

PAPER TAPE NO. 12996-16001

**HP 9866A/12566B  
LINE PRINTER AND INTERFACE  
DIAGNOSTIC**

for

hp-2100 SERIES COMPUTERS

**reference manual**



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# LIST OF EFFECTIVE PAGES

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Section I  
INTRODUCTION

1-1. GENERAL

This diagnostic checks the operation of the HP 12996A Line Printer Subsystem which includes the HP 9866A Line Printer and HP 12566B-004 Line Printer Interface Kit. The subsystem may be used with any of the HP 2100 Series Computers. This diagnostic aids the operator in detecting any component that has failed. The Diagnostic Serial Number (DSN) for the line printer subsystem diagnostic resides in memory location 126 (octal). The DSN is 105004 (octal).

1-2. REQUIRED HARDWARE

The following hardware is required:

An HP 2100 Series Computer with at least 4K of memory.

An HP 12566-60024 Microcircuit Interface.

An HP 12566-60028 Connecting Cable.

An HP 9866A Line Printer.

A paper tape reading device (used only for loading).

A console device for message reporting (recommended but not required).

Note: If DMA (DCPC) is not present use the Pseudo Operator Design test and omit the DMA portion.

1-3. REQUIRED SOFTWARE

The following software is required:

The Diagnostic Configurator (part numbers listed below) is used for equipment configuration and as a console device driver.

Binary object tape	Part No. 24296-60001
Manual	Part No. 02100-90157

HP 9866A Line Printer Diagnostic binary object tape, Part No. 12996-16001.

## Section II

### PROGRAM ORGANIZATION

#### 2-1. ORGANIZATION

This diagnostic program consists of an Initialization and Control section, seven tests, and a Pseudo Operator Design section (Opdesign). The Initialization and Control sections accept the select code and options required by the tests. The tests are named as follows:

Basic I/O (Flag and Interrupt logic).

Status and Buffer Clear Test.

Cyclic Pattern Test.

Triangle Print and Over Buffer Full Test.

Non-printing Characters Test.

Worst Case Pattern Test.

DMA/DCPC Test.

Pseudo Operator Design (Opdesign).

#### 2-2. TEST CONTROL AND EXECUTION

The diagnostic outputs a title message to the console device for operator information and then executes the tests according to the options selected on the Switch Register. The Control section primarily checks Switch Register bits 15, 13, and 12.

The diagnostic also keeps count of the number of passes that have been completed and will output the pass count at the completion of each pass (if Switch Register bit 10 is clear). The count will be reset only if the diagnostic is restarted.

Test sections are executed one after the other in each diagnostic pass. User selection or default will determine which test sections will be executed. (Refer to paragraph 2-3.)

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### 2-3. SELECTION OF TESTS BY OPERATOR

The operator has the capability of selecting his own tests or sequences of tests with the help of bit 9 in the Switch Register. Paragraph 3-3 outlines test selection.

### 2-4. MESSAGE REPORTING

There are two types of messages output for diagnostics: error and information. Error messages are used to inform the operator when the subsystem fails to respond to a given control or sequence. Information messages are used to inform the operator of the progress of the diagnostic or to instruct the operator to perform some operation related to the function of the unit. In the latter case, an associated halt will occur to allow the operator time to perform the function. The operator must then press RUN. If a console device is used, the printed message will be preceded by the letter E (error) or the letter H (information) and a number (in octal). The number is also related to the halt code when a console device is not available. Examples of error and information messages are as follows: (Specific meanings are listed in section IV.)

Example - Error with halt

Message: E027 FLAG TIME OUT (CHR)  
Halt Code: 102027 (octal) (T-register or Memory  
Data Register)

Example - Information with halt

Message: H024 PRESS PRESET (EXT & INT), RUN  
Halt Code: 102024 (octal)

Example - Information only

Message: H025 BI-0 COMP  
Halt Code: None

Error messages can be suppressed by setting Switch Register bit 11 and error halts can be suppressed by setting Switch Register bit 14. This is useful when looping on a single section that has several errors. The A-register contains the actual status and the B-register contains the expected status when an appropriate error halt takes place.

Information messages are suppressed by setting Switch Register bit 10.

Operator intervention is suppressed by setting Switch Register bit 8 (i.e., Preset Test in BI-0). When Switch Register bit 12 is set the tests that are selected will be repeated, and all operator intervention will be suppressed.

#### 2-5. DