0            FLIP-FLOP
0319   00502 006020          SSB                SET?
0320   00503 024506          JMP *+3          YES.
0321   00504 060410          LDA ERNO         NO.  ERROR 16
0322   00505 070635          STA E16
0323   00506 107700          CLC 0,C          INITIALIZE, INTERRUPT OFF
0324   00507 014522          JSB EBH          HALT AT ERROR BUFFER?
0325   00510 024545          JMP POUT         NO.
0326*
0327*FLAG TIMEOUT SUBROUTINE
0328*
0329*TIMEOUT CONSTANT IN B
0330*IF "FLAG" BEFORE TIMEOUT, EXIT TO TOS.  IF NOT,
0331*EXIT TO TOS + 1.   ONE ITERATION = 6.4 MICROSEC.
0332*
0333   03511 000000    TOS    NOP              ENTER SUBROUTINE
0334   00512 102300    SFS5   SFS 0            FLAG SET?
0335   00513 024515          JMP *+2
0336   00514 124511          JMP TOS,I        YES.  EXIT THROUGH TOS
0337   00515 006006          INB,SZB          NO.  TIMEOUT YET?
0338   00516 024512          JMP SFS5         NO.  REPEAT
0339   00517 034511          ISZ TOS          YES.  EXIT
0340   00520 000000          NOP                THROUGH
0341   00521 124511          JMP TOS,I           TOS + 1
0342*
```

```
0343*ERROR BUFFER HALT SUBROUTINE
0344*
0345    00522 000000    EBH    NOP             ENTER SUBROUTINE
0346    00523 070532           STA  AS1        STORE A
0347    00524 014145           JSB  MODE       CHECK SW. REG.
0348    00525 060175           LDA  BIT1       HALT AT
0349    00526 000010           SLA                ERROR BUFFER?
0350    00527 014614           JSB  POF        YES.
0351    00530 060532           LDA  AS1        NO.  RESTORE A
0352    00531 124522           JMP  EBH,I      EXIT SUBROUTINE
0353    00532 000000    AS1    OCT  0          TEMPORARY STORAGE
0354*
0355*ILLEGAL INTERRUPT SUBROUTINE
0356*
0357*FOR AN ILLEGAL TTY INTERRUPT, THE PROGRAM ADDRESS IS SAVED.
0358*
0359    00533 000000    ILINT  NOP             ENTER SUBROUTINE
0360    00534 070543           STA  AS2        STORE A
0361    00535 060533           LDA  *-2        STORE PROGRAM ADDRESS
0362    00536 070637           STA  IA
0363    00537 060544           LDA  IE         STORE
0364    00540 070636           STA  E17          ERROR 17
0365    00541 060543           LDA  AS2        RESTORE A
0366    00542 124533           JMP  ILINT,I    EXIT SUBROUTINE
0367    00543 000000    AS2    OCT  0          TEMPORARY STORAGE
0368    00544 000017    IE     OCT  17
0369*
0370*THE FOLLOWING PRINTS OUT THE RESULTS OF THE BASIC TEST.
0371*IN CASE OF FAILURE TO PRINT OUT, THE PROGRAM
0372*HALTS AT THE BEGINNING OF THE ERROR BUFFER.
0373*PRESSING "DISPLAY MEMORY" WILL SHOW WHICH ERRORS OCCURED.
0374*
0375    00545 000000    POUT   NOP
0376    00546 107700           CLC  0,C        INITIALIZE, INTERRUPT OFF
0377    00547 006400           CLB
0378    00550 014511           JSB  TOS        FLAG SET?
0379    00551 024553           JMP  *+2        YES.
0380    00552 014614           JSB  POF        NO.  HALT AT ERROR BUFFER
0381    00553 060665           LDA  SC2        PREPARE TO
0382    00554 070666           STA  M16           PRINT OUT
0383    00555 060667           LDA  S13             ERROR CODES
0384    00556 070557           STA  P4
0385    00557 064620    P4     LDB  E1         LOAD B WITH
0386    00560 034557           ISZ  *-1           ERROR STORAGE
0387    00561 006002           SZB             ZERO?
0388    00562 024566           JMP  *+4        NO.
0389    00563 034666           ISZ  M16        YES.  PARTIALLY DONE?
0390    00564 024557           JMP  P4         NO.
0391    00565 024574           JMP  P5         YES.  CHECK INTERRUPT ERRORS
0392    00566 060670           LDA  E          PRINT
0393    00567 014706           JSB  OYNA          OUT
0394    00570 014733           JSB  POUT2           ERROR
0395    00571 014752           JSB  EOL                CODE
0396    00572 014522           JSB  EBH        HALT AT ERROR BUFFER?
0397    00573 024563           JMP  *-10B      NO.
0398    00574 064636    P5     LDB  E17        E17 = 0?
0399    00575 006003           SZB,RSS
```

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0400   00576 024610        JMP P6        YES.
0401   00577 060670        LDA E         NO.
0402   00600 014706        JSB OYNA      PRINT OUT
0403   00601 014733        JSB POUT2       ERROR CODE
0404   00602 060705        LDA SI4           AND
0405   00603 015003        JSB MPO             PROGRAM ADDRESS
0406   00604 060637        LDA IA                WHEN ERROR
0407   00605 015026        JSB OPA                 OCCURRED
0408   00606 014752        JSB EOL       LINE FEED
0409   00607 014752        JSB EOL       LINE FEED
0410   00610 060664   P6   LDA SI2       PRINT SECOND
0411   00611 014765        JSB SMPOC       BT MESSAGE
0412   00612 014522        JSB EBH       HALT AT ERROR BUFFER?
0413   00613 124304        JMP BT,I      NO.  EXIT ROUTINE
0414   00614 000000   POF  NOP
0415   00615 060614        LDA *-1       PUT PROGRAM ADDRSSS
0416   00616 064614        LDB *-2         FOR PRINT FAILURE
0417   00617 102055        HLT 55B           INTO A AND B
0418*
0419*ERROR BUFFER
0420*
0421   00620 000000   E1   OCT 0         SFC   TRUE AFTER    CLC 0,C
0422   00621 000000   E2   OCT 0         SFS FALSE AFTER     CLC 0,C
0423   00622 000000   E3   OCT 0         SFC FALSE AFTER     CLF TTY
0424   00623 000000   E4   OCT 0         SFS  TRUE AFTER     CLF TTY
0425   00624 000000   E5   OCT 0         SFC FALSE AFTER     CLF TTY AND STC
0426   00625 000000   E6   OCT 0         SFS  TRUE AFTER     CLF TTY AND STC
0427   00626 000000   E7   OCT 0         NO INTERRUPT AFTER  STC TTY,STF 0
0428   00627 000000   E10  OCT 0         SFC   TRUE AFTER INTERRUPT
0429   00630 000000   E11  OCT 0         SFS FALSE AFTER INTERRUPT
0430   00631 000000   E12  OCT 0         DATA CLOCK ON TTY BOARD TOO FAST
0431   00632 000000   E13  OCT 0         DATA CLOCK ON TTY BOARD TOO SLOW
0432   00633 000000   E14  OCT 0         DATA BUFFER ERROR
0433   00634 000000   E15  OCT 0         CLOCK ENABLE FLIP-FLOP SET
0434   00635 000000   E16  OCT 0         CLOCK ENABLE FLIP-FLOP NOT SET
0435   00636 000000   E17  OCT 0         ILLEGAL INTERRUPT FROM TELETYPE
0436   00637 000000   IA   OCT 0         PROGRAM ADDRESS AT TIME OF E17
0437   00640 177777        OCT 177777    ERROR BUFFER TERMINAITON
0438   00641 024124        JMP MP1       RETURN TO MAIN PROGRAM
0439*
0440   00642 041105   BTM1 ASC 8,BEGIN BASIC TEST
       00643 043511
       00644 047040
       00645 041101
       00646 051511
       00647 041440
       00650 052105
       00651 051524
0441   00652 000000        OCT 0
0442   00653 060642   SI1  LDA BTM1
0443   00654 042516   BTM2 ASC 7,END BASIC TEST
       00655 042040
       00656 041101
       00657 051511
       00660 041440
       00661 052105
       00662 051524
```

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0444    00663 000000          OCT 0
0445    00664 060654    SI2   LDA BTM2
0446    00665 177762    SC2   OCT 177762
0447    00666 000000    M16   OCT 0
0448    00667 064620    SI3   LDB E1
0449    00670 000305    E     OCT 305
0450    00671 020040    PRAD  ASC 11,   PROGRAM ADDRESS =
        00672 020120
        00673 051117
        00674 043522
        00675 040515
        00676 020101
        00677 042104
        00700 051105
        00701 051523
        00702 020075
        00703 020040
0451    00704 000000          OCT 0
0452    00705 060671    SI4   LDA PRAD
0453*
0454*PRINT LEAST SIGNIFICANT 8 BITS OF A.
0455*
0456    00706 000000    OYNA  NOP               ENTER SUBROUTINE
0457    00707 107700          CLC 0,C           INITIALIZE, INTERRUPT OFF
0458    00710 070731          STA AS3           STORE A
0459    00711 074732          STB BS1           STORE B
0460    00712 060727          LDA OYN           PUT BUFFER INTO OUTPUT
0461    00713 102600    OTA4  OTA 0                AND PRINT MODE
0462    00714 060731          LDA AS3           RESTORE A
0463    00715 010463          AND MSK2          OUTPUT LEAST
0464    00716 102600    OTA5  OTA 0               SIGNIFICANT 8
0465    00717 103700    STCC2 STC 0,C              BITS OF A
0466    00720 006400          CLB
0467    00721 014511          JSB TOS           FLAG SET?
0468    00722 024724          JMP *+2
0469    00723 014614          JSB POF           NO.  HALT AT ERROR BUFFER
0470    00724 060731          LDA AS3           YES.  RESTORE A
0471    00725 064732          LDB BS1           RESTORE B
0472    00726 124706          JMP OYNA,I        EXIT SUBROUTINE
0473    00727 120000    OYN   OCT 120000        OUTPUT,PRINT,NO PUNCH
0474    00730 120000    SOYN  OCT 120000
0475    00731 000000    AS3   OCT 0             TEMPORARY STORAGE
0476    00732 000000    BS1   OCT 0             TEMPORARY STORAGE
0477*
0478*PRINT OUT TWO OCTAL NUMBERS
0479*
0480    00733 000000    POUT2 NOP               ENTER SUBROUTINE
0481    00734 060001          LDA 1             OUTPUT
0482    00735 001100          ARS                  FIRST
0483    00736 001100          ARS                     NUMBER
0484    00737 001100          ARS
0485    00740 010751          AND MSK5
0486    00741 030750          IOR MSK4
0487    00742 014706          JSB OYNA
0488    00743 060001          LDA 1             OUTPUT
0489    00744 010751          AND MSK5             SECOND
0490    00745 030750          IOR MSK4               NUMBER
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0491  00746 014706        JSB OYNA
0492  00747 124733        JMP POUT2,I  EXIT SUBROUTINE
0493  00750 000260  MSK4  OCT 260
0494  00751 000007  MSK5  OCT 7
0495*
0496*END OF LINE SUBROUTINE
0497*
0498  00752 000000  EOL   NOP          ENTER SUBROUTINE
0499  00753 070762        STA AS4      STORE A
0500  00754 060763        LDA CR       CARRIAGE
0501  00755 014706        JSB OYNA       RETURN
0502  00756 060764        LDA LF       LINE
0503  00757 014706        JSB OYNA       FEED
0504  00760 060762        LDA AS4      RESTORE A
0505  00761 124752        JMP EOL,I    EXIT SUBROUTINE
0506  00762 000000  AS4   OCT 0        TEMPORARY STORAGE
0507  00763 000215  CR    OCT 215
0508  00764 000212  LF    OCT 212
0509*
0510*SUPPRESS MESSAGE PRINTOUT CHECK SUBROUTINE
0511*
0512  00765 000000  SMPOC NOP          ENTER SUBROUTINE
0513  00766 071002        STA AS5      STORE A
0514  00767 014145        JSB MODE     CHECK SW. REG.
0515  00770 060176        LDA BIT2     SUPPRESS EXCESS
0516  00771 002011        SLA,RSS        PRINTING?
0517  00772 024775        JMP *+3      NO.
0518  00773 061002        LDA AS5      YES.  RESTORE A
0519  00774 124765        JMP SMPOC,I  EXIT SUBROUTINE
0520  00775 061002        LDA AS5      RESTORE A
0521  00776 015003        JSB MPO      PRINT MESSAGE
0522  00777 014752        JSB EOL      LINE FEED
0523  01000 014752        JSB EOL      LINE FEED
0524  01001 124765        JMP SMPOC,I  EXIT SUBROUTINE
0525  01002 000000  AS5   OCT 0        TEMPORARY STORAGE
0526*
0527*MESSAGE PRINTOUT SUBROUTINE
0528*
0529  01003 000000  MPO   NOP          ENTER SUBROUTINE
0530  01004 071005        STA *+1
0531  01005 060000        LDA 0        LOAD A WORD
0532  01006 035005        ISZ *-1
0533  01007 002003        SZA,RSS      WORD = 0?
0534  01010 125003        JMP MPO,I    YES.  EXIT SUBROUTINE
0535  01011 015013        JSB PACO     NO.  PRINT THE WORD
0536  01012 025005        JMP *-5      REPEAT FOR NEXT WORD
0537*
0538*PACKED ASCII CHARACTER OUTPUT SUBROUTINE
0539*MOST SIGNIFICANT 8 BITS OF A REGISTER PRINTED FIRST.
0540*
0541  01013 000000  PACO  NOP          ENTER SUBROUTINE
0542  01014 071025        STA AS6      STORE A
0543  01015 001700        ALF          PRINT
0544  01016 001700        ALF            FIRST
0545  01017 010463        AND MSK2         CHARACTER
0546  01020 014706        JSB OYNA
0547  01021 061025        LDA AS6      PRINT
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0548   01022 010463           AND MSK2         SECOND
0549   01023 014706           JSB OYNA            CHARACTER
0550   01024 125013           JMP PACO,I       EXIT SUBROUTINE
0551   01025 000000   AS6     OCT 0            TEMPORARY STORAGE
0552*
0553*OCTAL PRINTOUT OF A
0554*
0555   01026 000000   OPA     NOP              ENTER SUBROUTINE
0556   01027 001200           RAL
0557   01030 071042           STA AS7          STORE A
0558   01031 011043           AND MSK6         PRINT
0559   01032 030750           IOR MSK4            FIRST
0560   01033 014706           JSB OYNA             NUMBER
0561   01034 015044           JSB NXT          PRINT
0562   01035 015044           JSB NXT            NEXT
0563   01036 015044           JSB NXT             FIVE
0564   01037 015044           J8B NXT               NUMBERS
0565   01040 015044           JSB NXT
0566   01041 125026           JMP OPA,I        EXIT SUBROUTINE
0567   01042 000000   AS7     OCT 0            TEMPORARY STORAGE
0568   01043 000001   MSK6    OCT 1
0569*
0570*NEXT OCTAL CHARACTER OUTPUT
0571*
0572   01044 000000   NXT     NOP              ENTER SUBROUTINE
0573   01045 061042           LDA AS7          PREPARE
0574   01046 001200           RAL                 THE
0575   01047 001200           RAL                   NEXT
0576   01050 001200           RAL                    NUMBER
0577   01051 071042           STA AS7                  FOR
0578   01052 010751           AND MSK5                   OUTPUTING
0579   01053 030750           IOR MSK4
0580   01054 014706           JSC OYNA         OUTPUT
0581   01055 125044           JMP NXT,I        EXIT SUBROUTINE
0582*
0583*
0584*
0585*PUNCH AND READ ROUTINE
0586*
0587*TESTS TAPE PUNCH AND TAPE READER
0588*BY OUTPUTING ALL COMBINATIONS OF
0589*EIGHT BITS AND READING THEM BACK.
0590*
0591   01056 000000   PAR     NOP              ENTER ROUTINE
0592   01057 107700           CLC 0,C          INITIALIZE, INTERRUPT OFF
0593   01060 006400           CLB
0594   01061 014511           JSB TOS          FLAG SET?
0595   01062 025064           JMP *+2          YES.
0596   01063 014614           JSB POF          NO.  HALT AT ERROR BUFFER
0597   01064 061250           LDA SI7          PRINT FIRST
0598   01065 014765           JSB SMPOC           PAR MESSAGE
0599   01066 061070           LDA *+2          HALT TO
0600   01067 065070           LDB *+1             TURN ON
0601   01070 102002           HLT 2                 PUNCH
0602   01071 061143           LDA CNY          PREPARE TO
0603   01072 070727           STA OYN             PUNCH TAPE
0604   01073 015264           JSB ZEROS        PUNCH LEADER
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0605   01074 003400        CCA            OUTPUT ALL ONES
0606   01075 010463        AND MSK2          AS A BEGINNING
0607   01076 014706        JSB OYNA             INDICATOR
0608   01077 002400        CLA            PUNCH
0609   01100 015274        JSB .64CH         ALL
0610   01101 015274        JSB .64CH            COMBINATIONS
0611   01102 061144        LDA OYY                 OF EIGHT
0612   01103 070727        STA OYN                   BITS
0613   01104 060762        LDA AS4
0614   01105 015274        JSB .64CH
0615   01106 015274        JSB .64CH
0616   01107 015264        JSB ZEROS         PUNCH
0617   01110 015264        JSB ZEROS            TRAILER
0618   01111 015264        JSB ZEROS
0619   01112 015151        JSB PARE          EXIT ROUTINE?
0620   01113 061115        LDA *+2           NO.  HALT TO
0621   01114 065115        LDB *+1              LOAD TAPE
0622   01115 102003        HLT 3                  INTO READER
0623   01116 061150        LDA INN           PREPARE TO
0624   01117 070727        STA OYN              READ
0625   01120 002400        CLA                     TAPE
0626   01121 014706        JSB OYNA          READ A
0627   01122 106500  LIB4  LIB 0                CHARACTER
0628   01123 006003        SZB,RSS           CHARACTER = 0?
0629   01124 025121        JMP *-3           YES.  READ NEXT CHARACTER
0630   01125 015305        JSB R64CH         NO.  READ FIRST BLOCK
0631   01126 061145        LDA IYN
0632   01127 070727        STA OYN
0633   01130 061341        LDA AS11
0634   01131 015305        JSB R64CH         READ SECOND BLOCK
0635   01132 061146        LDA INY
0636   01133 070727        STA OYN
0637   01134 061341        LDA AS11
0638   01135 015305        JSB R64CH         READ THIRD BLOCK
0639   01136 061147        LDA IYY
0640   01137 070727        STA OYN
0641   01140 061341        LDA AS11
0642   01141 015305        JSB R64CH         READ FOURTH BLOCK
0643   01142 025151        JMP P7            EXIT ROUTINE
0644   01143 110000  ONY   OCT 110000        OUTPUT,NO PRINT,PUNCH
0645   01144 130000  OYY   OCT 130000        OUTPUT,PRINT,PUNCH
0646   01145 160000  IYN   OCT 160000        INPUT,PRINT,NO PUNCH
0647   01146 150000  INY   OCT 150000        INPUT,NO PRINT,PUNCH
0648   01147 170000  IYY   OCT 170000        INPUT,PRINT,PUNCH
0649   01150 140000  INN   OCT 140000        INPUT, NO PRINT, NO PUNCH
0650*
0651*PUNCH AND READ EXIT SUBROUTINE
0652*
0653   01151 000000  PARE  NOP               ENTER SUBROUTINE
0654   01152 071167        STA ASR           STORE A
0655   01153 014145        JSB MODE          CHECK SW. REG.
0656   01154 060200        LDA BIT4          EXIT THIS
0657   01155 002011        SLA,RSS              ROUTINE?
0658   01156 025161        JMP *+3           YES.
0659   01157 061167        LDA ASR           NO.  RESTORE A
0660   01160 125151        JMP PARE,I        EXIT SUBROUTINE
0661   01161 060730  P7    LDA SOYN          RESTORE
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0662    01162 070727         STA OYN          OUTPUT CODE
0663    01163 014752         JSB EOL          LINE FEED
0664    01164 061263         LDA SI8          PRINT SECOND
0665    01165 014765         JSB SMPOC          PAR MESSAGE
0666    01166 125056         JMP PAR,I        EXIT ROUTINE
0667    01167 000000  AS8    OCT 0            TEMPORARY STORAGE
0668*
0669*PRINT OUT ERRORS ROUTINE
0670*
0671    01170 000000  POE    NOP              ENTER SUBROUTINE
0672    01171 071214         STA AS9          STORE A
0673    01172 060727         LDA OYN          SAVE
0674    01173 071215         STA AS10            STATE
0675    01174 060730         LDA SOYN
0676    01175 070727         STA OYN
0677    01176 014752         JSB EOL          LINE FEED
0678    01177 061224         LDA SI5          PRINT "OUTPUT ="
0679    01200 015003         JSB MPO
0680    01201 061214         LDA AS9          RESTORE A
0681    01202 015026         JSB OPA          PRINT OCTAL NUMBER
0682    01203 061234         LDA SI6          PRINT "INPUT ="
0683    01204 015003         JSB MPO
0684    01205 060001         LDA 1            PRINT OCTAL
0685    01206 015026         JSB OPA            NUMBER
0686    01207 014752         JSB EOL          LINE FEED
0687    01210 061215         LDA AS10         RESTORE
0688    01211 070727         STA OYN            STATE
0689    01212 061214         LDA AS9          RESTORE A
0690    01213 125170         JMP POE,I        EXIT SUBROUTINE
0691    01214 000000  AS9    OCT 0            TEMPORARY STORAGE
0692    01215 000000  AS10   OCT 0            TEMPORARY STORAGE
0693    01216 047525  00     ASC 5,OUTPUT =
        01217 052120
        01220 052524
        01221 020075
        01222 020040
0694    01223 000000         OCT 0
0695    01224 061216  SI5    LDA 00
0696    01225 020040  OI     ASC 6,    INPUT =
        01226 020040
        01227 044516
        01230 050125
        01231 052040
        01232 036440
0697    01233 000000         OCT 0
0698    01234 061225  SI6    LDA OI
0699    01235 041105  PARM1  ASC 10,BEGIN PUNCH AND READ
        01236 043511
        01237 047040
        01240 050125
        01241 047103
        01242 044040
        01243 040516
        01244 042040
        01245 051105
        01246 040504
0700    01247 000000         OCT 0
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0701   01250 061235   SI7    LDA PARM1
0702   01251 042516   PARM2  ASC 9,END PUNCH AND READ
       01252 042040
       01253 050125
       01254 047103
       01255 044040
       01256 040516
       01257 042040
       01260 051105
       01261 040504
0703   01262 000000          OCT 0
0704   01263 061251   SI8    LDA PARM2
0705*
0706*OUTPUT BLANK TAPE
0707*
0708   01264 000000   ZEROS  NOP            ENTER SUBROUTINE
0709   01265 002400          CLA
0710   01266 065273          LDB SC3
0711   01267 014706          JSB OYNA       OUTPUT ZERO
0712   01270 006006          INB,SZB        32 ZEROS?
0713   01271 025267          JMP *-2        NO.
0714   01272 125264          JMP ZEROS,I    YES.  EXIT SUBROUTINE
0715   01273 177740   SC3    OCT 177740
0716*
0717*INCREMENT AND OUTPUT A REG. 64 TIMES
0718*
0719   01274 000000   .64CH  NOP            ENTER SUBROUTINE
0720   01275 065304          LDB SC4        RESET COUNTER
0721   01276 014706          JSB OYNA       OUTPUT A
0722   01277 002004          INA            INCREMENT OUTPUT WORD
0723   01300 006006          INB,SZB        64 CHARACTERS?
0724   01301 025276          JMP *-3        NO.
0725   01302 014752          JSB EOL        YES.
0726   01303 125274          JMP .64CH,I    EXIT ROUTINE
0727   01304 177700   SC4    OCT 177700
0728*
0729*READ AND CHECK 64 CHARACTERS
0730*
0731   01305 000000   R64CH  NOP            ENTER SUBROUTINE
0732   01306 065304          LDB SC4        RESET
0733   01307 075340          STB M64           CHARACTER COUNTER
0734   01310 014706   P8     JSB OYNA       READ A
0735   01311 106500   LIB5   LIB 0             CHARACTER
0736   01312 015151          JSB PARE       EXIT ROUTINE?
0737   01313 050001          CPA 1          NO.  ERROR?
0738   01314 025316          JMP *+2        NO.
0739   01315 015170          JSB POE        YES.  PRINT OUT ERROR
0740   01316 002004          INA            INCREMENT REFERENCE
0741   01317 035340          ISZ M64        64 CHARACTERS?
0742   01320 025310          JMP P8         NO.
0743   01321 071341          STA AS11       YES.  STORE A
0744   01322 060763          LDA CR         CHECK FOR
0745   01323 014706          JSB OYNA          CARRIAGE
0746   01324 106500   LIB6   LIB 0             RETURN
0747   01325 050001          CPA 1          ERROR?
0748   01326 025330          JMP *+2        NO.
0749   01327 015170          JSB POE        YES.  PRINT OUT ERROR
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0750   01330 060764          LDA LF        CHECK FOR
0751   01331 014706          JSB OYNA        LINE
0752   01332 106500  LIB7    LIB 0            FEED
0753   01333 050001          CPA 1         ERROR?
0754   01334 025336          JMP *+2       NO.
0755   01335 015170          JSB POE       YES.  PRINT OUT ERROR
0756   01336 061341          LDA AS11      RESTORE A
0757   01337 125305          JMP R64CH,I   EXIT SUBROUTINE
0758   01340 177700  M64     OCT 177700
0759   01341 000000  AS11    OCT 0         TEMPORARY STORAGE
0760*
0761*
0762*
0763*PRINT AND KEYBOARD ROUTINE
0764*
0765   01342 000000  PAK     NOP           ENTER ROUTINE
0766   01343 107700          CLC 0,C       INITIALIZE, INTERRUPT OFF
0767   01344 060730          LDA SOYN      PREPARE
0768   01345 070727          STA OYN         TO PRINT
0769   01346 061423          LDA SI9       PRINT FIRST
0770   01347 014765          JSB SMPOC       PAK MESSAGE
0771   01350 015464          JSB PRALL     PRINT 64 ASCII CHARACTERS
0772   01351 015464          JSB PRALL     PRINT 64 ASCII CHARACTERS
0773   01352 014752          JSB EOL       LINE FEED
0774   01353 015372          JSB PAKE      EXIT ROUTINE?
0775   01354 061446          LDA SI10      NO.  PRINT SECOND
0776   01355 014765          JSB SMPOC       PAK MESSAGE
0777   01356 061150  P9      LDA INN       PREPARE TO READ
0778   01357 102600  OTA6    OTA 0           IN FROM KEYBOARD
0779   01360 015372  P10     JSB PAKE      EXIT ROUTINE?
0780   01361 103700  STCC3   STC 0,C       NO.  WAIT
0781   01362 006400          CLB             FOR INPUT
0782   01363 014511          JSB TOS       ANY INPUT?
0783   01364 025366          JMP *+2       YES.
0784   01365 025360          JMP P10       NO.
0785   01366 106500  LIB8    LIB 0         LOAD DATA INTO B
0786   01367 060001          LDA 1         PUT B INTO A
0787   01370 014706          JSB OYNA      OUTPUT A
0788   01371 025356          JMP P9        READ NEXT CHARACTER
0789*
0790*PRINT AND KEYBOARD EXIT
0791*
0792   01372 000000  PAKE    NOP           ENTER SUBROUTINE
0793   01373 071214          STA AS9       STORE A
0794   01374 014145          JSB MODE      CHECK SW. REG.
0795   01375 060291          LDA BIT5      EXIT THIS
0796   01376 002011          SLA,RSS         ROUTINE?
0797   01377 025402          JMP *+3       YES.
0798   01400 061214          LDA AS9       NO.  RESTORE A
0799   01401 125372          JMP PAKE,I    EXIT SUBROUTINE
0800   01402 014752          JSB EOL
0801   01403 061463          LDA SI11      PRINT THIRD
0802   01404 014765          JSB SMPOC       PAK MESSAGE
0803   01405 125342          JMP PAK,I     EXIT ROUTINE
0804   01406 041105  PAKM1   ASC 12,BEGIN PRINT AND KEYBOARD
       01407 043511
       01410 047240
```

```
       01411 050122
       01412 044516
       01413 052240
       01414 040516
       01415 042040
       01416 045505
       01417 054502
       01420 047501
       01421 051104
0805   01422 000000          OCT 0
0806   01423 061496   SI9    LDA PAKM1
0807   01424 052523   PAKM2  ASC 17,USE KEYBOARD SLOWLY (5 CHS./SEC.)
       01425 042440
       01426 045505
       01427 054502
       01430 047501
       01431 051104
       01432 020123
       01433 046117
       01434 053514
       01435 054440
       01436 624065
       01437 020103
       01440 044123
       01441 027057
       01442 051505
       01443 041456
       01444 024440
0808   01445 000000          OCT 0
0809   01446 061424   SI10   LDA PAKM2
0810   01447 042516   PAKM3  ASC 11,END PRINT AND KEYBUARD
       01450 042740
       01451 050122
       01452 044516
       01453 052040
       01454 040516
       01455 042040
       01456 045505
       01457 054502
       01460 047501
       01461 051104
0811   01462 000000          OCT 0
0812   01463 061447   SI11   LDA PAKM3
0813*
0814*PRINT ALL CHARACTERS SUBROUTINE
0815*
0816   01464 000000   PRALL  NOP          ENTER SUBROUTINE
0817   01465 061472          LDA SC5      PRINT FIRST
0818   01466 015474          JSB .32CH      LINE OF CHARACTERS
0819   01467 061473          LDA SC6      PRINT SECOND
0820   01470 015474          JSB .32CH      LINE OF CHARACTERS
0821   01471 125464          JMP PRALL,I   EXIT SUBROUTINE
0822   01472 000300   SC5    OCT 300
0823   01473 000240   SC6    OCT 240
0824*
0825*PRINT 32 CHARACTERS SUBROUTINE
0826*
```

```
0827   01474 000000   .32CH  NOP            ENTER SUBROUTINE
0828   01475 075506          STB BS2        STORE B
0829   01476 065273          LDB SC3        RESET COUNTER
0830   01477 014706          JSB OYNA       PRINT A
0831   01500 002004          INA            INCREMENT A
0832   01501 006006          INB,SZB        32 CHARACTERS?
0833   01502 025477          JMP *-3        NO, PRINT NEXT CHARACTER
0834   01503 014752          JSB EOL        YES. LINE FEED
0835   01504 065506          LDB BS2        RESTORE B
0836   01505 125474          JMP .32CH,I    EXIT SUBROUTINE
0837   01506 000000   BS2    OCT 0          TEMPORARY STORAGE
0838                         END
** NO ERRORS*
```

2115A/14A BUFFERED TELETYPE TEST

BINARY TAPE   - HP20420B

SOURCE TAPE   - HP 20474B

SOURCE LISTING - HP 20420BL

0001   ASMB,A,B,L
** NO ERRORS*

```
0001                    ASMB,A,B,L
0002*
0003*
0004*
0005*BUFFERED TELETYPE DIAGNOSTIC  2115/14  07/08/68
0006*
0007*
0008*
0009*STARTING OCTAL ADDRESS  =  100
0010****
0011*THE FOLLOWING SWITCH REGISTER SETTINGS
0012*ARE USED FOR PROGRAM CONTROL
0013*
0014*BIT  0 = 1  ->  HALT AT BEGINNING OF PROGRAM
0015*BIT  1 = 1  ->  HALT AT ERROR BUFFER
0016*BIT  2 = 1  ->  SUPPRESS MESSAGE PRINTOUT
0017*BIT  3 = 1  ->  PERFORM BASIC TEST ROUTINE
0018*BIT  4 = 1  ->  PERFORM PUNCH AND READ ROUTINE
0019*BIT  5 = 1  ->  PERFORM PRINT AND KEYBOARD ROUTINE
0020****
0021*
0022*
0023*MAIN PROGRAM
0024*
0025   00077                 ORG  77B
0026   00077 102000  END     HLT  0
0027   00100 107700          CLC  0,C          INITIALIZE, INTERRUPT OFF
0028   00101 102501          LIA  1            PUT TTY
0029   00102 010141          AND  MSK0            ADDRESS
0030   00103 070303          STA  BTA              INTO ALL I/O
0031   00104 014203          JSB  INIT               INSTRUCTIONS
0032   00105 064142          LDB  M67          PREPARE
0033   00106 060143          LDA  HIS            TRAP
0034   00107 070111          STA  *+2              FOR
0035   00110 060144          LDA  HI                ILLEGAL
0036   00111 070010          STA  10B                 INTERRUPT
0037   00112 034111          ISZ  *-1                    FROM
0038   00113 002004          INA                           ANOTHER
0039   00114 006006          INB,SZB                         DEVICE
0040   00115 024111          JMP  *-4
0041   00116 060407          LDA  IIJ          PREPARE ILLEGAL TTY
0042   00117 070000  STA1    STA  0              INTERRUPT TRAP
0043   00120 014752          JSB  EOL          LINE FEED
0044   00121 060123          LDA  *+2          HALT TO CHOOSE
0045   00122 064123          LDB  *+1            SWITCH REGISTER
0046   00123 102001          HLT  1                OPTIONS
0047   00124 014145  MP1     JSB  MODE         CHECK SW. REG.
0048   00125 060177          LDA  BIT3         PERFORM
0049   00126 000010          SLA               BASIC TEST?
0050   00127 014304          JSB  BT           YES,
0051   00130 014145          JSB  MODE         NO, CHECK SW. REG.
0052   00131 060200          LDA  BIT4         PERFORM
0053   00132 000010          SLA                 PUNCH AND READ?
0054   00133 015056          JSB  PAR          YES,
0055   00134 014145          JSB  MODE         NO, CHECK SW. REG.
0056   00135 060201          LDA  BIT5         PERFORM
0057   00136 000010          SLA                 PRINT AND KEYBOARD?
```

```
0058   00137 015342        JSB PAK        YES.
0059   00140 024124        JMP MP1        NO.
0060   00141 000077  MSKA  OCT 77
0061   00142 177711  M67   OCT 177711
0062   00143 070010  HIS   STA 10B
0063   00144 102010  HI    HLT 10B
0064*
0065*SWITCH REGISTER MONITORED
0066*FOR CURRENT OPERATING MODE
0067*
0068   00145 000000  MODE  NOP            ENTER SUBROUTINE
0069   00146 070173        STA AS0        STORE A
0070   00147 102501        LIA 1          EACH BIT
0071   00150 070174        STA BIT0         FROM THE
0072   00151 001300        RAR              SWITCH REGISTER
0073   00152 070175        STA BIT1          IS ROTATED
0074   00153 001300        RAR               INTO THE
0075   00154 070176        STA BIT2            LEAST SIGNIFICANT
0076   00155 001300        RAR                  POSITION AND
0077   00156 070177        STA BIT3              STORED IN THE
0078   00157 001300        RAR                    STORAGE LOCATION
0079   00160 070200        STA BIT4                BEARING ITS NAME
0080   00161 001300        RAR
0081   00162 070201        STA BIT5
0082   00163 060174        LDA BIT0       HALT AT BEGINNING
0083   00164 002011        SLA,RSS          OF PROGRAM?
0084   00165 024171        JMP *+4        NO.
0085   00166 060202        LDA HAD        YES.  LOAD A AND B
0086   00167 064202        LDB HAD          WITH 100
0087   00170 024377        JMP END            AND HALT
0088   00171 060173        LDA ASO        RESTORE A
0089   00172 124145        JMP MODE,I     EXIT SUBROUTINE
0090   00173 000000  ASO   OCT 0          TEMPORARY STORAGE
0091   00174 000000  BIT0  OCT 0
0092   00175 000000  BIT1  OCT 0
0093   00176 000000  BIT2  OCT 0
0094   00177 000000  BIT3  OCT 0
0095   00200 000000  BIT4  OCT 0
0096   00201 000000  BIT5  OCT 0
0097   00202 000100  HAD   OCT 100
0098*
0099*
0100*INITIALIZATION ROUTINE
0101*
0102*THIS ROUTINE ADDS THE BUFFERED TELETYPE ADDRESS TO
0103*ALL I/O INSTRUCTIONS.
0104*
0105*
0106   00203 000000  INIT  NOP            ENTER ROUTINE
0107   00204 107700        CLC 0,C        INITIALIZE, INTERRUPT OFF
0108   00205 014274        JSB ADIN       PUT TTY ADDRESS
0109   00206 102300        SFS 0            INTO SFS INSTRUCTIONS
0110   00207 070340        STA SFS1
0111   00210 070347        STA SFS2
0112   00211 070357        STA SFS3
0113   00212 070401        STA SFS4
0114   00213 070512        STA SFS5
```

```
0115    00214 014274        JSB ADIN        PUT TTY ADDRESS
0116    00215 102200        SFC 0             INTO SFC INSTRUCTIONS
0117    00216 070334        STA SFC1
0118    00217 070344        STA SFC2
0119    00220 070354        STA SFC3
0120    00221 070375        STA SFC4
0121    00222 014274        JSB ADIN        PUT TTY ADDRESS
0122    00223 102600        OTA 0             INTO OTA INSTRUCTIONS
0123    00224 070415        STA OTA1
0124    00225 070450        STA OTA2
0125    00226 070471        STA OTA3
0126    00227 070713        STA OTA4
0127    00230 070716        STA OTA5
0128    00231 071357        STA OTA6
0129    00232 014274        JSB ADIN        PUT TTY ADDRESS
0130    00233 103700        STC 0,C           INTO STC,C  INSTRUCTIONS
0131    00234 070417        STA STCC1
0132    00235 070717        STA STCC2
0133    00236 071361        STA STCC3
0134    00237 014274        JSB ADIN        PUT TTY ADDRESS
0135    00240 106700        CLC 0             INTO CLC INSTRUCTION
0136    00241 070420        STA CLC1
0137    00242 014274        JSB ADIN        PUT TTY ADDRESS
0138    00243 102700        STC 0             INTO STC INSTRUCTION
0139    00244 070353        STA STC1
0140    00245 070500        STA STC2
0141    00246 014274        JSB ADIN        PUT TTY ADDRESS
0142    00247 103100        CLF 0             INTO CLF INSTRUCTION
0143    00250 070343        STA CLF1
0144    00251 014274        JSB ADIN        PUT TTY ADDRESS
0145    00252 102100        STF 0             INTO STF INSTRUCTION
0146    00253 070366        STA STF1
0147    00254 014274        JSB ADIN        PUT TTY ADDRESS
0148    00255 106500        LIB 0             INTO LIB INSTRUCTIONS
0149    00256 070451        STA LIB1
0150    00257 070472        STA LIB2
0151    00260 070501        STA LIB3
0152    00261 071122        STA LIB4
0153    00262 071311        STA LIB5
0154    00263 071324        STA LIB6
0155    00264 071332        STA LIB7
0156    00265 071366        STA LIB8
0157    00266 014274        JSB ADIN        PUT TTY ADDRESS
0158    00267 070000        STA 0             INTO STA INSTRUCTIONS
0159    00270 070117        STA STA1
0160    00271 070364        STA STA2
0161    00272 070374        STA STA3
0162    00273 124203        JMP INIT,I       EXIT ROUTINE
0163*
0164*ADDRESS INCLUSION SUBROUTINE.
0165*THE BUFFERED TTY ADDRESS IS PUT INTO
0166*THE INSTRUCTION FOLLOWING JSB ADIN.
0167*
0168    00274 000000  ADIN  NOP             ENTER SUBROUTINE
0169    00275 160274        LDA ADIN,I       BRING I/O INSTRUCTION INTO A
0170    00276 010302        AND MSK1         ADD TTY ADDRESS
0171    00277 030303        IOR BTA           TO INSTRUCTION
```

```
0172   00300 034274        ISZ ADIN       EXIT
0173   00301 124274        JMP ADIN,I       SUBROUTINE
0174   00302 177700   MSK1  OCT 177700
0175   00303 000000   BTA   OCT 0          TTY ADDRESS STORAGE
0176*
0177*
0178*
0179*BASIC TEST ROUTINE
0180*
0181*THE FOLLOWING TESTS THE FLAG, CONTROL,
0182*AND INTERRUPT CIRCUITRY
0183*
0184   00304 000030   BT    NOP
0185   00305 107700         CLC 0,C        INITIALIZE, INTERRUPT OFF
0186   00306 060730         LDA SOYN       RESTORE
0187   00307 070727         STA OYN          OUTPUT CODE
0188   00310 060653         LDA SI1        PRINT FIRST
0189   00311 014765         JSB SMPOC        BT MESSAGE
0190   00312 006400         CLB            CLEAR
0191   00313 074620         STB E1           ERROR
0192   00314 074621         STB E2             BUFFER
0193   00315 074622         STB E3
0194   00316 074623         STB E4
0195   00317 074624         STB E5
0196   00320 074625         STB E6
0197   00321 074626         STB E7
0198   00322 074627         STB E10
0199   00323 074630         STB E11
0200   00324 074631         STB E12
0201   00325 074632         STB E13
0202   00326 074633         STB E14
0203   00327 074634         STB E15
0204   00330 074635         STB E16
0205   00331 074636         STB E17
0206   00332 074637         STB IA
0207   00333 006004         INB            INCREMENT ERROR CODE
0208   00334 102200   SFC1  SFC 0          FLAG CLEAR?
0209   00335 024337         JMP *+2          NO.
0210   00336 074620         STB E1           YES. ERROR 1
0211   00337 006004         INB              INCREMENT ERROR CODE
0212   00340 102300   SFS1  SFS 0          FLAG SET?
0213   00341 074621         STB E2           NO. ERROR 2
0214   00342 006004         INB              YES.
0215   00343 103100   CLF1  CLF 0          CLEAR FLAG
0216   00344 102200   SFC2  SFC 0          FLAG CLEAR?
0217   00345 074622         STB E3           NO. ERROR 3
0218   00346 006004         INB              YES.
0219   00347 102300   SFS2  SFS 0          FLAG SET?
0220   00350 024352         JMP *+2          NO.
0221   00351 074623         STB E4           YES. ERROR 4
0222   00352 006004         INB
0223   00353 102700   STC1  STC 0          SET CONTROL
0224   00354 102200   SFC3  SFC 0          FLAG CLEAR?
0225   00355 074624         STB E5           NO. ERROR 5
0226   00356 006004         INB              YES.
0227   00357 102300   SFS3  SFS 0          FLAG SET?
0228   00360 024362         JMP *+2          NO.
```

```
0229   00361 074625          STB E6          YES.   ERROR 6
0230   00362 006004          INR
0231   00363 060436          LDA IJ1         PREPARE TO TEST
0232   00364 070000   STA2   STA 0             INTERRUPT SYSTEM
0233   00365 102100          STF 0           TURN ON INTERRUPT SYSTEM
0234   00366 102100   STF1   STF 0           SET FLAG
0235   00367 000000          NOP             WAIT FOR
0236   00370 000000          NOP               INTERRUPT
0237   00371 074626          STB E7          NO INTERRUPT - ERROR 7
0238   00372 006004   P1     INB             INTERRUPT ENTRY
0239   00373 060407          LDA IIJ         RENEW ILLEGAL
0240   00374 070000   STA3   STA 0             INTERRUPT TRAP
0241   00375 102200   SFC4   SFC 0           FLAG CLEAR?
0242   00376 024400          JMP *+2            NO.
0243   00377 074627          STB E10            YES.   ERROR 10
0244   00400 006004          INB
0245   00401 102300   SFS4   SFS 0           FLAG SET?
0246   00402 074630          STB E11            NO.  ERROR 11
0247   00403 006004          INB                YES.
0248   00404 074410          STB ERNO        STORE ERROR CODE
0249   00405 024411          JMP TOUT
0250   00406 024372   IJ1    JMP P1
0251   00407 014533   IIJ    JSB ILINT
0252   00410 000000   ERNO   OCT 0           ERROR CODE STORAGE
0253*
0254*THE FOLLOWING TESTS THE TIME FOR OUTPUTING ONE CHARACTER.
0255*
0256   00411 000000   TOUT   NOP
0257   00412 107700          CLC 0,C         INITIALIZE, INTERRUPT OFF
0258   00413 102100          STF 0           INTERRUPT ON
0259   00414 060440          LDA ONN         PUT INTO OUTPUT, NO
0260   00415 102600   OTA1   OTA 0             PRINT, NO PUNCH MODE
0261   00416 064441          LDB TOC1        CHECK
0262   00417 103700   STCC1  STC 0,C           LOWER
0263   00420 106700   CLC1   CLC 0               TIME LIMIT
0264   00421 014511          JSB TOS         FLAG SET?
0265   00422 024424          JMP *+2         YES.  DATA CLOCK TOO FAST
0266   00423 024426          JMP *+3         NO.
0267   00424 064410          LDB ERNO        ERROR 12
0268   00425 074631          STB E12
0269   00426 034410          ISZ ERNO        INCREMENT ERROR CODE
0270   00427 000000          NOP             CHECK UPPER
0271   00430 064442          LDB TOC2          TIME LIMIT
0272   00431 014511          JSB TOS         FLAG SET?
0273   00432 024435          JMP *+3         YES.  TIMING OK
0274   00433 064410          LDB ERNO        NO.  DATA CLOCK TOO SLOW
0275   00434 074632          STB E13           ERROR 13
0276   00435 034410          ISZ ERNO        INCREMENT ERROR CODE
0277   00436 000000          NOP
0278   00437 024443          JMP DT
0279   00440 100000   ONN    OCT 100000      OUTPUT,NO PRINT, NO PUNCH
0280   00441 142000   TOC1   OCT 142000      TIMEOUT CONSTANT 1
0281   00442 176700   TOC2   OCT 176700      TIMEOUT CONSTANT 2
0282*
0283*THE FOLLOWING TESTS THE EIGHT BIT DATA BUFFER.
0284*
0285   00443 000000   DT     NOP
```

```
0286    00444 107700           CLC 0,C      INITIALIZE, INTERRUPT OFF
0287    00445 002400           CLA
0288    00446 070465    P2      STA CURWD    OUTPUT THE
0289    00447 010463           AND MSK2         CURRENT
0290    00450 102600    OTA2    OTA 0             WORD
0291    00451 106500    LIB1    LIB 0
0292    00452 050001           CPA 1        INPUT = OUTPUT ?
0293    00453 024456           JMP *+3      YES.
0294    00454 060410           LDA ERNO     NO.  ERROR 14
0295    00455 070633           STA E14
0296    00456 060465           LDA CURWD    INCREMENT
0297    00457 002006           INA,SZA          CURRENT WORD
0298    00460 024446           JMP P2
0299    00461 034410           ISZ ERNO     INCREMENT ERROR CODE
0300    00462 024467           JMP CET
0301    00463 000377    MSK2    OCT 377
0302    00464 000200    MSK3    OCT 200
0303    00465 000000    CURWD   OCT 0
0304    00466 000000    NBE     OCT 0
0305*
0306*THE FOLLOWING TESTS THE CLOCK ENABLE FLIP-FLOP
0307*
0308    00467 107700    CET     CLC 0,C      INITIALIZE, INTERRUPT OFF
0309    00470 060440           LDA ONN      PUT BUFFER INTO "OUTPUT, NO
0310    00471 102600    OTA3    OTA 0            PRINT, NO PUNCH" STATE
0311    00472 106500    LIB2    LIB 0        FLIP-FLOP
0312    00473 006021           SSB,RSS          SET?
0313    00474 024477           JMP *+3      NO.
0314    00475 060410           LDA ERNO     YES.  ERROR 15
0315    00476 070634           STA E15
0316    00477 034410           ISZ ERNO     INCREMENT ERROR CODE
0317    00500 102700    STC2    STC 0        SET FLIP-FLOP
0318    00501 106500    LIB3    LIB 0        FLIP-FLOP
0319    00502 006020           SSB              SET?
0320    00503 024506           JMP *+3      YES.
0321    00504 060410           LDA ERNO     NO.  ERROR 16
0322    00505 070635           STA E16
0323    00506 107700           CLC 0,C      INITIALIZE, INTERRUPT OFF
0324    00507 014522           JSB EBH      HALT AT ERROR BUFFER?
0325    00510 024545           JMP POUT     NO.
0326*
0327*FLAG TIMEOUT SUBROUTINE
0328*
0329*TIMEOUT CONSTANT IN B
0330*IF "FLAG" BEFORE TIMEOUT, EXIT TO TOS.  IF NOT,
0331*EXIT TO TOS + 1.  ONE ITERATION = 6.4 MICROSEC.
0332*
0333    00511 000000    TOS     NOP          ENTER SUBROUTINE
0334    00512 102300    SFS5    SFS 0        FLAG SET?
0335    00513 024515           JMP *+2
0336    00514 124511           JMP TOS,I     YES.  EXIT THROUGH TOS
0337    00515 006006           INB,SZB       NO.  TIMEOUT YET?
0338    00516 024512           JMP SFS5      NO.  REPEAT
0339    00517 034511           ISZ TOS       YES.  EXIT
0340    00520 000000           NOP               THROUGH
0341    00521 124511           JMP TOS,I          TOS + 1
0342*
```

```
0343*ERROR BUFFER HALT SUBROUTINE
0344*
0345    00522 000000    EBH   NOP            ENTER SUBROUTINE
0346    00523 070532          STA AS1        STORE A
0347    00524 014145          JSB MODE       CHECK SW. REG.
0348    00525 060175          LDA BIT1       HALT AT
0349    00526 000010          SLA              ERROR BUFFER?
0350    00527 014614          JSB POF        YES.
0351    00530 060532          LDA AS1        NO.  RESTORE A
0352    00531 124522          JMP EBH,I      EXIT SUBROUTINE
0353    00532 000000    AS1   OCT 0          TEMPORARY STORAGE
0354*
0355*ILLEGAL INTERRUPT SUBROUTINE
0356*
0357*FOR AN ILLEGAL TTY INTERRUPT, THE PROGRAM ADDRESS IS SAVED.
0358*
0359    00533 000000    ILINT NOP            ENTER SUBROUTINE
0360    00534 070543          STA AS2        STORE A
0361    00535 060533          LDA *-2        STORE PROGRAM ADDRESS
0362    00536 070637          STA IA
0363    00537 060544          LDA IE         STORE
0364    00540 070636          STA E17          ERROR 17
0365    00541 060543          LDA AS2        RESTORE A
0366    00542 124533          JMP ILINT,I    EXIT SUBROUTINE
0367    00543 000000    AS2   OCT 0          TEMPORARY STORAGE
0368    00544 000017    IE    OCT 17
0369*
0370*THE FOLLOWING PRINTS OUT THE RESULTS OF THE BASIC TEST.
0371*IN CASE OF FAILURE TO PRINT OUT, THE PROGRAM
0372*HALTS AT THE BEGINNING OF THE ERROR BUFFER.
0373*PRESSING "DISPLAY MEMORY" WILL SHOW WHICH ERRORS OCCURED.
0374*
0375    00545 000000    POUT  NOP
0376    00546 107700          CLC 0,C        INITIALIZE, INTERRUPT OFF
0377    00547 006400          CLB
0378    00550 014511          JSB TOS        FLAG SET?
0379    00551 024553          JMP *+2        YES.
0380    00552 014614          JSB POF        NO.  HALT AT ERROR BUFFER
0381    00553 060665          LDA SC2        PREPARE TO
0382    00554 070666          STA M16          PRINT OUT
0383    00555 060667          LDA S13            ERROR CODES
0384    00556 070557          STA P4
0385    00557 064620    P4    LDB E1         LOAD B WITH
0386    00560 034557          ISZ *-1          ERROR STORAGE
0387    00561 006002          SZB            ZERO?
0388    00562 024566          JMP *+4        NO.
0389    00563 034666          ISZ M16        YES.  PARTIALLY DONE?
0390    00564 024557          JMP P4         NO.
0391    00565 024574          JMP P5         YES.  CHECK INTERRUPT ERRORS
0392    00566 060670          LDA E          PRINT
0393    00567 014706          JSB OYNA         OUT
0394    00570 014733          JSB POUT2          ERROR
0395    00571 014752          JSB EOL              CODE
0396    00572 014522          JSB EBH        HALT AT ERROR BUFFER?
0397    00573 024563          JMP *-108      NO.
0398    00574 064636    P5    LDB E17        E17 = 0?
0399    00575 006003          SZB,RSS
```

```
0400    03576  024610           JMP  P6           YES.
0401    00577  060670           LDA  E            NO.
0402    00600  014706           JSB  OYNA         PRINT OUT
0403    00601  014733           JSB  POUT2          ERROR CODE
0404    00602  060705           LDA  SI4              AND
0405    00603  015003           JSB  MPO                PROGRAM ADDRESS
0406    00604  060637           LDA  IA                   WHEN ERROR
0407    00605  015026           JSB  OPA                    OCCURRED
0408    00606  014752           JSB  EOL          LINE FEED
0409    00607  014752           JSB  EOL          LINE FEED
0410    00610  060664     P6    LDA  SI2          PRINT SECOND
0411    00611  014765           JSB  SMPOC          BT MESSAGE
0412    00612  014522           JSB  EBH          HALT AT ERROR BUFFER?
0413    00613  124304           JMP  BT,I         NO.  EXIT ROUTINE
0414    00614  000000     POF   NOP
0415    00615  060614           LDA  *-1          PUT PROGRAM ADDRSSS
0416    00616  064614           LDB  *-2            FOR PRINT FAILURE
0417    00617  102055           HLT  55B              INTO A AND B
0418*
0419*ERROR BUFFER
0420*
0421    00620  000000     E1    OCT  0           SFC   TRUE AFTER    CLC 0,C
0422    00621  000000     E2    OCT  0           SFS FALSE AFTER    CLC 0,C
0423    00622  000000     E3    OCT  0           SFC FALSE AFTER    CLF TTY
0424    00623  000000     E4    OCT  0           SFS  TRUE AFTER    CLF TTY
0425    00624  000000     E5    OCT  0           SFC FALSE AFTER    CLF TTY AND STC
0426    00625  000000     E6    OCT  0           SFS  TRUE AFTER    CLF TTY AND STC
0427    00626  000000     E7    OCT  0           NO INTERRUPT AFTER  STC TTY,STF 0
0428    00627  000000     E10   OCT  0           SFC   TRUE AFTER INTERRUPT
0429    00630  000000     E11   OCT  0           SFS FALSE AFTER INTERRUPT
0430    00631  000000     E12   OCT  0           DATA CLOCK ON TTY BOARD TOO FAST
0431    00632  000000     E13   OCT  0           DATA CLOCK ON TTY BOARD TOO SLOW
0432    00633  000000     E14   OCT  0           DATA BUFFER ERROR
0433    00634  000000     E15   OCT  0           CLOCK ENABLE FLIP-FLOP SET
0434    00635  000000     E16   OCT  0           CLOCK ENABLE FLIP-FLOP NOT SET
0435    00636  000000     E17   OCT  0           ILLEGAL INTERRUPT FROM TELETYPE
0436    00637  000000     IA    OCT  0           PROGRAM ADDRESS AT TIME OF E17
0437    00640  177777           OCT  177777      ERROR BUFFER TERMINAITON
0438    00641  024124           JMP  MP1         RETURN TO MAIN PROGRAM
0439*
0440    00642  041105     BTM1  ASC  8,BEGIN BASIC TEST
        00643  043511
        00644  047240
        00645  041101
        00646  051511
        00647  041440
        00650  052105
        00651  051524
0441    00652  000000           OCT  0
0442    00653  060642     SI1   LDA  BTM1
0443    00654  042516     BTM2  ASC  7,END BASIC TEST
        00655  042040
        00656  041101
        00657  051511
        00660  041440
        00661  052105
        00662  051524
```

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0444   00663 000000          OCT 0
0445   00664 060654   SI2     LDA BTM2
0446   00665 177762   SC2     OCT 177762
0447   00666 000000   M16     OCT 0
0448   00667 064620   SI3     LDB E1
0449   00670 000305   E       OCT 305
0450   00671 020040   PRAD    ASC 11,   PROGRAM ADDRESS =
       00672 020120
       00673 051117
       00674 043522
       00675 040515
       00676 020101
       00677 042104
       00700 051105
       00701 051523
       00702 020075
       00703 020040
0451   00704 000000          OCT 0
0452   00705 060671   SI4     LDA PRAD
0453*
0454*PRINT LEAST SIGNIFICANT 8 BITS OF A.
0455*
0456   00706 000000   OYNA    NOP               ENTER SUBROUTINE
0457   00707 107700           CLC 0,C           INITIALIZE, INTERRUPT OFF
0458   00710 070731           STA AS3           STORE A
0459   00711 074732           STB BS1           STORE B
0460   00712 060727           LDA OYN           PUT BUFFER INTO OUTPUT
0461   00713 102600   OTA4    OTA 0                AND PRINT MODE
0462   00714 060731           LDA AS3           RESTORE A
0463   00715 010463           AND MSK2          OUTPUT LEAST
0464   00716 102600   OTA5    OTA 0                SIGNIFICANT 8
0465   00717 103700   STCC2   STC 0,C              BITS OF A
0466   00720 006400           CLB
0467   00721 014511           JSB TOS           FLAG SET?
0468   00722 024724           JMP *+2
0469   00723 014614           JSB POF           NO.  HALT AT ERROR BUFFER
0470   00724 060731           LDA AS3           YES.  RESTORE A
0471   00725 064732           LDB BS1           RESTORE B
0472   00726 124706           JMP OYNA,I        EXIT SUBROUTINE
0473   00727 120000   OYN     OCT 120000        OUTPUT,PRINT,NO PUNCH
0474   00730 120000   SOYN    OCT 120000
0475   00731 000000   AS3     OCT 0             TEMPORARY STORAGE
0476   00732 000000   BS1     OCT 0             TEMPORARY STORAGE
0477*
0478*PRINT OUT TWO OCTAL NUMBERS
0479*
0480   00733 000000   POUT2   NOP               ENTER SUBROUTINE
0481   00734 060001           LDA 1             OUTPUT
0482   00735 001100           ARS                  FIRST
0483   00736 001100           ARS                     NUMBER
0484   00737 001100           ARS
0485   00740 010751           AND MSK5
0486   00741 030750           IOR MSK4
0487   00742 014706           JSB OYNA
0488   00743 060001           LDA 1             OUTPUT
0489   00744 010751           AND MSK5             SECOND
0490   00745 030750           IOR MSK4                NUMBER
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0491   00746 014706          JSB OYNA
0492   00747 124733          JMP POUT2,I   EXIT SUBROUTINE
0493   00750 000260   MSK4   OCT 260
0494   00751 000007   MSK5   OCT 7
0495*
0496*END OF LINE SUBROUTINE
0497*
0498   00752 000000   EOL    NOP           ENTER SUBROUTINE
0499   00753 070762          STA AS4        STORE A
0500   00754 060763          LDA CR        CARRIAGE
0501   00755 014706          JSB OYNA         RETURN
0502   00756 060764          LDA LF        LINE
0503   00757 014706          JSB OYNA         FEED
0504   00760 060762          LDA AS4       RESTORE A
0505   00761 124752          JMP EOL,I     EXIT SUBROUTINE
0506   00762 000000   AS4    OCT 0         TEMPORARY STORAGE
0507   00763 000215   CR     OCT 215
0508   00764 000212   LF     OCT 212
0509*
0510*SUPPRESS MESSAGE PRINTOUT CHECK SUBROUTINE
0511*
0512   00765 000000   SMPOC  NOP           ENTER SUBROUTINE
0513   00766 071002          STA AS5        STORE A
0514   00767 014145          JSB MODE      CHECK SW. REG.
0515   00770 060176          LDA BIT2      SUPPRESS EXCESS
0516   00771 002011          SLA,RSS          PRINTING?
0517   00772 024775          JMP *+3       NO.
0518   00773 061002          LDA AS5       YES.  RESTORE A
0519   00774 124765          JMP SMPOC,I   EXIT SUBROUTINE
0520   00775 061002          LDA AS5       RESTORE A
0521   00776 015003          JSB MPO       PRINT MESSAGE
0522   00777 014752          JSB EOL       LINE FEED
0523   01000 014752          JSB EOL       LINE FEED
0524   01001 124765          JMP SMPOC,I   EXIT SUBROUTINE
0525   01002 000000   AS5    OCT 0         TEMPORARY STORAGE
0526*
0527*MESSAGE PRINTOUT SUBROUTINE
0528*
0529   01003 000000   MPO    NOP           ENTER SUBROUTINE
0530   01004 071005          STA *+1
0531   01005 060000          LDA 0         LOAD A WORD
0532   01006 035005          ISZ *-1
0533   01007 002003          SZA,RSS       WORD = 0?
0534   01010 125003          JMP MPO,I     YES.  EXIT SUBROUTINE
0535   01011 015013          JSB PACO      NO.  PRINT THE WORD
0536   01012 025005          JMP *-5       REPEAT FOR NEXT WORD
0537*
0538*PACKED ASCII CHARACTER OUTPUT SUBROUTINE
0539*MOST SIGNIFICANT 8 BITS OF A REGISTER PRINTED FIRST.
0540*
0541   01013 000000   PACO   NOP           ENTER SUBROUTINE
0542   01014 071025          STA AS6        STORE A
0543   01015 001700          ALF           PRINT
0544   01016 001700          ALF              FIRST
0545   01017 010463          AND MSK2            CHARACTER
0546   01020 014706          JSB OYNA
0547   01021 061025          LDA AS6        PRINT
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0548   01022 010453        AND MSK2        SECOND
0549   01023 014706        JSB OYNA          CHARACTER
0550   01024 125013        JMP PACO,I      EXIT SUBROUTINE
0551   01025 000000  AS6   OCT 0           TEMPORARY STORAGE
0552*
0553*OCTAL PRINTOUT OF A
0554*
0555   01026 000000  OPA   NOP             ENTER SUBROUTINE
0556   01027 001200        RAL
0557   01030 071042        STA AS7         STORE A
0558   01031 011043        AND MSK6        PRINT
0559   01032 030750        IOR MSK4          FIRST
0560   01033 014706        JSB OYNA            NUMBER
0561   01034 015044        JSB NXT         PRINT
0562   01035 015044        JSB NXT           NEXT
0563   01036 015044        JSB NXT             FIVE
0564   01037 015044        JSB NXT               NUMBERS
0565   01040 015044        JSB NXT
0566   01041 125026        JMP OPA,I       EXIT SUBROUTINE
0567   01042 000000  AS7   OCT 0           TEMPORARY STORAGE
0568   01043 000001  MSK6  OCT 1
0569*
0570*NEXT OCTAL CHARACTER OUTPUT
0571*
0572   01044 000000  NXT   NOP             ENTER SUBROUTINE
0573   01045 061042        LDA AS7         PREPARE
0574   01046 001200        RAL               THE
0575   01047 001200        RAL                 NEXT
0576   01050 001200        RAL                   NUMBER
0577   01051 071042        STA AS7                 FOR
0578   01052 010751        AND MSK5                  OUTPUTING
0579   01053 030750        IOR MSK4
0580   01054 014706        JSB OYNA        OUTPUT
0581   01055 125044        JMP NXT,I       EXIT SUBROUTINE
0582*
0583*
0584*
0585*PUNCH AND READ ROUTINE
0586*
0587*TESTS TAPE PUNCH AND TAPE READER
0588*BY OUTPUTING ALL COMBINATIONS OF
0589*EIGHT BITS AND READING THEM BACK.
0590*
0591   01056 000000  PAR   NOP             ENTER ROUTINE
0592   01057 107700        CLC 0,C         INITIALIZE, INTERRUPT OFF
0593   01060 006400        CLB
0594   01061 014511        JSB TOS         FLAG SET?
0595   01062 025064        JMP *+2         YES.
0596   01063 014614        JSB POF         NO.  HALT AT ERROR BUFFER
0597   01064 061250        LDA SI7         PRINT FIRST
0598   01065 014765        JSB SMPOC         PAR MESSAGE
0599   01066 061070        LDA *+2         HALT TO
0600   01067 065070        LDB *+1           TURN ON
0601   01070 102002        HLT 2               PUNCH
0602   01071 061143        LDA ONY         PREPARE TO
0603   01072 070727        STA OYN           PUNCH TAPE
0604   01073 015264        JSB ZEROS       PUNCH LEADER
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0605   01074 003400        CCA           OUTPUT ALL ONES
0606   01075 010463        AND MSK2        AS A BEGINNING
0607   01076 014706        JSB OYNA          INDICATOR
0608   01077 002400        CLA           PUNCH
0609   01100 015274        JSB .64CH       ALL
0610   01101 015274        JSB .64CH         COMBINATIONS
0611   01102 061144        LDA OYY             OF EIGHT
0612   01103 070727        STA OYN               BITS
0613   01104 060762        LDA AS4
0614   01105 015274        JSB .64CH
0615   01106 015274        JSB .64CH
0616   01107 015264        JSB ZEROS       PUNCH
0617   01110 015264        JSB ZEROS         TRAILER
0618   01111 015264        JSB ZEROS
0619   01112 015151        JSB PARE        EXIT ROUTINE?
0620   01113 061115        LDA *+2         NO.  HALT TO
0621   01114 065115        LDB *+1           LOAD TAPE
0622   01115 102003        HLT 3               INTO READER
0623   01116 061150        LDA INN         PREPARE TO
0624   01117 070727        STA OYN           READ
0625   01120 002400        CLA               TAPE
0626   01121 014706        JSB OYNA        READ A
0627   01122 106500  LIB4  LIB 0             CHARACTER
0628   01123 006003        SZB,RSS         CHARACTER = 0?
0629   01124 025121        JMP *-3         YES.  READ NEXT CHARACTER
0630   01125 015305        JSB R64CH       NO.  READ FIRST BLOCK
0631   01126 061145        LDA IYN
0632   01127 070727        STA OYN
0633   01130 061341        LDA AS11
0634   01131 015305        JSB R64CH       READ SECOND BLOCK
0635   01132 061146        LDA INY
0636   01133 070727        STA OYN
0637   01134 061341        LDA AS11
0638   01135 015305        JSB R64CH       READ THIRD BLOCK
0639   01136 061147        LDA IYY
0640   01137 070727        STA OYN
0641   01140 061341        LDA AS11
0642   01141 015305        JSB R64CH       READ FOURTH BLOCK
0643   01142 025161        JMP P7          EXIT ROUTINE
0644   01143 110000  ONY   OCT 110000      OUTPUT,NO PRINT,PUNCH
0645   01144 130000  OYY   OCT 130000      OUTPUT,PRINT,PUNCH
0646   01145 160000  IYN   OCT 160000      INPUT,PRINT,NO PUNCH
0647   01146 150000  INY   OCT 150000      INPUT,NO PRINT,PUNCH
0648   01147 170000  IYY   OCT 170000      INPUT,PRINT,PUNCH
0649   01150 140000  INN   OCT 140000      INPUT, NO PRINT, NO PUNCH
0650*
0651*PUNCH AND READ EXIT SUBROUTINE
0652*
0653   01151 000000  PARE  NOP             ENTER SUBROUTINE
0654   01152 071167        STA AS8         STORE A
0655   01153 014145        JSB MODE        CHECK SW. REG.
0656   01154 060200        LDA BIT4        EXIT THIS
0657   01155 002011        SLA,RSS           ROUTINE?
0658   01156 025161        JMP *+3         YES.
0659   01157 061167        LDA AS8         NO.  RESTORE A
0660   01160 125151        JMP PARE,I      EXIT SUBROUTINE
0661   01161 060730  P7    LDA SOYN        RESTORE
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0662    01162 078727           STA OYN          OUTPUT CODE
0663    01163 014752           JSB EOL          LINE FEED
0664    01164 061263           LDA SI8          PRINT SECOND
0665    01165 014765           JSB SMPOC         PAR MESSAGE
0666    01166 125056           JMP PAR,I        EXIT ROUTINE
0667    01167 000000    AS8    OCT 0            TEMPORARY STORAGE
0668*
0669*PRINT OUT ERRORS ROUTINE
0670*
0671    01170 000000    POE    NOP              ENTER SUBROUTINE
0672    01171 071214           STA AS9          STORE A
0673    01172 060727           LDA OYN          SAVE
0674    01173 071215           STA AS10            STATE
0675    01174 060730           LDA SOYN
0676    01175 070727           STA OYN
0677    01176 014752           JSB EOL          LINE FEED
0678    01177 061224           LDA SI5          PRINT "OUTPUT ="
0679    01200 015003           JSB MPO
0680    01201 061214           LDA AS9          RESTORE A
0681    01202 015026           JSB OPA          PRINT OCTAL NUMBER
0682    01203 061234           LDA SI6          PRINT "INPUT ="
0683    01204 015003           JSB MPO
0684    01205 060001           LDA 1            PRINT OCTAL
0685    01206 015026           JSB OPA             NUMBER
0686    01207 014752           JSB EOL          LINE FEED
0687    01210 061215           LDA AS10         RESTORE
0688    01211 070727           STA OYN             STATE
0689    01212 061214           LDA AS9          RESTORE A
0690    01213 125170           JMP POE,I        EXIT SUBROUTINE
0691    01214 000000    AS9    OCT 0            TEMPORARY STORAGE
0692    01215 000000    AS10   OCT 0            TEMPORARY STORAGE
0693    01216 047525    00     ASC 5,OUTPUT =
        01217 052120
        01220 052524
        01221 020075
        01222 020040
0694    01223 000000           OCT 0
0695    01224 061216    SI5    LDA 00
0696    01225 020040    OI     ASC 6,    INPUT =
        01226 020040
        01227 044516
        01230 050125
        01231 052040
        01232 036440
0697    01233 000000           OCT 0
0698    01234 061225    SI6    LDA OI
0699    01235 041105    PARM1  ASC 10,BEGIN PUNCH AND READ
        01236 043511
        01237 047040
        01240 050125
        01241 047103
        01242 044040
        01243 040516
        01244 042040
        01245 051105
        01246 040504
0700    01247 000000           OCT 0
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0701   01250 061235   SI7    LDA PARM1
0702   01251 042516   PARM2 ASC 9,END PUNCH AND READ
       01252 042040
       01253 050125
       01254 047103
       01255 044040
       01256 040516
       01257 042040
       01260 051105
       01261 040504
0703   01262 000000          OCT 0
0704   01263 061251   SI8    LDA PARM2
0705*
0706*OUTPUT BLANK TAPE
0707*
0708   01264 000000   ZEROS NOP          ENTER SUBROUTINE
0709   01265 002400          CLA
0710   01266 065273          LDB SC3
0711   01267 014706          JSB OYNA     OUTPUT ZERO
0712   01270 006006          INB,SZB      32 ZEROS?
0713   01271 025267          JMP *-2      NO.
0714   01272 125264          JMP ZEROS,I  YES.  EXIT SUBROUTINE
0715   01273 177740   SC3    OCT 177740
0716*
0717*INCREMENT AND OUTPUT A REG. 64 TIMES
0718*
0719   01274 000000   .64CH NOP          ENTER SUBROUTINE
0720   01275 065304          LDB SC4      RESET COUNTER
0721   01276 014706          JSB OYNA     OUTPUT A
0722   01277 002004          INA          INCREMENT OUTPUT WORD
0723   01300 006006          INB,SZB      64 CHARACTERS?
0724   01301 025276          JMP *-3      NO.
0725   01302 014752          JSB EOL      YES.
0726   01303 125274          JMP .64CH,I  EXIT ROUTINE
0727   01304 177700   SC4    OCT 177700
0728*
0729*READ AND CHECK 64 CHARACTERS
0730*
0731   01305 000000   R64CH NOP          ENTER SUBROUTINE
0732   01306 065304          LDB SC4      RESET
0733   01307 075340          STB M64        CHARACTER COUNTER
0734   01310 014706   P8     JSB OYNA     READ A
0735   01311 106500   LIB5   LIB 0          CHARACTER
0736   01312 015151          JSB PARE     EXIT ROUTINE?
0737   01313 050001          CPA 1        NO.  ERROR?
0738   01314 025316          JMP *+2      NO.
0739   01315 015170          JSB POE      YES.  PRINT OUT ERROR
0740   01316 002004          INA          INCREMENT REFERENCE
0741   01317 035340          ISZ M64      64 CHARACTERS?
0742   01320 025310          JMP P8       NO.
0743   01321 071341          STA AS11     YES.  STORE A
0744   01322 060763          LDA CR       CHECK FOR
0745   01323 014706          JSB OYNA       CARRIAGE
0746   01324 106500   LIB6   LIB 0          RETURN
0747   01325 050001          CPA 1        ERROR?
0748   01326 025330          JMP *+2      NO.
0749   01327 015170          JSB POE      YES.  PRINT OUT ERROR
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0750    01330  060764           LDA  LF         CHECK FOR
0751    01331  014706           JSB  OYNA          LINE
0752    01332  106500   LIB7    LIB  0                FEED
0753    01333  050001           CPA  1          ERROR?
0754    01334  025336           JMP  *+2        NO.
0755    01335  015170           JSB  POE        YES.  PRINT OUT ERROR
0756    01336  061341           LDA  AS11       RESTORE A
0757    01337  125305           JMP  R64CH,I    EXIT SUBROUTINE
0758    01340  177700   M64     OCT  177700
0759    01341  000000   AS11    OCT  0          TEMPORARY STORAGE
0760*
0761*
0762*
0763*PRINT AND KEYBOARD ROUTINE
0764*
0765    01342  000000   PAK     NOP             ENTER ROUTINE
0766    01343  107700           CLC  0,C        INITIALIZE, INTERRUPT OFF
0767    01344  060730           LDA  SOYN       PREPARE
0768    01345  070727           STA  OYN           TO PRINT
0769    01346  061423           LDA  SI9        PRINT FIRST
0770    01347  014765           JSB  SMPOC         PAK MESSAGE
0771    01350  015464           JSB  PRALL      PRINT 64 ASCII CHARACTERS
0772    01351  015464           JSB  PRALL      PRINT 64 ASCII CHARACTERS
0773    01352  014752           JSB  EOL        LINE FEED
0774    01353  015372           JSB  PAKE       EXIT ROUTINE?
0775    01354  061446           LDA  SI10       NO.  PRINT SECOND
0776    01355  014765           JSB  SMPOC         PAK MESSAGE
0777    01356  061150   P9      LDA  INN        PREPARE TO READ
0778    01357  102600   OTA6    OTA  0             IN FROM KEYBOARD
0779    01360  015372   P10     JSB  PAKE       EXIT ROUTINE?
0780    01361  103700   STCC3   STC  0,C        NO.  WAIT
0781    01362  006400           CLB                FOR INPUT
0782    01363  014511           JSB  TOS        ANY INPUT?
0783    01364  025366           JMP  *+2        YES.
0784    01365  025360           JMP  P10        NO.
0785    01366  106500   LIB8    LIB  0          LOAD DATA INTO B
0786    01367  060001           LDA  1          PUT B INTO A
0787    01370  014706           JSB  OYNA       OUTPUT A
0788    01371  025356           JMP  P9         READ NEXT CHARACTER
0789*
0790*PRINT AND KEYBOARD EXIT
0791*
0792    01372  000000   PAKE    NOP             ENTER SUBROUTINE
0793    01373  071214           STA  AS9        STORE A
0794    01374  014145           JSB  MODE       CHECK SW. REG.
0795    01375  060201           LDA  BIT5       EXIT THIS
0796    01376  002011           SLA,RSS            ROUTINE?
0797    01377  025402           JMP  *+3        YES.
0798    01400  061214           LDA  AS9        NO.  RESTORE A
0799    01401  125372           JMP  PAKE,I     EXIT SUBROUTINE
0800    01402  014752           JSB  EOL
0801    01403  061463           LDA  SI11       PRINT THIRD
0802    01404  014765           JSB  SMPOC         PAK MESSAGE
0803    01405  125342           JMP  PAK,I      EXIT ROUTINE
0804    01406  041105   PAKM1   ASC  12,BEGIN  PRINT AND KEYBOARD
        01407  043511
        01410  047040
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        01411 050122
        01412 044516
        01413 052040
        01414 040516
        01415 042040
        01416 045505
        01417 054502
        01420 047501
        01421 051104
0805    01422 000000          OCT 0
0806    01423 061406    SI9   LDA PAKM1
0807    01424 052523    PAKM2 ASC 17,USE KEYBOARD SLOWLY (5 CHS./SEC.)
        01425 042440
        01426 045505
        01427 054502
        01430 047501
        01431 051104
        01432 020123
        01433 046117
        01434 053514
        01435 054440
        01436 024065
        01437 020103
        01440 044123
        01441 027057
        01442 051505
        01443 041456
        01444 024440
0808    01445 000000          OCT 0
0809    01446 061424    SI10  LDA PAKM2
0810    01447 042516    PAKM3 ASC 11,END PRINT AND KEYBOARD
        01450 042040
        01451 050122
        01452 044516
        01453 052040
        01454 040516
        01455 042040
        01456 045505
        01457 054502
        01460 047501
        01461 051104
0811    01462 000000          OCT 0
0812    01463 061447    SI11  LDA PAKM3
0813*
0814*PRINT ALL CHARACTERS SUBROUTINE
0815*
0816    01464 000000    PRALL NOP             ENTER SUBROUTINE
0817    01465 061472          LDA SC5         PRINT FIRST
0818    01466 015474          JSB .32CH         LINE OF CHARACTERS
0819    01467 061473          LDA SC6         PRINT SECOND
0820    01470 015474          JSB .32CH         LINE OF CHARACTERS
0821    01471 125464          JMP PRALL,I   EXIT SUBROUTINE
0822    01472 000300    SC5   OCT 300
0823    01473 000240    SC6   OCT 240
0824*
0825*PRINT 32 CHARACTERS SUBROUTINE
0826*
```

```
0827   01474 000000   .32CH  NOP            ENTER SUBROUTINE
0828   01475 075506          STB BS2        STORE B
0829   01476 065273          LDB SC3        RESET COUNTER
0830   01477 014706          JSB OYNA       PRINT A
0831   01500 002004          INA            INCREMENT A
0832   01501 006006          INB,SZB        32 CHARACTERS?
0833   01502 025477          JMP *-3        NO, PRINT NEXT CHARACTER
0834   01503 014752          JSB EOL        YES, LINE FEED
0835   01504 065506          LDB BS2        RESTORE B
0836   01505 125474          JMP .32CH,I    EXIT SUBROUTINE
0837   01506 000000   BS2    OCT 0          TEMPORARY STORAGE
0838                         END
**   NO ERRORS*
```

2115A BUFFERED

TELETYPE TEST

Binary Tape   -   HP20420A

Source Listing-   HP20420AL

0001   ASMB,A,B,L
**   NO ERRORS*

```
0001                    ASMB,A,B,L
0002*
0003*
0004*
0005*BUFFERED TELETYPE DIAGNOSTIC
0006*
0007*
0008*
0009*STARTING OCTAL ADDRESS  =  100
0010****
0011*THE FOLLOWING SWITCH REGISTER SETTINGS
0012*ARE USED FOR PROGRAM CONTROL
0013*
0014*BIT    0 = 1    ->   HALT AT BEGINNING OF PROGRAM
0015*BIT    1 = 1    ->   HALT AT ERROR BUFFER
0016*BIT    2 = 1    ->   SUPPRESS MESSAGE PRINTOUT
0017*BIT    3 = 1    ->   PERFORM BASIC TEST ROUTINE
0018*BIT    4 = 1    ->   PERFORM PUNCH AND READ ROUTINE
0019*BIT    5 = 1    ->   PERFORM PRINT AND KEYBOARD ROUTINE
0020****
0021*
0022*
0023*MAIN PROGRAM
0024*
0025   00177                 ORG 77B
0026   00177 102000  END     HLT 0
0027   00100 107700          CLC 0,C           INITIALIZE, INTERRUPT OFF
0028   00101 102501          LIA 1             PUT TTY
0029   00102 010141          AND MSKB            ADDRESS
0030   00103 070277          STA BTA              INTO ALL I/O
0031   00104 014243          JSB INIT               INSTRUCTIONS
0032   00105 064142          LDB M67           PREPARE
0033   00106 060143          LDA HIS           TRAP
0034   00107 070111          STA *+2             FOR
0035   00110 060144          LDA HI               ILLEGAL
0036   00111 070010          STA 10B               INTERRUPT
0037   00112 034111          ISZ *-1                FROM
0038   00113 002004          INA                     ANOTHER
0039   00114 006006          INB,SZB                  DEVICE
0040   00115 024111          JMP *-4
0041   00116 064401          LDA III           PREPARE ILLEGAL TTY
0042   00117 070000  STA1    STA 0               INTERRUPT TRAP
0043   00120 014720          JSB EOL           LINE FEED
0044   00121 060123          LDA *+2           HALT TO CHOOSE
0045   00122 064123          LDB *+1             SWITCH REGISTER
0046   00123 102001          HLT 1                OPTIONS
0047   00124 014145  MP1     JSB MODE          CHECK SW. REG.
0048   00125 060177          LDA BIT3          PERFORM
0049   00126 000010          SLA                 BASIC TEST?
0050   00127 014300          JSB ET            YES.
0051   00130 014145          JSB MODE          NO.  CHECK SW. REG.
0052   00131 060200          LDA BIT4          PERFORM
0053   00132 000010          SLA                 PUNCH AND READ?
0054   00133 015024          JSB PAR           YES.
0055   00134 014145          JSB MODE          NO.  CHECK SW. REG.
0056   00135 060201          LDA BIT5          PERFORM
0057   00136 000010          SLA                 PRINT AND KEYBOARD?
```

```
0058   00137 015310          JSR PAK        YES.
0059   00140 024124          JMP MP1        NO.
0060   00141 000077   MSK0   OCT 77
0061   00142 177711   M67    OCT 177711
0062   00143 070310   HI5    STA 10B
0063   00144 102010   HI     HLT 10B
0064*
0065*SWITCH REGISTER MONITORED
0066*FOR CURRENT OPERATING MODE
0067*
0068   00145 000000   MODE   NOP            ENTER SUBROUTINE
0069   00146 070173          STA AS0        STORE A
0070   00147 102501          LIA 1          EACH BIT
0071   00150 070174          STA BIT0         FROM THE
0072   00151 001300          RAR               SWITCH REGISTER
0073   00152 070175          STA BIT1           IS ROTATED
0074   00153 001300          RAR                 INTO THE
0075   00154 070176          STA BIT2             LEAST SIGNIFICANT
0076   00155 001300          RAR                   POSITION AND
0077   00156 070177          STA BIT3               STORED IN THE
0078   00157 001300          RAR                     STORAGE LOCATION
0079   00160 070200          STA BIT4                 BEARING ITS NAME
0080   00161 001300          RAR
0081   00162 070201          STA BIT5
0082   00163 060174          LDA BIT0       HALT AT BEGINNING
0083   00164 002011          SLA,RSS          OF PROGRAM?
0084   00165 024171          JMP *+4        NO.
0085   00166 060202          LDA HAD         YES.  LOAD A AND B
0086   00167 064202          LDB HAD            WITH 100
0087   00170 024377          JMP END             AND HALT
0088   00171 060173          LDA AS0        RESTORE A
0089   00172 124145          JMP MODE,I     EXIT SUBROUTINE
0090   00173 000000   AS0    OCT 0          TEMPORARY STORAGE
0091   00174 000000   BIT0   OCT 0
0092   00175 000000   BIT1   OCT 0
0093   00176 000000   BIT2   OCT 0
0094   00177 000000   BIT3   OCT 0
0095   00200 000000   BIT4   OCT 0
0096   00201 000000   BIT5   OCT 0
0097   00202 000100   HAD    OCT 100
0098*
0099*
0100*INITIALIZATION ROUTINE
0101*
0102*THIS ROUTINE ADDS THE BUFFERED TELETYPE ADDRESS TO
0103*ALL I/O INSTRUCTIONS.
0104*
0105*
0106   00203 000000   INIT   NOP            ENTER ROUTINE
0107   00204 107700          CLC 0,C        INITIALIZE, INTERRUPT OFF
0108   00205 014270          JSR ADIN       PUT TTY ADDRESS
0109   00206 102300          SFS 0            INTO SFS INSTRUCTIONS
0110   00207 070332          STA SFS1
0111   00210 070341          STA SFS2
0112   00211 070351          STA SFS3
0113   00212 070373          STA SFS4
0114   00213 070452          STA SFS5
```

```
0115    00214 014270           JSB ADIN         PUT TTY ADDRESS
0116    00215 102200           SFC 0              INTO SFC INSTRUCTIONS
0117    00216 070326           STA SFC1
0118    00217 070336           STA SFC2
0119    00220 070346           STA SFC3
0120    00221 070367           STA SFC4
0121    00222 014270           JSB ADIN         PUT TTY ADDRESS
0122    00223 102600           OTA 0              INTO OTA INSTRUCTIONS
0123    00224 070407           STA OTA1
0124    00225 070442           STA OTA2
0125    00226 070661           STA OTA3
0126    00227 070664           STA OTA4
0127    00230 071325           STA OTA5
0128    00231 014270           JSB ADIN         PUT TTY ADDRESS
0129    00232 103700           STC 0,C            INTO STC,C  INSTRUCTIONS
0130    00233 070411           STA STCC1
0131    00234 070665           STA STCC2
0132    00235 071327           STA STCC3
0133    00236 014270           JSB ADIN         PUT TTY ADDRESS
0134    00237 106700           CLC 0              INTO CLC INSTRUCTION
0135    00240 070412           STA CLC1
0136    00241 014270           JSB ADIN         PUT TTY ADDRESS
0137    00242 102700           STC 0              INTO STC INSTRUCTION
0138    00243 070345           STA STC1
0139    00244 014270           JSB ADIN         PUT TTY ADDRESS
0140    00245 103100           CLF 0              INTO CLF INSTRUCTION
0141    00246 070335           STA CLF1
0142    00247 014270           JSB ADIN         PUT TTY ADDRESS
0143    00250 102100           STF 0              INTO STF INSTRUCTION
0144    00251 070360           STA STF1
0145    00252 014270           JSB ADIN         PUT TTY ADDRESS
0146    00253 105500           LIB 0              INTO LIB INSTRUCTIONS
0147    00254 070443           STA LIB1
0148    00255 071070           STA LIB2
0149    00256 071257           STA LIB3
0150    00257 071272           STA LIB4
0151    00260 071300           STA LIB5
0152    00261 071334           STA LIB6
0153    00262 014270           JSB ADIN         PUT TTY ADDRESS
0154    00263 070000           STA 0              INTO STA INSTRUCTIONS
0155    00264 070117           STA STA1
0156    00265 070356           STA STA2
0157    00266 070366           STA STA3
0158    00267 124243           JMP INIT,I   EXIT ROUTINE
0159*
0160*ADDRESS INCLUSION SUBROUTINE.
0161*THE BUFFERED TTY ADDRESS IS PUT INTO
0162*THE INSTRUCTION FOLLOWING JSB ADIN.
0163*
0164    00270 000000    ADIN   NOP              ENTER SUBROUTINE
0165    00271 160270           LDA ADIN,I   BRING I/O INSTRUCTION INTO A
0166    00272 010276           AND MSK1     ADD TTY ADDRESS
0167    00273 030277           IOR BTA          TO INSTRUCTION
0168    00274 034270           ISZ ADIN     EXIT
0169    00275 124270           JMP ADIN,I       SUBROUTINE
0170    00276 177700    MSK1   OCT 177700
0171    00277 000000    BTA    OCT 0        TTY ADDRESS STORAGE
```

-7-

```
0172*
0173*
0174*
0175*BASIC TEST ROUTINE
0176*
0177*THE FOLLOWING TESTS THE FLAG, CONTROL,
0178*AND INTERRUPT CIRCUITRY
0179*
0180   00300 000000   BT     NOP
0181   00301 107700          CLC 0,C       INITIALIZE, INTERRUPT OFF
0182   00302 060676          LDA SOYN      RESTORE
0183   00303 070675          STA OYN          OUTPUT CODE
0184   00304 060621          LDA SI1       PRINT FIRST
0185   00305 014733          JSB SMPOC        BT MESSAGE
0186   00306 006400          CLB           CLEAR
0187   00307 074570          STB E1           ERROR
0188   00310 074571          STB E2              BUFFER
0189   00311 074572          STB E3
0190   00312 074573          STB E4
0191   00313 074574          STB E5
0192   00314 074575          STB E6
0193   00315 074576          STB E7
0194   00316 074577          STB E10
0195   00317 074600          STB E11
0196   00320 074601          STB E12
0197   00321 074602          STB E13
0198   00322 074603          STB E14
0199   00323 074604          STB E15
0200   00324 074605          STB IA
0201   00325 006004          INB           INCREMENT ERROR CODE
0202   00326 102200   SFC1   SFC 0         FLAG CLEAR?
0203   00327 024331          JMP *+2          NO.
0204   00330 074570          STB E1           YES.  ERROR 1
0205   00331 006004          INB              INCREMENT ERROR CODE
0206   00332 102300   SFS1   SFS 0         FLAG SET?
0207   00333 074571          STB E2           NO.  ERROR 2
0208   00334 006004          INB              YES.
0209   00335 103100   CLF1   CLF 0         CLEAR FLAG
0210   00336 102200   SFC2   SFC 0         FLAG CLEAR?
0211   00337 074572          STB E3           NO.  ERROR 3
0212   00340 006004          INB              YES.
0213   00341 102300   SFS2   SFS 0         FLAG SET?
0214   00342 024344          JMP *+2          NO.
0215   00343 074573          STB E4           YES.  ERROR 4
0216   00344 006004          INB
0217   00345 102700   STC1   STC 0         SET CONTROL
0218   00346 102200   SFC3   SFC 0         FLAG CLEAR?
0219   00347 074574          STB E5           NO.  ERROR 5
0220   00350 006004          INB              YES.
0221   00351 102300   SFS3   SFS 0         FLAG SET?
0222   00352 024354          JMP *+2          NO.
0223   00353 074575          STB E6           YES.  ERROR 6
0224   00354 006004          INB
0225   00355 060400          LDA IJ1       PREPARE TO TEST
0226   00356 070000   STA2   STA 0            INTERRUPT SYSTEM
0227   00357 102100          STF 0         TURN ON INTERRUPT SYSTEM
0228   00360 102100   STF1   STF 0         SET FLAG
```

```
0229    00361  000000           NOP          WAIT FOR
0230    00362  000000           NOP            INTERRUPT
0231    00363  074576           STB E7       NO INTERRUPT - ERROR 7
0232    00364  006004    P1     INB          INTERRUPT ENTRY
0233    00365  060401           LDA IIJ      RENEW ILLEGAL
0234    00366  070000    STA3   STA 0          INTERRUPT TRAP
0235    00367  102200    SFC4   SFC 0        FLAG CLEAR?
0236    00370  024372           JMP *+2        NO.
0237    00371  074577           STB E10        YES.  ERROR 10
0238    00372  006004           INB
0239    00373  102300    SFS4   SFS 0        FLAG SET?
0240    00374  074600           STB E11        NO.  ERROR 11
0241    00375  006004           INB            YES.
0242    00376  074442           STB ERNO     STORE ERROR CODE
0243    00377  024443           JMP TOUT
0244    00400  024364    IJ1    JMP P1
0245    00401  014503    IIJ    JSB ILINT
0246    00402  000000    ERNO   OCT 0        ERROR CODE STORAGE
0247*
0248*THE FOLLOWING TESTS THE TIME FOR OUTPUTING ONE CHARACTER.
0249*
0250    00403  000000    TOUT   NOP
0251    00404  107700           CLC 0,C      INITIALIZE, INTERRUPT OFF
0252    00405  102100           STF 0        INTERRUPT ON
0253    00406  060432           LDA ONN      PUT INTO OUTPUT, NO
0254    00407  102600    OTA1   OTA 0          PRINT, NO PUNCH MODE
0255    00410  064433           LDB TOC1     CHECK
0256    00411  103700    STCC1  STC 0,C        LOWER
0257    00412  100700    CLC1   CLC 0            TIME LIMIT
0258    00413  014401           JSB TOS      FLAG SET?
0259    00414  024416           JMP *+2        YES.  DATA CLOCK TOO FAST
0260    00415  024420           JMP *+3        NO.
0261    00416  064442           LDB ERNO     ERROR 12
0262    00417  074641           STB E12
0263    00420  034442           ISZ ERNO     INCREMENT ERROR CODE
0264    00421  000000           NOP          CHECK UPPER
0265    00422  064434           LDB TOC2       TIME LIMIT
0266    00423  014401           JSB TOS      FLAG SET?
0267    00424  024427           JMP *+3        YES.  TIMING OK
0268    00425  064442           LDB ERNO     NO.  DATA CLOCK TOO SLOW
0269    00426  074602           STB E13          ERROR 13
0270    00427  034442           ISZ ERNO     INCREMENT ERROR CODE
0271    00430  000000           NOP
0272    00431  024435           JMP DT
0273    00432  100000    ONN    OCT 100000   OUTPUT,NO PRINT, NO PUNCH
0274    00433  142000    TOC1   OCT 142000   TIMEOUT CONSTANT 1
0275    00434  176700    TOC2   OCT 176700   TIMEOUT CONSTANT 2
0276*
0277*THE FOLLOWING TESTS THE EIGHT BIT DATA BUFFER.
0278*
0279    00435  000000    DT     NOP
0280    00436  107700           CLC 0,C      INITIALIZE, INTERRUPT OFF
0281    00437  002400           CLA
0282    00440  070457    P2     STA CURWD    OUTPUT THE
0283    00441  014455           AND MSK2       CURRENT
0284    00442  102600    OTA2   OTA 0           WORD
0285    00443  105500    LIB1   LIB 0
```

```
0286    00444 050001        CPA 1           INPUT = OUTPUT ?
0287    00445 024450        JMP P3          YES.
0288    00446 060402        LDA ERNO        NO.  ERROR 14
0289    00447 070603        STA E14
0290    00450 060457   P3   LDA CURWD       INCREMENT
0291    00451 002006        INA,SZA           CURRENT WORD
0292    00452 024440        JMP P2
0293    00453 014472        JSB EBH         HALT AT ERROR BUFFER?
0294    00454 024515        JMP FOUT        NO.
0295    00455 000377   MSK2 OCT 377
0296    00456 000200   MSK3 OCT 200
0297    00457 000000   CURWD OCT 0
0298    00460 000000   NBE  OCT 0
0299*
0300*FLAG TIMEOUT SUBROUTINE
0301*
0302*TIMEOUT CONSTANT IN B
0303*IF "FLAG" BEFORE TIMEOUT, EXIT TO TOS.  IF NOT,
0304*EXIT TO TOS + 1.  ONE ITERATION = 6.4 MICROSEC.
0305*
0306    00461 000000   TOS  NOP            ENTER SUBROUTINE
0307    00462 102300   SFS5 SFS 0          FLAG SET?
0308    00463 024465        JMP *+2
0309    00464 124461        JMP TOS,I       YES.  EXIT THROUGH TOS
0310    00465 006006        INB,SZB         NO.  TIMEOUT YET?
0311    00466 024462        JMP SFS5        NO.  REPEAT
0312    00467 034461        ISZ TOS         YES.  EXIT
0313    00470 000000        NOP               THROUGH
0314    00471 124461        JMP TOS,I          TOS + 1
0315*
0316*ERROR BUFFER HALT SUBROUTINE
0317*
0318    00472 000000   EBH  NOP            ENTER SUBROUTINE
0319    00473 070502        STA AS1         STORE A
0320    00474 014145        JSB MODE        CHECK SW. REG.
0321    00475 060175        LDA BIT1        HALT AT
0322    00476 000010        SLA               ERROR BUFFER?
0323    00477 014564        JSB POF         YES.
0324    00500 060502        LDA AS1         NO.  RESTORE A
0325    00501 124472        JMP EBH,I       EXIT SUBROUTINE
0326    00502 000000   AS1  OCT 0           TEMPORARY STORAGE
0327*
0328*ILLEGAL INTERRUPT SUBROUTINE
0329*
0330*FOR AN ILLEGAL TTY INTERRUPT, THE PROGRAM ADDRESS IS SAVED.
0331*
0332    00503 000000   ILINT NOP           ENTER SUBROUTINE
0333    00504 070513        STA AS2         STORE A
0334    00505 060513        LDA *-2         STORE PROGRAM ADDRESS
0335    00506 070605        STA IA
0336    00507 060514        LDA IE          STORE
0337    00510 070604        STA E15           ERROR 15
0338    00511 060513        LDA AS2         RESTORE A
0339    00512 124503        JMP ILINT,I     EXIT SUBROUTINE
0340    00513 000000   AS2  OCT 0           TEMPORARY STORAGE
0341    00514 000015   IE   OCT 15
0342*
```

0343*THE FOLLOWING PRINTS OUT THE RESULTS OF THE BASIC TEST.
0344*IN CASE OF FAILURE TO PRINT OUT, THE PROGRAM
0345*HALTS AT THE BEGINNING OF THE ERROR BUFFER.
0346*PRESSING "DISPLAY MEMORY" WILL SHOW WHICH ERRORS OCCURED.
0347*

```
0348   00515 000000   POUT   NOP
0349   00516 107700          CLC 0,C      INITIALIZE, INTERRUPT OFF
0350   00517 006400          CLB
0351   00520 014461          JSB TOS       FLAG SET?
0352   00521 024523          JMP *+2       YES.
0353   00522 014564          JSB POF       NO.  HALT AT ERROR BUFFER
0354   00523 060633          LDA SC2       PREPARE TO
0355   00524 070634          STA M14          PRINT OUT
0356   00525 060635          LDA S13             ERROR CODES
0357   00526 070527          STA P4
0358   00527 064570   P4     LDB E1        LOAD B WITH
0359   00530 034527          ISZ *-1          ERROR STORAGE
0360   00531 006202          SZB           ZERO?
0361   00532 024536          JMP *+4       NO.
0362   00533 034634          ISZ M14       YES.  PARTIALLY DONE?
0363   00534 024527          JMP P4        NO.
0364   00535 024544          JMP P5        YES.  CHECK INTERRUPT ERRORS
0365   00536 060636          LDA E         PRINT
0366   00537 014654          JSB OYNA         OUT
0367   00540 014701          JSB POUT2            ERROR
0368   00541 014720          JSB EOL               CODE
0369   00542 014472          JSB EBH       HALT AT ERROR BUFFER?
0370   00543 024533          JMP *-10B     NO.
0371   00544 064644   P5     LDB E15       E15 = 0?
0372   00545 006003          SZB,RSS
0373   00546 024560          JMP P6        YES.
0374   00547 060636          LDA E         NO.
0375   00550 014654          JSB OYNA      PRINT OUT
0376   00551 014701          JSB POUT2        ERROR CODE
0377   00552 060653          LDA S14             AND
0378   00553 014751          JSB PPO             PROGRAM ADDRESS
0379   00554 060635          LDA IA                WHEN ERROR
0380   00555 014774          JSB OPA                  OCCURRED
0381   00556 014720          JSB EOL       LINE FEED
0382   00557 014720          JSB EOL       LINE FEED
0383   00560 060632   P6     LDA S12       PRINT SECOND
0384   00561 014733          JSB SMPOC        BT MESSAGE
0385   00562 014472          JSB EBH       HALT AT ERROR BUFFER?
0386   00563 124300          JMP BT,I      NO.  EXIT ROUTINE
0387   00564 000000   POF    NOP
0388   00565 060564          LDA *-1       PUT PROGRAM ADDRSSS
0389   00566 064564          LDB *-2          FOR PRINT FAILURE
0390   00567 102055          HLT 55B             INTO A AND B
```

0391*
0392*ERROR BUFFER
0393*

```
0394   00570 000000   E1   OCT 0   SFC  TRUE AFTER   CLC 0,C
0395   00571 000000   E2   OCT 0   SFS FALSE AFTER   CLC 0,C
0396   00572 000000   E3   OCT 0   SFC FALSE AFTER   CLF TTY
0397   00573 000000   E4   OCT 0   SFS  TRUE AFTER   CLF TTY
0398   00574 000000   E5   OCT 0   SFC FALSE AFTER   CLF TTY AND STC
0399   00575 000000   E6   OCT 0   SFS  TRUE AFTER   CLF TTY AND STC
```

```
0400   00576 000000   E7     OCT 0        NO INTERRUPT AFTER  STC TTY,STF 0
0401   00577 000000   E10    OCT 0        SFC   TRUE AFTER INTERRUPT
0402   00600 000000   E11    OCT 0        SFS FALSE AFTER INTERRUPT
0403   00601 000000   E12    OCT 0        DATA CLOCK ON TTY BOARD TOO FAST
0404   00602 000000   E13    OCT 0        DATA CLOCK ON TTY BOARD TOO SLOW
0405   00603 000000   E14    OCT 0        DATA BUFFER ERROR
0406   00604 000000   E15    OCT 0        ILLEGAL INTERRUPT FROM TELETYPE
0407   00605 000000   IA     OCT 0        PROGRAM ADDRESS AT TIME OF E15
0408   00606 177777          OCT 177777   ERROR BUFFER TERMINAITON
0409   00607 024124          JMP MP1      RETURN TO MAIN PROGRAM
0410*
0411   00610 041105   BTM1   ASC 8,BEGIN BASIC TEST
       00611 043511
       00612 047040
       00613 041101
       00614 051511
       00615 041440
       00616 052105
       00617 051524
0412   00620 000000          OCT 0
0413   00621 060610   SI1    LDA BTM1
0414   00622 042516   BTM2   ASC 7,END BASIC TEST
       00623 042040
       00624 041101
       00625 051511
       00626 041440
       00627 052105
       00630 051524
0415   00631 000000          OCT 0
0416   00632 060622   SI2    LDA BTM2
0417   00633 177764   SC2    OCT 177764
0418   00634 000000   M14    OCT 0
0419   00635 064570   SI3    LDB E1
0420   00636 000305   E      OCT 305
0421   00637 020040   PRAD   ASC 11,    PROGRAM ADDRESS =
       00640 020120
       00641 051117
       00642 043522
       00643 040515
       00644 020101
       00645 042104
       00646 051105
       00647 051523
       00650 020075
       00651 020040
0422   00652 000000          OCT 0
0423   00653 060637   SI4    LDA PRAD
0424*
0425*PRINT LEAST SIGNIFICANT 8 BITS OF A.
0426*
0427   00654 000000   OYNA   NOP          ENTER SUBROUTINE
0428   00655 107700          CLC 0,C      INITIALIZE, INTERRUPT UFF
0429   00656 070677          STA AS3      STORE A
0430   00657 074700          STB BS1      STORE B
0431   00660 060675          LDA OYN      PUT BUFFER INTO OUTPUT
0432   00661 102600   OTA3   OTA 0           AND PRINT MODE
0433   00662 060677          LDA AS3      RESTORE A
```

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```
0434    00663  010455          AND  MSK2      OUTPUT LEAST
0435    00664  102500   OTA4   OTA  0           SIGNIFICANT 8
0436    00665  103700   STCC2  STC  0,C           BITS OF A
0437    00666  006400          CLA
0438    00667  014461          JSB  TOS       FLAG SET?
0439    00670  024672          JMP  *+2
0440    00671  014564          JSB  POF       NO.  HALT AT ERROR BUFFER
0441    00672  060677          LDA  AS3       YES.  RESTORE A
0442    00673  064700          LDB  BS1       RESTORE B
0443    00674  124654          JMP  OYNA,I    EXIT SUBROUTINE
0444    00675  120000   OYN    OCT  120000    OUTPUT,PRINT,NO PUNCH
0445    00676  120000   SOYN   OCT  120000
0446    00677  000000   AS3    OCT  0         TEMPORARY STORAGE
0447    00700  000000   BS1    OCT  0         TEMPORARY STORAGE
0448*
0449*PRINT OUT TWO OCTAL NUMBERS
0450*
0451    00701  000000   POUT2  NOP            ENTER SUBROUTINE
0452    00702  060001          LDA  1         OUTPUT
0453    00703  001100          ARS              FIRST
0454    00704  001100          ARS                NUMBER
0455    00705  001100          ARS
0456    00706  010717          AND  MSK5
0457    00707  030716          IOR  MSK4
0458    00710  014654          JSB  OYNA
0459    00711  060001          LDA  1         OUTPUT
0460    00712  010717          AND  MSK5        SECOND
0461    00713  030716          IOR  MSK4          NUMBER
0462    00714  014654          JSB  OYNA
0463    00715  124701          JMP  POUT2,I   EXIT SUBROUTINE
0464    00716  000260   MSK4   OCT  260
0465    00717  000007   MSK5   OCT  7
0466*
0467*END OF LINE SUBROUTINE
0468*
0469    00720  000000   EOL    NOP            ENTER SUBROUTINE
0470    00721  070730          STA  AS4       STORE A
0471    00722  060731          LDA  CR        CARRIAGE
0472    00723  014654          JSB  OYNA          RETURN
0473    00724  060732          LDA  LF        LINE
0474    00725  014654          JSB  OYNA          FEED
0475    00726  060730          LDA  AS4       RESTORE A
0476    00727  124720          JMP  EOL,I     EXIT SUBROUTINE
0477    00730  000000   AS4    OCT  0         TEMPORARY STORAGE
0478    00731  000215   CR     OCT  215
0479    00732  000212   LF     OCT  212
0480*
0481*SUPPRESS MESSAGE PRINTOUT CHECK SUBROUTINE
0482*
0483    00733  000000   SMPOC  NOP            ENTER SUBROUTINE
0484    00734  070750          STA  AS5       STORE A
0485    00735  014145          JSB  MODE      CHECK SW. REG.
0486    00736  060176          LDA  BIT2      SUPPRESS EXCESS
0487    00737  002011          SLA,RSS          PRINTING?
0488    00740  024743          JMP  *+3       NO.
0489    00741  060750          LDA  AS5       YES.  RESTORE A
0490    00742  124733          JMP  SMPOC,I   EXIT SUBROUTINE
```

```
0491  00743 060750         LDA AS5    RESTORE A
0492  00744 014751         JSB MPO    PRINT MESSAGE
0493  00745 014720         JSB EOL    LINE FEED
0494  00746 014720         JSB EOL    LINE FEED
0495  00747 124733         JMP SMPOC,I  EXIT SUBROUTINE
0496  00750 000000  AS5    OCT 0      TEMPORARY STORAGE
0497*
0498*MESSAGE PRINTOUT SUBROUTINE
0499*
0500  00751 000000  MPO    NOP        ENTER SUBROUTINE
0501  00752 070753         STA *+1
0502  00753 060000         LDA 0      LOAD A WORD
0503  00754 034753         ISZ *-1
0504  00755 002043         SZA,RSS    WORD = 0?
0505  00756 124751         JMP MPO,I   YES.  EXIT SUBROUTINE
0506  00757 014751         JSB PACO    NO.  PRINT THE WORD
0507  00760 024753         JMP *-5    REPEAT FOR NEXT WORD
0508*
0509*PACKED ASCII CHARACTER OUTPUT SUBROUTINE
0510*MOST SIGNIFICANT 8 BITS OF A REGISTER PRINTED FIRST.
0511*
0512  00761 000000  PACO   NOP        ENTER SUBROUTINE
0513  00762 072773         STA AS6    STORE A
0514  00763 001700         ALF        PRINT
0515  00764 001700         ALF          FIRST
0516  00765 010455         AND MSK2       CHARACTER
0517  00766 014654         JSB OYNA
0518  00767 060773         LDA AS6    PRINT
0519  00770 010455         AND MSK2     SECOND
0520  00771 014654         JSB OYNA       CHARACTER
0521  00772 124761         JMP PACO,I  EXIT SUBROUTINE
0522  00773 000000  AS6    OCT 0      TEMPORARY STORAGE
0523*
0524*OCTAL PRINTOUT OF A
0525*
0526  00774 000000  OPA    NOP        ENTER SUBROUTINE
0527  00775 001200         RAL
0528  00776 071010         STA AS7    STORE A
0529  00777 011011         AND MSK6   PRINT
0530  01000 030716         IOR MSK4     FIRST
0531  01001 014654         JSB OYNA       NUMBER
0532  01002 015012         JSB NXT    PRINT
0533  01003 015012         JSB NXT      NEXT
0534  01004 015012         JSB NXT        FIVE
0535  01005 015012         JSB NXT          NUMBERS
0536  01006 015012         JSB NXT
0537  01007 124774         JMP OPA,I   EXIT SUBROUTINE
0538  01010 000000  AS7    OCT 0      TEMPORARY STORAGE
0539  01011 000001  MSK6   OCT 1
0540*
0541*NEXT OCTAL CHARACTER OUTPUT
0542*
0543  01012 000000  NXT    NOP        ENTER SUBROUTINE
0544  01013 061010         LDA AS7    PREPARE
0545  01014 001200         RAL          THE
0546  01015 001200         RAL            NEXT
0547  01016 001200         RAL              NUMBER
```

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```
0548   01017 071010        STA AS7              FOR
0549   01020 010717        AND MSK5                OUTPUTING
0550   01021 030716        IOR MSK4
0551   01022 014654        JSR OYNA     OUTPUT
0552   01023 125012        JMP NXT,I    EXIT SUBROUTINE
0553*
0554*
0555*
0556*PUNCH AND READ ROUTINE
0557*
0558*TESTS TAPE PUNCH AND TAPE READER
0559*BY OUTPUTING ALL COMBINATIONS OF
0560*EIGHT BITS AND READING THEM BACK.
0561*
0562   01024 000000   PAR  NOP            ENTER ROUTINE
0563   01025 107700        CLC 0,C        INITIALIZE, INTERRUPT OFF
0564   01026 006400        CLR
0565   01027 014461        JSB TOS        FLAG SET?
0566   01030 025052        JMP *+2        YES.
0567   01031 014564        JSR POF        NO. HALT AT ERROR BUFFER
0568   01032 061216        LDA SI7        PRINT FIRST
0569   01033 014733        JSR SMPOC        PAR MESSAGE
0570   01034 061036        LDA *+2        HALT TO
0571   01035 065036        LDB *+1          TURN ON
0572   01036 102302        HLT 2              PUNCH
0573   01037 061111        LDA ONY        PREPARE TO
0574   01040 070675        STA OYN          PUNCH TAPE
0575   01041 015232        JSB ZEROS      PUNCH LEADER
0576   01042 003400        CCA            OUTPUT ALL ONES
0577   01043 010455        AND MSK2         AS A BEGINNING
0578   01044 014654        JSB OYNA           INDICATOR
0579   01045 002400        CLA            PUNCH
0580   01046 015242        JSB .64CH        ALL
0581   01047 015242        JSR .64CH          COMBINATIONS
0582   01050 061112        LDA OYY            OF EIGHT
0583   01051 070675        STA OYN              BITS
0584   01052 060730        LDA ASA
0585   01053 015242        JSB .64CH
0586   01054 015242        JSB .64CH
0587   01055 015232        ISR ZEROS      PUNCH
0588   01056 015232        JSR ZEROS        TRAILER
0589   01057 015232        JSB ZEROS
0590   01060 015117        JSR PARE       EXIT ROUTINE?
0591   01061 061063        LDA *+2        NO. HALT TO
0592   01062 065063        LDB *+1          LOAD TAPE
0593   01063 102303        HLT 3              INTO READER
0594   01064 061116        LDA INN        PREPARE TO
0595   01065 070675        STA OYN          READ
0596   01066 002400        CLA                TAPE
0597   01067 014654        JSB OYNA       READ A
0598   01070 106500   LIH2 LIB 0           CHARACTER
0599   01071 006303        SZB,RSS        CHARACTER = 0?
0600   01072 025067        JMP *-3        YES. READ NEXT CHARACTER
0601   01073 015253        JSB R64CH      NO. READ FIRST BLOCK
0602   01074 061113        LDA IYN
0603   01075 070675        STA OYN
0604   01076 061337        LDA AS11
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0605    01077 015253           JSB  R64CH      READ SECOND BLOCK
0606    01100 061114           LDA  INY
0607    01101 070675           STA  OYN
0608    01102 061307           LDA  AS11
0609    01103 015253           JSB  R64CH      READ THIRD BLOCK
0610    01104 061115           LDA  IYY
0611    01105 070675           STA  OYN
0612    01106 061307           LDA  AS11
0613    01107 015253           JSB  R64CH      READ FOURTH BLOCK
0614    01110 025127           JMP  P7         EXIT ROUTINE
0615    01111 110000    ONY    OCT  110000     OUTPUT,NO PRINT,PUNCH
0616    01112 130000    OYY    OCT  130000     OUTPUT,PRINT,PUNCH
0617    01113 160000    IYN    OCT  160000     INPUT,PRINT,NO PUNCH
0618    01114 150000    INY    OCT  150000     INPUT,NO PRINT,PUNCH
0619    01115 170000    IYY    OCT  170000     INPUT,PRINT,PUNCH
0620    01116 140000    INN    OCT  140000     INPUT, NO PRINT, NO PUNCH
0621*
0622*PUNCH AND READ EXIT SUBROUTINE
0623*
0624    01117 000000    PARE   NOP             ENTER SUBROUTINE
0625    01120 071135           STA  AS8        STORE A
0626    01121 014145           JSB  MODE       CHECK SW. REG.
0627    01122 060200           LDA  BIT4       EXIT THIS
0628    01123 002011           SLA,RSS             ROUTINE?
0629    01124 025127           JMP  *+3        YES.
0630    01125 061135           LDA  AS8        NO.  RESTORE A
0631    01126 125117           JMP  PARE,I     EXIT SUBROUTINE
0632    01127 060676    P7     LDA  SOYN       RESTORE
0633    01130 070675           STA  OYN            OUTPUT CODE
0634    01131 014720           JSB  EOL        LINE FEED
0635    01132 061231           LDA  S18        PRINT SECOND
0636    01133 014733           JSB  SMPOC          PAR MESSAGE
0637    01134 125024           JMP  PAR,I      EXIT ROUTINE
0638    01135 000000    AS8    OCT  0          TEMPORARY STORAGE
0639*
0640*PRINT OUT ERRORS ROUTINE
0641*
0642    01136 000000    POE    NOP             ENTER SUBROUTINE
0643    01137 071152           STA  AS9        STORE A
0644    01140 060675           LDA  OYN        SAVE
0645    01141 071153           STA  AS10           STATE
0646    01142 060676           LDA  SOYN
0647    01143 070675           STA  OYN
0648    01144 014720           JSB  EOL        LINE FEED
0649    01145 061172           LDA  S15        PRINT "OUTPUT ="
0650    01146 014751           JSB  MPO
0651    01147 061152           LDA  AS9        RESTORE A
0652    01150 014774           JSB  OPA        PRINT OCTAL NUMBER
0653    01151 061202           LDA  S16        PRINT "INPUT ="
0654    01152 014751           JSB  MPO
0655    01153 060001           LDA  1          PRINT OCTAL
0656    01154 014774           JSB  OPA            NUMBER
0657    01155 014720           JSB  EOL        LINE FEED
0658    01156 061153           LDA  AS10       RESTORE
0659    01157 070675           STA  OYN            STATE
0660    01160 061152           LDA  AS9        RESTORE A
0661    01161 125136           JMP  POE,I      EXIT SUBROUTINE
```

```
0662   01162 000000   AS9    OCT 0           TEMPORARY STORAGE
0663   01163 000000   AS10   OCT 0           TEMPORARY STORAGE
0664   01164 047525   OO     ASC 5,OUTPUT =
       01165 052120
       01166 052524
       01167 020075
       01170 020040
0665   01171 000000          OCT 0
0666   01172 061164   SI5    LDA OO
0667   01173 020040   OI     ASC 6,    INPUT =
       01174 020040
       01175 044516
       01176 050125
       01177 052040
       01200 036440
0668   01201 000000          OCT 0
0669   01202 061173   SI6    LDA OI
0670   01203 041105   PARM1  ASC 10,BEGIN PUNCH AND READ
       01204 043511
       01205 047040
       01206 050125
       01207 047103
       01210 044040
       01211 040516
       01212 042040
       01213 051105
       01214 040504
0671   01215 000000          OCT 0
0672   01216 061233   SI7    LDA PARM1
0673   01217 042516   PARM2  ASC 9,END PUNCH AND READ
       01220 042040
       01221 050125
       01222 047103
       01223 044040
       01224 040516
       01225 042040
       01226 051105
       01227 040504
0674   01230 000000          OCT 0
0675   01231 061217   SI8    LDA PARM2
0676*
0677*OUTPUT BLANK TAPE
0678*
0679   01232 000000   ZEROS  NOP           ENTER SUBROUTINE
0680   01233 002400          CLA
0681   01234 065241          LDB SC3
0682   01235 014654          JSB OYNA      OUTPUT ZERO
0683   01236 006206          INB,SZB       32 ZEROS?
0684   01237 025235          JMP *-2       NO.
0685   01240 125232          JMP ZEROS,I   YES.  EXIT SUBROUTINE
0686   01241 177740   SC3    OCT 177740
0687*
0688*INCREMENT AND OUTPUT A REG. 64 TIMES
0689*
0690   01242 000000   .64CH  NOP           ENTER SUBROUTINE
0691   01243 065252          LDB SC4       RESET COUNTER
0692   01244 014654          JSB OYNA      OUTPUT A
```

```
0693    01245 002004          INA                INCREMENT OUTPUT WORD
0694    01246 006006          INB,SZB            64 CHARACTERS?
0695    01247 025244          JMP *-3            NO.
0696    01250 014720          JSB EOL            YES.
0697    01251 125242          JMP .64CH,I        EXIT ROUTINE
0698    01252 177700    SC4   OCT 177700
0699*
0700*READ AND CHECK 64 CHARACTERS
0701*
0702    01253 000000    R64CH NOP                ENTER SUBROUTINE
0703    01254 065252          LDB SC4            RESET
0704    01255 075306          STB M64              CHARACTER COUNTER
0705    01256 014654    P8    JSB OYNA           READ A
0706    01257 106500    LIB3  LIB 0               CHARACTER
0707    01260 015117          JSB PARE           EXIT ROUTINE?
0708    01261 050001          CPA 1              NO. ERROR?
0709    01262 025264          JMP *+2            NO.
0710    01263 015136          JSB POE            YES.  PRINT OUT ERROR
0711    01264 002004          INA                INCREMENT REFERENCE
0712    01265 035306          ISZ M64            64 CHARACTERS?
0713    01266 025256          JMP P8             NO.
0714    01267 071307          STA AS11           YES.  STORE A
0715    01270 060731          LDA CR             CHECK FOR
0716    01271 014654          JSB OYNA             CARRIAGE
0717    01272 106500    LIB4  LIB 0                 RETURN
0718    01273 050001          CPA 1              ERROR?
0719    01274 025276          JMP *+2            NO.
0720    01275 015136          JSB POE            YES.  PRINT OUT ERROR
0721    01276 060732          LDA LF             CHECK FOR
0722    01277 014654          JSB OYNA             LINE
0723    01300 106500    LIB5  LIB 0                 FEED
0724    01301 050001          CPA 1              ERROR?
0725    01302 025304          JMP *+2            NO.
0726    01303 015136          JSB POE            YES.  PRINT OUT ERROR
0727    01304 061307          LDA AS11           RESTORE A
0728    01305 125253          JMP R64CH,I        EXIT SUBROUTINE
0729    01306 177700    M64   OCT 177700
0730    01307 000000    AS11  OCT 0              TEMPORARY STORAGE
0731*
0732*
0733*
0734*PRINT AND KEYBOARD ROUTINE
0735*
0736    01310 000000    PAK   NOP                ENTER ROUTINE
0737    01311 107700          CLC 0,C            INITIALIZE, INTERRUPT OFF
0738    01312 062676          LDA SOYN           PREPARE
0739    01313 072675          STA OYN              TO PRINT
0740    01314 061371          LDA SIO            PRINT FIRST
0741    01315 014733          JSB SMPOC            PAK MESSAGE
0742    01316 015432          JSB PRALL          PRINT 64 ASCII CHARACTERS
0743    01317 015432          JSB PRALL          PRINT 64 ASCII CHARACTERS
0744    01320 014720          JSB EOL            LINE FEED
0745    01321 015340          JSB PAKE           EXIT ROUTINE?
0746    01322 061414          LDA SI10           NO.  PRINT SECOND
0747    01323 014733          JSB SMPOC            PAK MESSAGE
0748    01324 061116    P9    LDA INN            PREPARE TO READ
0749    01325 102600    OTA5  OTA 0                IN FROM KEYBOARD
```

```
0750   01326 015340   P10    JSB PAKE      EXIT ROUTINE?
0751   01327 103700   STCC3  STC 0,C       NO.  WAIT
0752   01330 006400          CLB              FOR INPUT
0753   01331 014461          JSB TOS       ANY INPUT?
0754   01332 025334          JMP *+2       YES.
0755   01333 025326          JMP P10       NO.
0756   01334 106500   LIB6   LIB 0         LOAD DATA INTO B
0757   01335 060001          LDA 1         PUT B INTO A
0758   01336 014654          JSB OYNA      OUTPUT A
0759   01337 025324          JMP P9        READ NEXT CHARACTER
0760*
0761*PRINT AND KEYBOARD EXIT
0762*
0763   01340 000000   PAKE   NOP           ENTER SUBROUTINE
0764   01341 071162          STA ASQ       STORE A
0765   01342 014145          JSR MODE      CHECK SW. REG.
0766   01343 060201          LDA BIT5      EXIT THIS
0767   01344 002011          SLA,RSS          ROUTINE?
0768   01345 025350          JMP *+3       YES.
0769   01346 061162          LDA ASQ       NO.  RESTORE A
0770   01347 125340          JMP PAKE,I    EXIT SUBROUTINE
0771   01350 014720          JSB EOL
0772   01351 061431          LDA SI11      PRINT THIRD
0773   01352 014733          JSB SMPOC        PAK MESSAGE
0774   01353 125310          JMP PAK,I     EXIT ROUTINE
0775   01354 041105   PAKM1  ASC 12,BEGIN PRINT AND KEYBOARD
       01355 043511
       01356 047040
       01357 050122
       01360 044516
       01361 052040
       01362 040516
       01363 042340
       01364 045505
       01365 054502
       01366 047501
       01367 051104
0776   01370 000000          OCT 0
0777   01371 061354   SI9    LDA PAKM1
0778   01372 052523   PAKM2  ASC 17,USE KEYBOARD SLOWLY (5 CHS./SEC.)
       01373 042440
       01374 045505
       01375 054502
       01376 047501
       01377 051104
       01400 020123
       01401 046117
       01402 053514
       01403 054440
       01404 024065
       01405 020103
       01406 044123
       01407 027057
       01410 051505
       01411 041456
       01412 024440
0779   01413 000000          OCT 0
```

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0780    01414  061372    S110    LDA PAKM2
0781    01415  042516    PAKM3   ASC 11,END PRINT AND KEYBOARD
        01416  042040
        01417  050122
        01420  044516
        01421  052040
        01422  040516
        01423  042040
        01424  045505
        01425  054502
        01426  047501
        01427  051104
0782    01430  000300            OCT 0
0783    01431  061415    S111    LDA PAKM3
0784*
0785*PRINT ALL CHARACTERS SUBROUTINE
0786*
0787    01432  000000    PRALL   NOP             ENTER SUBROUTINE
0788    01433  061440            LDA SC5         PRINT FIRST
0789    01434  015442            JSB .32CH          LINE OF CHARACTERS
0790    01435  061441            LDA SC6         PRINT SECOND
0791    01436  015442            JSB .32CH          LINE OF CHARACTERS
0792    01437  125432            JMP PRALL,I     EXIT SUBROUTINE
0793    01440  000300    SC5     OCT 300
0794    01441  000240    SC6     OCT 240
0795*
0796*PRINT 32 CHARACTERS SUBROUTINE
0797*
0798    01442  000000    .32CH   NOP             ENTER SUBROUTINE
0799    01443  075454            STB BS2         STORE B
0800    01444  065241            LDB SC3         RESET COUNTER
0801    01445  014654            JSB DYNA        PRINT A
0802    01446  002004            INA             INCREMENT A
0803    01447  006006            INB,SZB         32 CHARACTERS?
0804    01450  025445            JMP *-3         NO. PRINT NEXT CHARACTER
0805    01451  014720            JSB EOL         YES. LINE FEED
0806    01452  065454            LDB BS2         RESTORE B
0807    01453  125442            JMP .32CH,I     EXIT SUBROUTINE
0808    01454  000000    BS2     OCT 0           TEMPORARY STORAGE
0809                             END
**   NO ERRORS*
```

2116A BUFFERED

TELEPRINTER TEST

Binary Tape   —   HP20417B

Source Listing—   HP20417BL

PAGE 0001

0001   ASMB,A,R,L
**   NO ERRORS*

```
0001                    ASMB,A,B,L
0002*
0003*
0004*
0005*BUFFERED TELETYPE DIAGNOSTIC
0006*
0007*
0008*
0009*STARTING OCTAL ADDRESS  =  100
0010****
0011*THE FOLLOWING SWITCH REGISTER SETTINGS
0012*ARE USED FOR PROGRAM CONTROL
0013*
0014*BIT   0 = 1   ->   HALT AT BEGINNING OF PROGRAM
0015*BIT   1 = 1   ->   HALT AT ERROR BUFFER
0016*BIT   2 = 1   ->   SUPPRESS MESSAGE PRINTOUT
0017*BIT   3 = 1   ->   PERFORM BASIC TEST ROUTINE
0018*BIT   4 = 1   ->   PERFORM PUNCH AND READ ROUTINE
0019*BIT   5 = 1   ->   PERFORM PRINT AND KEYBOARD ROUTINE
0020****
0021*
0022*
0023*MAIN PROGRAM
0024*
0025   00077                    ORG 77B
0026   00077 102000    END      HLT 0
0027   00100 107700             CLC 0,C        INITIALIZE, INTERRUPT OFF
0028   00101 102501             LIA 1          PUT TTY
0029   00102 010141             AND MSK0         ADDRESS
0030   00103 070277             STA BTA            INTO ALL I/O
0031   00104 014203             JSB INIT             INSTRUCTIONS
0032   00105 064142             LDB M67        PREPARE
0033   00106 062143             LDA HIS          TRAP
0034   00107 070111             STA *+2            FOR
0035   00110 060144             LDA HI               ILLEGAL
0036   00111 070010             STA 10B                INTERRUPT
0037   00112 034111             ISZ *-1                  FROM
0038   00113 002004             INA                        ANOTHER
0039   00114 006006             INB,SZB                      DEVICE
0040   00115 024111             JMP *-4
0041   00116 060001             LDA IIJ        PREPARE ILLEGAL TTY
0042   00117 070000    STA1     STA 0            INTERRUPT TRAP
0043   00120 014726             JSB FOL        LINE FEED
0044   00121 062123             LDA *+2        HALT TO CHOOSE
0045   00122 054123             LDB *+1          SWITCH REGISTER
0046   00123 102001             HLT 1              OPTIONS
0047   00124 014145    MP1      JSB MODE       CHECK SW. REG.
0048   00125 060177             LDA BITS       PERFORM
0049   00126 002010             SLA              BASIC TEST?
0050   00127 014310             JSB BT         YES.
0051   00130 014145             JSB MODE       NO.  CHECK SW. REG.
0052   00131 060200             LDA BIT4       PERFORM
0053   00132 002010             SLA              PUNCH AND READ?
0054   00133 015024             JSB PAR        YES.
0055   00134 014145             JSB MODE       NO.  CHECK SW. REG.
0056   00135 060201             LDA BIT5       PERFORM
0057   00136 002010             SLA              PRINT AND KEYBOARD?
```

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0058    00137 015310          JSB PAK      YES.
0059    00140 024124          JMP MP1      NO.
0060    00141 000077   MSK    OCT 77
0061    00142 177711   M67    OCT 177711
0062    00143 070010   HIS    STA 10B
0063    00144 102010   HI     HLT 10B
0064*
0065*SWITCH REGISTER MONITORED
0066*FOR CURRENT OPERATING MODE
0067*
0068    00145 000000   MODE   NOP          ENTER SUBROUTINE
0069    00146 070173          STA ASW      STORE A
0070    00147 102531          LIA 1        EACH BIT
0071    00150 070174          STA BIT0       FROM THE
0072    00151 001300          RAR            SWITCH REGISTER
0073    00152 070175          STA BIT1         IS ROTATED
0074    00153 001300          RAR              INTO THE
0075    00154 070176          STA BIT2          LEAST SIGNIFICANT
0076    00155 001300          RAR                POSITION AND
0077    00156 070177          STA BIT3            STORED IN THE
0078    00157 001300          RAR                  STORAGE LOCATION
0079    00160 070200          STA BIT4              BEARING ITS NAME
0080    00161 001300          RAR
0081    00162 070201          STA BIT5
0082    00163 060174          LDA BIT0     HALT AT BEGINNING
0083    00164 002011          SLA,RSS        OF PROGRAM?
0084    00165 024171          JMP *+3      NO.
0085    00166 060202          LDA HAD      YES.  LOAD A AND B
0086    00167 064202          LDB HAD        WITH 100
0087    00170 024077          JMP END          AND HALT
0088    00171 060173          LDA ASW      RESTORE A
0089    00172 124145          JMP MODE,I   EXIT SUBROUTINE
0090    00173 000000   ASW    OCT 0        TEMPORARY STORAGE
0091    00174 000000   BIT0   OCT 0
0092    00175 000000   BIT1   OCT 0
0093    00176 000000   BIT2   OCT 0
0094    00177 000000   BIT3   OCT 0
0095    00200 000000   BIT4   OCT 0
0096    00201 000000   BIT5   OCT 0
0097    00202 000100   HAD    OCT 100
0098*
0099*
0100*INITIALIZATION ROUTINE
0101*
0102*THIS ROUTINE ADDS THE BUFFERED TELETYPE ADDRESS TO
0103*ALL I/O INSTRUCTIONS.
0104*
0105*
0106    00203 000000   INIT   NOP          ENTER ROUTINE
0107    00204 107740          CLC 0,C      INITIALIZE, INTERRUPT OFF
0108    00205 014270          JSB ADIN     PUT TTY ADDRESS
0109    00206 162340          SFS 0          INTO SFS INSTRUCTIONS
0110    00207 070332          STA SFS1
0111    00210 070341          STA SFS2
0112    00211 070351          STA SFS3
0113    00212 070373          STA SFS4
0114    00213 070462          STA SFS5
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0115   00214  014270        JSB ADIN       PUT TTY ADDRESS
0116   00215  102200        SFC 0            INTO SFC INSTRUCTIONS
0117   00216  070326        STA SFC1
0118   00217  070336        STA SFC2
0119   00220  070346        STA SFC3
0120   00221  070357        STA SFC4
0121   00222  014270        JSB ADIN       PUT TTY ADDRESS
0122   00223  102600        OTA 0            INTO OTA INSTRUCTIONS
0123   00224  070437        STA OTA1
0124   00225  070442        STA OTA2
0125   00226  070561        STA OTA3
0126   00227  070664        STA OTA4
0127   00230  071325        STA OTA5
0128   00231  014270        JSB ADIN       PUT TTY ADDRESS
0129   00232  103700        STC 0,C          INTO STC,C  INSTRUCTIONS
0130   00233  070411        STA STCC1
0131   00234  070665        STA STCC2
0132   00235  071327        STA STCC3
0133   00236  014270        JSB ADIN       PUT TTY ADDRESS
0134   00237  106700        CLC 0            INTO CLC INSTRUCTION
0135   00240  070412        STA CLC1
0136   00241  014270        JSB ADIN       PUT TTY ADDRESS
0137   00242  102700        STC 0            INTO STC INSTRUCTION
0138   00243  070345        STA STC1
0139   00244  014270        JSB ADIN       PUT TTY ADDRESS
0140   00245  103100        CLF 0            INTO CLF INSTRUCTION
0141   00246  070335        STA CLF1
0142   00247  014270        JSB ADIN       PUT TTY ADDRESS
0143   00250  102100        STF 0            INTO STF INSTRUCTION
0144   00251  070360        STA STF1
0145   00252  014270        JSB ADIN       PUT TTY ADDRESS
0146   00253  106500        LIB 0            INTO LIB INSTRUCTIONS
0147   00254  070643        STA LIB1
0148   00255  071276        STA LIB2
0149   00256  071257        STA LIB3
0150   00257  071272        STA LIB4
0151   00260  071300        STA LIB5
0152   00261  071354        STA LIB6
0153   00262  014270        JSB ADIN       PUT TTY ADDRESS
0154   00263  070000        STA 0            INTO STA INSTRUCTIONS
0155   00264  070117        STA STA1
0156   00265  070356        STA STA2
0157   00266  070366        STA STA3
0158   00267  124243        JMP INIT,I     EXIT ROUTINE
0159*
0160*ADDRESS INCLUSION SUBROUTINE.
0161*THE BUFFERED TTY ADDRESS IS PUT INTO
0162*THE INSTRUCTION FOLLOWING JSB ADIN.
0163*
0164   00270  000000  ADIN  NOP            ENTER SUBROUTINE
0165   00271  160270        LDA ADIN,I     BRING I/O INSTRUCTION INTO A
0166   00272  010276        AND MSK1       ADD TTY ADDRESS
0167   00273  050277        IOR BTA          TO INSTRUCTION
0168   00274  050270        ISZ ADIN       EXIT
0169   00275  124270        JMP ADIN,I       SUBROUTINE
0170   00276  177700  MSK1  OCT 177700
0171   00277  000000  BTA   OCT 0          TTY ADDRESS STORAGE
```

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0172*
0173*
0174*
0175*BASIC TEST ROUTINE
0176*
0177*THE FOLLOWING TESTS THE FLAG, CONTROL,
0178*AND INTERRUPT CIRCUITRY
0179*
0180   00500 000400    BT     NOP
0181   00501 107700           CLC 0,C       INITIALIZE, INTERRUPT OFF
0182   00502 060576           LDA SOVN      RESTORE
0183   00503 070675           STA OVN          OUTPUT CODE
0184   00504 060621           LDA SI1       PRINT FIRST
0185   00505 014733           JSB SMPOC        BT MESSAGE
0186   00506 006400           CLA           CLEAR
0187   00507 074570           STA E1           ERROR
0188   00510 074571           STA E2             BUFFER
0189   00511 074572           STA E3
0190   00512 074573           STA E4
0191   00513 074574           STA E5
0192   00514 074575           STA E6
0193   00515 074576           STA E7
0194   00516 074577           STA E10
0195   00517 074600           STA E11
0196   00520 074601           STA E12
0197   00521 074602           STA E13
0198   00522 074603           STA E14
0199   00523 074604           STA E15
0200   00524 074605           STA IA
0201   00525 006044           INA           INCREMENT ERROR CODE
0202   00526 102200    SFC1   SFC 0         FLAG CLEAR?
0203   00527 024331           JMP *+2          NO.
0204   00530 074570           STA E1           YES,  ERROR 1
0205   00531 006044           INA              INCREMENT ERROR CODE
0206   00532 102300    SFS1   SFS 0         FLAG SET?
0207   00533 074571           STA E2           NO,  ERROR 2
0208   00534 006044           INA              YES.
0209   00535 105140    CLF1   CLF 0         CLEAR FLAG
0210   00536 102230    SFC2   SFC 0         FLAG CLEAR?
0211   00537 074572           STA E3           NO,  ERROR 3
0212   00540 006044           INA              YES.
0213   00541 102300    SFS2   SFS 0         FLAG SET?
0214   00542 024344           JMP *+2          NO.
0215   00543 074573           STA E4           YES,  ERROR 4
0216   00544 006044           INA
0217   00545 102700    STC1   STC 0         SET CONTROL
0218   00546 102200    SFC3   SFC 0         FLAG CLEAR?
0219   00547 074574           STA E5           NO, ERROR 5
0220   00550 006044           INA              YES.
0221   00551 102300    SFS3   SFS 0         FLAG SET?
0222   00552 024354           JMP *+2          NO.
0223   00553 074575           STA E6           YES.  ERROR 6
0224   00554 006044           INA
0225   00555 060400           LDA IJ1       PREPARE TO TEST
0226   00556 070000    STA2   STA 0            INTERRUPT SYSTEM
0227   00557 102100           STF 0         TURN ON INTERRUPT SYSTEM
0228   00560 102100    STF1   STF 0         SET FLAG
```

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0229   00361  000000          NOP         WAIT FOR
0230   00362  000000          NOP            INTERRUPT
0231   00363  074576          STH E7      NO INTERRUPT - ERROR 7
0232   00364  006244   PI     INB         INTERRUPT ENTRY
0233   00365  064411          LDA IIJ     RENEW ILLEGAL
0234   00366  074403   STA3   STA 0          INTERRUPT TRAP
0235   00367  102200   SFC4   SFC 0       FLAG CLEAR?
0236   00370  024372          JMP *+2        NO.
0237   00371  074577          STH F10        YES.  ERROR 10
0238   00372  006004          INB
0239   00373  102300   SFS4   SFS 0       FLAG SET?
0240   00374  074600          STH E11        NO.  ERROR 11
0241   00375  006004          INB            YES.
0242   00376  074412          STB ERNO    STORE ERROR CODE
0243   00377  024443          JMP TOUT
0244   00400  024304   IJI    JMP PI
0245   00401  014543   IIJ    JSB ILINT
0246   00402  000000   ERNO   OCT 0       ERROR CODE STORAGE
0247*
0248*THE FOLLOWING TESTS THE TIME FOR OUTPUTING ONE CHARACTER.
0249*
0250   00403  000000   TOUT   NOP
0251   00404  107700          CLC 0,C     INITIALIZE, INTERRUPT OFF
0252   00405  102100          STF 0       INTERRUPT ON
0253   00406  064432          LDA ONN     PUT INTO OUTPUT, NO
0254   00407  102500   OTA1   OTA 0          PRINT, NO PUNCH MODE
0255   00410  064433          LDB TOC1    CHECK
0256   00411  103700   STOC1  STC 0,C        LOWER
0257   00412  106700   CLC1   CLC 0           TIME LIMIT
0258   00413  014451          JSB TOS     FLAG SET?
0259   00414  024416          JMP *+2     YES.  DATA CLOCK TOO FAST
0260   00415  024420          JMP *+3     NO.
0261   00416  064442          LDB ERNO    ERROR 12
0262   00417  074561          STB E12
0263   00420  034442          ISZ ERNO    INCREMENT ERROR CODE
0264   00421  000000          NOP         CHECK UPPER
0265   00422  064434          LDB TOC2       TIME LIMIT
0266   00423  014461          JSB TOS     FLAG SET?
0267   00424  024427          JMP *+3     YES.  TIMING OK
0268   00425  064442          LDB ERNO    NO.  DATA CLOCK TOO SLOW
0269   00426  074562          STB E13        ERROR 13
0270   00427  034442          ISZ ERNO    INCREMENT ERROR CODE
0271   00430  000000          NOP
0272   00431  024435          JMP DT
0273   00432  100000   ONN    OCT 100000  OUTPUT,NO PRINT, NO PUNCH
0274   00433  150000   TOC1   OCT 150000  TIMEOUT CONSTANT 1
0275   00434  177040   TOC2   OCT 177040  TIMEOUT CONSTANT 2
0276*
0277*THE FOLLOWING TESTS THE EIGHT BIT DATA BUFFER.
0278*
0279   00435  000000   DT     NOP
0280   00436  107700          CLC 0,C     INITIALIZE, INTERRUPT OFF
0281   00437  002400          CLA
0282   00440  070457   D2     STA CURWD   OUTPUT THE
0283   00441  010455          AND MSK2       CURRENT
0284   00442  102502   OTA2   OTA 0          WORD
0285   00443  105500   LIB1   LIB 0
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```
0286   00444  050001         CPA  1         INPUT = OUTPUT ?
0287   00445  024450         JMP  P3        YES.
0288   00446  060402         LDA  ERNO      NO.  ERROR 14
0289   00447  070603         STA  E14
0290   00450  060457   P3    LDA  CURWD     INCREMENT
0291   00451  002006         INA,SZA          CURRENT WORD
0292   00452  024440         JMP  P2
0293   00453  014472         JSB  EBH       HALT AT ERROR BUFFER?
0294   00454  024515         JMP  POUT      NO.
0295   00455  000377   MSK2  OCT  377
0296   00456  000200   MSK3  OCT  200
0297   00457  000000   CURWD OCT  0
0298   00460  000000   NBE   OCT  0
0299*
0300*FLAG TIMEOUT SUBROUTINE
0301*
0302*TIMEOUT CONSTANT IN B
0303*IF "FLAG" BEFORE TIMEOUT, EXIT TO TOS.  IF NOT,
0304*EXIT TO TOS + 1.  ONE ITERATION = 6.4 MICROSEC.
0305*
0306   00461  000000   TOS   NOP           ENTER SUBROUTINE
0307   00462  102300   SFS5  SFS  0         FLAG SET?
0308   00463  024465         JMP  *+2
0309   00464  124461         JMP  TOS,I     YES.  EXIT THROUGH TOS
0310   00465  006006         INB,SZB        NO.  TIMEOUT YET?
0311   00466  024462         JMP  SFS5      NO.  REPEAT
0312   00467  034461         ISZ  TOS       YES.  EXIT
0313   00470  000000         NOP              THROUGH
0314   00471  124461         JMP  TOS,I        TOS + 1
0315*
0316*ERROR BUFFER HALT SUBROUTINE
0317*
0318   00472  000000   EBH   NOP           ENTER SUBROUTINE
0319   00473  070542         STA  AS1       STORE A
0320   00474  014145         JSB  MODE      CHECK SW. REG.
0321   00475  060175         LDA  BIT1      HALT AT
0322   00476  030410         SLA              ERROR BUFFER?
0323   00477  014554         JSB  POF       YES.
0324   00500  060542         LDA  AS1       NO.  RESTORE A
0325   00501  124472         JMP  EBH,I     EXIT SUBROUTINE
0326   00502  000000   AS1   OCT  0         TEMPORARY STORAGE
0327*
0328*ILLEGAL INTERRUPT SUBROUTINE
0329*
0330*FOR AN ILLEGAL TTY INTERRUPT, THE PROGRAM ADDRESS IS SAVED.
0331*
0332   00503  000000   ILINT NOP           ENTER SUBROUTINE
0333   00504  070513         STA  AS2       STORE A
0334   00505  060503         LDA  *-2       STORE PROGRAM ADDRESS
0335   00506  070615         STA  IA
0336   00507  060514         LDA  IE        STORE
0337   00510  070604         STA  E15          ERROR 15
0338   00511  060513         LDA  AS2       RESTORE A
0339   00512  124503         JMP  ILINT,I   EXIT SUBROUTINE
0340   00513  000000   AS2   OCT  0         TEMPORARY STORAGE
0341   00514  000015   IE    OCT  15
0342*
```

```
0343*THE FOLLOWING PRINTS OUT THE RESULTS OF THE BASIC TEST.
0344*IN CASE OF FAILURE TO PRINT OUT, THE PROGRAM
0345*HALTS AT THE BEGINNING OF THE ERROR BUFFER.
0346*PRESSING "DISPLAY MEMORY" WILL SHOW WHICH ERRORS OCCURED.
0347*
0348    00515  000000   POUT   NOP
0349    00516  107700          CLC 0,C         INITIALIZE, INTERRUPT OFF
0350    00517  006400          CLB
0351    00520  014461          JSB TOS         FLAG SET?
0352    00521  024523          JMP *+2         YES.
0353    00522  014564          JSB POF         NO.  HALT AT ERROR BUFFER
0354    00523  060633          LDA SC2         PREPARE TO
0355    00524  070634          STA M14            PRINT OUT
0356    00525  060635          LDA SI3               ERROR CODES
0357    00526  070527          STA P4
0358    00527  064570   P4     LDB E1          LOAD B WITH
0359    00530  034527          ISZ *-1            ERROR STORAGE
0360    00531  006002          SZB             ZERO?
0361    00532  024536          JMP *+4         NO.
0362    00533  034634          ISZ M14         YES.   PARTIALLY DONE?
0363    00534  024527          JMP P4          NO.
0364    00535  024544          JMP P5          YES.   CHECK INTERRUPT ERRORS
0365    00536  060636          LDA E           PRINT
0366    00537  014554          JSB OYNA           OUT
0367    00540  014701          JSB POUT2             ERROR
0368    00541  014720          JSB FOL                 CODE
0369    00542  014472          JSB EBH         HALT AT ERROR BUFFER?
0370    00543  024533          JMP *-10B       NO.
0371    00544  064604   P5     LDB E15         E15 = A?
0372    00545  006003          SZB,RSS
0373    00546  024560          JMP P6          YES.
0374    00547  060636          LDA E           NO.
0375    00550  014554          JSB OYNA        PRINT OUT
0376    00551  014701          JSB POUT2          ERROR CODE
0377    00552  060653          LDA SI4               AND
0378    00553  014751          JSB MPG                 PROGRAM ADDRESS
0379    00554  060535          LDA IA                     WHEN ERROR
0380    00555  014774          JSB OPA                       OCCURRED
0381    00556  014720          JSB FOL         LINE FEED
0382    00557  014722          JSB FOL         LINE FEED
0383    00560  064532   P6     LDA SI2         PRINT SECOND
0384    00561  014733          JSB SMPOO          BT MESSAGE
0385    00562  014472          JSB FBH         HALT AT ERROR BUFFER?
0386    00563  124330          JMP BT,I        NO.  EXIT ROUTINE
0387    00564  000000   POF    NOP
0388    00565  064504          LDA *-1         PUT PROGRAM ADDRESS
0389    00566  064504          LDB *-2            FOR PRINT FAILURE
0390    00567  102055          HLT 55B                INTO A AND B
0391*
0392*ERROR BUFFER
0393*
0394    00570  000000   E1     OCT 0           SFC  TRUE AFTER    CLC 0,C
0395    00571  000000   E2     OCT 0           SFS  FALSE AFTER   CLC 0,C
0396    00572  000000   E3     OCT 0           SFC  FALSE AFTER   CLF TTY
0397    00573  000000   E4     OCT 0           SFS  TRUE AFTER    CLF TTY
0398    00574  000000   E5     OCT 0           SFC  FALSE AFTER   CLF TTY AND STC
0399    00575  000000   E6     OCT 0           SFS  TRUE AFTER    CLF TTY AND STC
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0400   00576 000000   E7     OCT 0          NO INTERRUPT AFTER  STC TTY,STF 0
0401   00577 000000   E10    OCT 0          SFC  TRUE AFTER INTERRUPT
0402   00600 000000   E11    OCT 0          SFS FALSE AFTER INTERRUPT
0403   00601 000000   E12    OCT 0          DATA CLOCK ON TTY BOARD TOO FAST
0404   00602 000200   E13    OCT 0          DATA CLOCK ON TTY BOARD TOO SLOW
0405   00603 000000   E14    OCT 0          DATA BUFFER ERROR
0406   00604 000000   E15    OCT 0          ILLEGAL INTERRUPT FROM TELETYPE
0407   00605 000000   IA     OCT 0          PROGRAM ADDRESS AT TIME OF E15
0408   00606 177777          OCT 177777     ERROR BUFFER TERMINAITON
0409   00607 024124          JMP MP1         RETURN TO MAIN PROGRAM
0410*
0411   00610 041105   BTM1   ASC 8,BEGIN BASIC TEST
       00611 043511
       00612 047040
       00613 041101
       00614 051511
       00615 041440
       00616 052105
       00617 051524
0412   00620 000000          OCT 0
0413   00621 000610   SI1    LDA BTM1
0414   00622 042516   BTM2   ASC 7,END BASIC TEST
       00623 042040
       00624 041101
       00625 051511
       00626 041440
       00627 052105
       00630 051524
0415   00631 000000          OCT 0
0416   00632 000622   SI2    LDA BTM2
0417   00633 177764   SC2    OCT 177764
0418   00634 000200   M10    OCT 0
0419   00635 004570   SI3    LDB E1
0420   00636 000305   E      OCT 305
0421   00637 020040   PRAD   ASC 11,    PROGRAM ADDRESS =
       00640 020120
       00641 051117
       00642 043522
       00643 040515
       00644 020101
       00645 042104
       00646 051145
       00647 051523
       00650 020075
       00651 020040
0422   00652 000000          OCT 0
0423   00653 000637   SI4    LDA PRAD
0424*
0425*PRINT LEAST SIGNIFICANT 8 BITS OF A.
0426*
0427   00654 000000   OYNA   NOP            ENTER SUBROUTINE
0428   00655 107700          CLC 0,C        INITIALIZE, INTERRUPT OFF
0429   00656 070677          STA AS3        STORE A
0430   00657 074733          STB BS1        STORE B
0431   00660 060675          LDA OYN        PUT BUFFER INTO OUTPUT
0432   00661 102600   OTA3   OTA 0             AND PRINT MODE
0433   00662 060677          LDA AS3        RESTORE A
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0434   00663 010455          AND MSK2      OUTPUT LEAST
0435   00664 102630   OT44   OTA 0           SIGNIFICANT 8
0436   00665 103700   STCO2  STC 0,C          BITS OF A
0437   00666 006400          CLA
0438   00667 014401          JSB TOS       FLAG SET?
0439   00670 024672          JMP *+2
0440   00671 014564          JSB POF       NO.  HALT AT ERROR BUFFER
0441   00672 060677          LDA AS3       YES.  RESTORE A
0442   00673 064700          LDB BS1       RESTORE B
0443   00674 124654          JMP OYNA,I     EXIT SUBROUTINE
0444   00675 120000   OYN    OCT 120000    OUTPUT,PRINT,NO PUNCH
0445   00676 120000   SOYN   OCT 120000
0446   00677 000000   AS3    OCT 0         TEMPORARY STORAGE
0447   00700 000000   BS1    OCT 0         TEMPORARY STORAGE
0448*
0449*PRINT OUT TWO OCTAL NUMBERS
0450*
0451   00701 000000   POUT2  NOP           ENTER SUBROUTINE
0452   00702 063001          LDA 1         OUTPUT
0453   00703 001100          ARS              FIRST
0454   00704 001100          ARS               NUMBER
0455   00705 001100          ARS
0456   00706 010717          AND MSK5
0457   00707 030716          IOR MSK4
0458   00710 014654          JSB OYNA
0459   00711 063001          LDA 1         OUTPUT
0460   00712 010717          AND MSK5         SECOND
0461   00713 030716          IOR MSK4          NUMBER
0462   00714 014654          JSB OYNA
0463   00715 124701          JMP POUT2,I   EXIT SUBROUTINE
0464   00716 000250   MSK4   OCT 250
0465   00717 000007   MSK5   OCT 7
0466*
0467*END OF LINE SUBROUTINE
0468*
0469   00720 000000   EOL    NOP           ENTER SUBROUTINE
0470   00721 070730          STA AS4       STORE A
0471   00722 060731          LDA CR        CARRIAGE
0472   00723 014654          JSB OYNA        RETURN
0473   00724 060732          LDA LF        LINE
0474   00725 014654          JSB OYNA        FEED
0475   00726 060730          LDA AS4       RESTORE A
0476   00727 124720          JMP EOL,I     EXIT SUBROUTINE
0477   00730 000000   AS4    OCT 0         TEMPORARY STORAGE
0478   00731 000215   CR     OCT 215
0479   00732 000212   LF     OCT 212
0480*
0481*SUPPRESS MESSAGE PRINTOUT CHECK SUBROUTINE
0482*
0483   00733 000000   SMPOC  NOP           ENTER SUBROUTINE
0484   00734 070750          STA AS5       STORE A
0485   00735 014145          JSB MODE      CHECK SW. REG.
0486   00736 060176          LDA BIT2      SUPPRESS EXCESS
0487   00737 002311          SLA,RSS          PRINTING?
0488   00740 024743          JMP *+3       NO.
0489   00741 060750          LDA AS5       YES.  RESTORE A
0490   00742 124733          JMP SMPOC,I   EXIT SUBROUTINE
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0491   00743 060730        LDA AS5        RESTORE A
0492   00744 014751        JSB MPO        PRINT MESSAGE
0493   00745 014720        JSB EOL        LINE FEED
0494   00746 014720        JSB EOL        LINE FEED
0495   00747 124733        JMP SMPOC,I    EXIT SUBROUTINE
0496   00750 000000  AS5   OCT 0          TEMPORARY STORAGE
0497*
0498*MESSAGE PRINTOUT SUBROUTINE
0499*
0500   00751 000000  MPO   NOP            ENTER SUBROUTINE
0501   00752 070753        STA *+1
0502   00753 060000        LDA 0          LOAD A WORD
0503   00754 034753        ISZ *-1
0504   00755 002303        SZA,RSS        WORD = 0?
0505   00756 124751        JMP MPO,I       YES.  EXIT SUBROUTINE
0506   00757 014761        JSB PACO        NO.  PRINT THE WORD
0507   00760 024753        JMP *-5        REPEAT FOR NEXT WORD
0508*
0509*PACKED ASCII CHARACTER OUTPUT SUBROUTINE
0510*MOST SIGNIFICANT 8 BITS OF A REGISTER PRINTED FIRST.
0511*
0512   00761 000000  PACO  NOP            ENTER SUBROUTINE
0513   00762 070773        STA AS6        STORE A
0514   00763 001700        ALF            PRINT
0515   00764 001700        ALF               FIRST
0516   00765 010455        AND MSK2           CHARACTER
0517   00766 014654        JSB OYNA
0518   00767 060773        LDA AS6        PRINT
0519   00770 010455        AND MSK2          SECOND
0520   00771 014654        JSB OYNA           CHARACTER
0521   00772 124761        JMP PACO,I     EXIT SUBROUTINE
0522   00773 000000  AS6   OCT 0          TEMPORARY STORAGE
0523*
0524*OCTAL PRINTOUT OF A
0525*
0526   00774 000000  OPA   NOP            ENTER SUBROUTINE
0527   00775 001200        RAL
0528   00776 071010        STA AS7        STORE A
0529   00777 011011        AND MSK6       PRINT
0530   01000 030716        IOR MSK4          FIRST
0531   01001 014654        JSB OYNA           NUMBER
0532   01002 015012        JSB NXT        PRINT
0533   01003 015012        JSB NXT           NEXT
0534   01004 015012        JSB NXT            FIVE
0535   01005 015012        JSB NXT             NUMBERS
0536   01006 015012        JSB NXT
0537   01007 124774        JMP OPA,I      EXIT SUBROUTINE
0538   01010 000000  AS7   OCT 0          TEMPORARY STORAGE
0539   01011 000001  MSK6  OCT 1
0540*
0541*NEXT OCTAL CHARACTER OUTPUT
0542*
0543   01012 000000  NXT   NOP            ENTER SUBROUTINE
0544   01013 061010        LDA AS7        PREPARE
0545   01014 001200        RAL               THE
0546   01015 001200        RAL               NEXT
0547   01016 001200        RAL                NUMBER
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0548   01017 071010        STA  AS7          FOR
0549   01020 010717        AND  MSK5              OUTPUTING
0550   01021 030716        IOR  MSK4
0551   01022 014654        JSB  OYNA         OUTPUT
0552   01023 125012        JMP  NXT,I        EXIT SUBROUTINE
0553*
0554*
0555*
0556*PUNCH AND READ ROUTINE
0557*
0558*TESTS TAPE PUNCH AND TAPE READER
0559*BY OUTPUTING ALL COMBINATIONS OF
0560*EIGHT BITS AND READING THEM BACK.
0561*
0562   01024 000000   PAR  NOP               ENTER ROUTINE
0563   01025 107700        CLC  0,C          INITIALIZE, INTERRUPT OFF
0564   01026 006400        CLB
0565   01027 014461        JSB  TOS          FLAG SET?
0566   01030 025032        JMP  *+2          YES.
0567   01031 014554        JSB  POF          NO.  HALT AT ERROR BUFFER
0568   01032 061216        LDA  SI7          PRINT FIRST
0569   01033 014733        JSB  SMPOC            PAR MESSAGE
0570   01034 061036        LDA  *+2          HALT TO
0571   01035 065036        LDB  *+1             TURN ON
0572   01036 102002        HLT  2                  PUNCH
0573   01037 061111        LDA  ONY          PREPARE TO
0574   01040 070675        STA  OYN             PUNCH TAPE
0575   01041 015232        JSB  ZEROS        PUNCH LEADER
0576   01042 003400        CCA               OUTPUT ALL ONES
0577   01043 010455        AND  MSK2             AS A BEGINNING
0578   01044 014654        JSB  OYNA              INDICATOR
0579   01045 002400        CLA               PUNCH
0580   01046 015242        JSB  .64CH            ALL
0581   01047 015242        JSB  .64CH             COMBINATIONS
0582   01050 061112        LDA  OYY                OF EIGHT
0583   01051 070675        STA  OYN                 BITS
0584   01052 065750        LDA  AS4
0585   01053 015242        JSB  .64CH
0586   01054 015242        JSB  .64CH
0587   01055 015232        JSB  ZEROS        PUNCH
0588   01056 015232        JSB  ZEROS            TRAILER
0589   01057 015232        JSB  ZERUS
0590   01060 015117        JSB  PARE         EXIT ROUTINE?
0591   01061 061063        LDA  *+2          NO.  HALT TO
0592   01062 065063        LDB  *+1             LOAD TAPE
0593   01063 102003        HLT  3                 INTO READER
0594   01064 061116        LDA  INN          PREPARE TO
0595   01065 070675        STA  OYN             READ
0596   01066 002400        CLA                  TAPE
0597   01067 014654        JSB  OYNA         READ A
0598   01070 106500   LIB2 LIB  0                CHARACTER
0599   01071 006003        SZB,RSS           CHARACTER = 0?
0600   01072 025067        JMP  *-3          YES.  READ NEXT CHARACTER
0601   01073 015253        JSB  R64CH        NO.  READ FIRST BLOCK
0602   01074 061113        LDA  IYN
0603   01075 070675        STA  OYN
0604   01076 061347        LDA  AS11
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0605    01077  015253              JSB  R64CH       READ SECOND BLOCK
0606    01100  061114              LDA  INY
0607    01101  070675              STA  OYN
0608    01102  061307              LDA  AS11
0609    01103  015253              JSB  R64CH       READ THIRD BLOCK
0610    01104  061115              LDA  IYY
0611    01105  070675              STA  OYN
0612    01106  061307              LDA  AS11
0613    01107  015253              JSB  R64CH       READ FOURTH BLOCK
0614    01110  025127              JMP  P7          EXIT ROUTINE
0615    01111  110000      ONY     OCT  110000      OUTPUT,NO PRINT,PUNCH
0616    01112  130000      OYY     OCT  130000      OUTPUT,PRINT,PUNCH
0617    01113  160000      IYN     OCT  160000      INPUT,PRINT,NO PUNCH
0618    01114  150000      INY     OCT  150000      INPUT,NO PRINT,PUNCH
0619    01115  170000      IYY     OCT  170000      INPUT,PRINT,PUNCH
0620    01116  140000      INN     OCT  140000      INPUT, NO PRINT, NO PUNCH
0621*
0622*PUNCH AND READ EXIT SUBROUTINE
0623*
0624    01117  000000      PARE    NOP              ENTER SUBROUTINE
0625    01120  071135              STA  ASR         STORE A
0626    01121  014145              JSB  MODE         CHECK SW. REG.
0627    01122  060200              LDA  HIT4        EXIT THIS
0628    01123  042011              SLA,RSS             ROUTINE?
0629    01124  025127              JMP  *+3         YES.
0630    01125  061135              LDA  ASR         NO.  RESTORE A
0631    01126  125117              JMP  PARE,I      EXIT SUBROUTINE
0632    01127  065676      P7      LDA  SOYN        RESTORE
0633    01130  070675              STA  OYN            OUTPUT CODE
0634    01131  014720              JSB  EOL         LINE FEED
0635    01132  061231              LDA  S15         PRINT SECOND
0636    01133  014733              JSB  SMPOC          PAR MESSAGE
0637    01134  125124              JMP  PAR,I       EXIT ROUTINE
0638    01135  000000      ASR     OCT  0           TEMPORARY STORAGE
0639*
0640*PRINT OCT ERRORS ROUTINE
0641*
0642    01136  000000      POE     NOP              ENTER SUBROUTINE
0643    01137  071152              STA  AS9         STORE A
0644    01140  060675              LDA  OYN         SAVE
0645    01141  071163              STA  AS10           STATE
0646    01142  065676              LDA  SOYN
0647    01143  070675              STA  OYN
0648    01144  014720              JSB  EOL         LINE FEED
0649    01145  061172              LDA  S15         PRINT "OUTPUT ="
0650    01146  014751              JSB  MPO
0651    01147  061152              LDA  AS9         RESTORE A
0652    01150  014774              JSB  OPA         PRINT OCTAL NUMBER
0653    01151  061242              LDA  S16         PRINT "INPUT ="
0654    01152  014751              JSB  MPO
0655    01153  064001              LDA  1           PRINT OCTAL
0656    01154  014774              JSB  OPA            NUMBER
0657    01155  014720              JSB  EOL         LINE FEED
0658    01156  061163              LDA  AS10        RESTORE
0659    01157  070675              STA  OYN            STATE
0660    01160  061152              LDA  AS9         RESTORE A
0661    01161  125136              JMP  POE,I       EXIT SUBROUTINE
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0662   01162 000000   AS9    OCT 0           TEMPORARY STORAGE
0663   01163 000000   AS10   OCT 0           TEMPORARY STORAGE
0664   01164 047525   OO     ASC 5,OUTPUT =
       01165 052120
       01166 052524
       01167 020075
       01170 020040
0665   01171 000000          OCT 0
0666   01172 061164   SI5    LDA OO
0667   01173 020040   OI     ASC 6,    INPUT =
       01174 020040
       01175 044516
       01176 050125
       01177 052040
       01200 036440
0668   01201 000000          OCT 0
0669   01202 061173   SI6    LDA OI
0670   01203 041145   PARM1  ASC 10,BEGIN PUNCH AND READ
       01204 043511
       01205 047440
       01206 050125
       01207 047103
       01210 044040
       01211 040516
       01212 042040
       01213 051105
       01214 040504
0671   01215 000000          OCT 0
0672   01216 061203   SI7    LDA PARM1
0673   01217 042516   PARM2  ASC 9,END PUNCH AND READ
       01220 042040
       01221 050125
       01222 047103
       01223 044040
       01224 042516
       01225 042040
       01226 051105
       01227 040504
0674   01230 000000          OCT 0
0675   01231 061217   SI8    LDA PARM2
0676*
0677*OUTPUT BLANK TAPE
0678*
0679   01232 000000   ZEROS  NOP             ENTER SUBROUTINE
0680   01233 002440          CLA
0681   01234 065241          LDB SC3
0682   01235 014654          JSB OYNA         OUTPUT ZERO
0683   01236 006406          INB,SZB          32 ZEROS?
0684   01237 025235          JMP *-2          NO.
0685   01240 125232          JMP ZEROS,I  YES.  EXIT SUBROUTINE
0686   01241 177740   SC3    OCT 177740
0687*
0688*INCREMENT AND OUTPUT A REG. 64 TIMES
0689*
0690   01242 000000   .64CR  NOP             ENTER SUBROUTINE
0691   01243 065252          LDB SC4          RESET COUNTER
0692   01244 014654          JSB OYNA         OUTPUT A
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0693    01245 002904            INA             INCREMENT OUTPUT WORD
0694    01246 006696            INB,SZB         64 CHARACTERS?
0695    01247 025244            JMP *-3         NO.
0696    01250 014720            JSR FOI         YES.
0697    01251 125242            JMP .64CH,I     EXIT ROUTINE
0698    01252 177700    SC4     OCT 177700
0699*
0700*READ AND CHECK 64 CHARACTERS
0701*
0702    01253 000000    R64CH   NOP             ENTER SUBROUTINE
0703    01254 065252            LDB SC4         RESET
0704    01255 075306            STB M64            CHARACTER COUNTER
0705    01256 014654    P8      JSR OYNA        READ A
0706    01257 106500    LIB3    LIB 0              CHARACTER
0707    01260 015117            JSR PARE        EXIT ROUTINE?
0708    01261 050001            CPA 1           NO.  ERROR?
0709    01262 025264            JMP *+2         NO.
0710    01263 015136            JSR PUE         YES.  PRINT OUT ERROR
0711    01264 002004            INA             INCREMENT REFERENCE
0712    01265 035306            ISZ M64         64 CHARACTERS?
0713    01266 025256            JMP P8          NO.
0714    01267 071347            STA AS11        YES.  STORE A
0715    01270 060731            LDA CR          CHECK FOR
0716    01271 014654            JSR OYNA           CARRIAGE
0717    01272 106500    LIB4    LIB 0              RETURN
0718    01273 050001            CPA 1           ERROR?
0719    01274 025276            JMP *+2         NO.
0720    01275 015136            JSR PUE         YES.  PRINT OUT ERROR
0721    01276 060732            LDA LF          CHECK FOR
0722    01277 014654            JSR OYNA           LINE
0723    01300 106500    LIB5    LIB 0              FEED
0724    01301 050001            CPA 1           ERROR?
0725    01302 025304            JMP *+2         NO.
0726    01303 015136            JSR PUE         YES.  PRINT OUT ERROR
0727    01304 061347            LDA AS11        RESTORE A
0728    01305 125253            JMP R64CH,I     EXIT SUBROUTINE
0729    01306 177700    M64     OCT 177700
0730    01307 000000    AS11    OCT 0           TEMPORARY STORAGE
0731*
0732*
0733*
0734*PRINT AND KEYBOARD ROUTINE
0735*
0736    01310 000000    PAK     NOP             ENTER ROUTINE
0737    01311 107706            CLC 0,C         INITIALIZE, INTERRUPT OFF
0738    01312 064676            LDA SOYN        PREPARE
0739    01313 070575            STA OYN            TO PRINT
0740    01314 061371            LDA SI0         PRINT FIRST
0741    01315 014733            JSR SMPOC          PAK MESSAGE
0742    01316 015452            JSR PRALL       PRINT 64 ASCII CHARACTERS
0743    01317 015452            JSR PRALL       PRINT 64 ASCII CHARACTERS
0744    01320 014720            JSR FOL         LINE FEED
0745    01321 015340            JSR PAKE        EXIT ROUTINE?
0746    01322 061414            LDA SI10        NO.  PRINT SECOND
0747    01323 014733            JSR SMPOC          PAK MESSAGE
0748    01324 061116    P9      LDA INN         PREPARE TO READ
0749    01325 102610    OTA5    OTA 0              IN FROM KEYBOARD
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0750    01326 015340    P10    JSB PAKE       EXIT ROUTINE?
0751    01327 103700    STCC3  STC 0,C        NO.  WAIT
0752    01330 006400           CLB              FOR INPUT
0753    01331 014461           JSB TOS        ANY INPUT?
0754    01332 025334           JMP *+2        YES.
0755    01333 025326           JMP P10        NO.
0756    01334 106500    LIB6   LIB 0          LOAD DATA INTO B
0757    01335 060001           LDA 1          PUT B INTO A
0758    01336 014654           JSB UYNA       OUTPUT A
0759    01337 025324           JMP P9         READ NEXT CHARACTER
0760*
0761*PRINT AND KEYBOARD EXIT
0762*
0763    01340 000000    PAKE   NOP            ENTER SUBROUTINE
0764    01341 071162           STA AS9        STORE A
0765    01342 014145           JSB MODE       CHECK SW. REG.
0766    01343 060241           LDA BITS       EXIT THIS
0767    01344 002011           SLA,RSS          ROUTINE?
0768    01345 025350           JMP *+3        YES.
0769    01346 061162           LDA AS9        NO.  RESTORE A
0770    01347 125340           JMP PAKE,I     EXIT SUBROUTINE
0771    01350 014720           JSB EOL
0772    01351 061151           LDA STI1       PRINT THIRD
0773    01352 014733           JSB SMPOC        PAK MESSAGE
0774    01353 125310           JMP PAK,I      EXIT ROUTINE
0775    01354 041105    PAKM1  ASC 12,BEGIN PRINT AND KEYBOARD
        01355 043511
        01356 047040
        01357 050122
        01360 044516
        01361 052040
        01362 044516
        01363 042040
        01364 045505
        01365 054502
        01366 047501
        01367 051104
0776    01370 000000           OCT 0
0777    01371 061354    SI9    LDA PAKM1
0778    01372 052523    PAKM2  ASC 17,USE KEYBOARD SLOWLY (5 CHS./SEC.)
        01373 042440
        01374 045505
        01375 054502
        01376 047501
        01377 051104
        01400 020123
        01401 046117
        01402 053514
        01403 054440
        01404 024055
        01405 020143
        01406 044123
        01407 027357
        01410 051545
        01411 041456
        01412 024447
0779    01413 000000           OCT 0
```

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0780   01414  061372   SI10   LDA PAKM2
0781   01415  042516   PAKM3  ASC 11,END PRINT AND KEYBOARD
       01416  042040
       01417  051122
       01420  044516
       01421  052040
       01422  040516
       01423  042040
       01424  045505
       01425  054512
       01426  047501
       01427  051104
0782   01430  000040          OCT 0
0783   01431  061415   SI11   LDA PAKM3
0784*
0785*PRINT ALL CHARACTERS SUBROUTINE
0786*
0787   01432  000000   PRALL  NOP           ENTER SUBROUTINE
0788   01433  061440          LDA SC5       PRINT FIRST
0789   01434  015442          JSR .32CH        LINE OF CHARACTERS
0790   01435  061441          LDA SC6       PRINT SECOND
0791   01436  015442          JSR .32CH        LINE OF CHARACTERS
0792   01437  125432          JMP PRALL,1   EXIT SUBROUTINE
0793   01440  000300   SC5    OCT 300
0794   01441  000240   SC6    OCT 240
0795*
0796*PRINT 32 CHARACTERS SUBROUTINE
0797*
0798   01442  000000   .32CH  NOP           ENTER SUBROUTINE
0799   01443  075454          STH BS2       STORE H
0800   01444  065241          LDH SC3       RESET COUNTER
0801   01445  014654          JSR DYNA      PRINT A
0802   01446  002304          INA           INCREMENT A
0803   01447  066406          INH,SZR       32 CHARACTERS?
0804   01450  025445          JMP *-3       NO, PRINT NEXT CHARACTER
0805   01451  014722          JSR EOL       YES, LINE FEED
0806   01452  065454          LDH BS2       RESTORE H
0807   01453  125442          JMP .32CH,1   EXIT SUBROUTINE
0808   01454  000000   BS2    OCT 0         TEMPORARY STORAGE
0809                          END
** NO ERRORS*
```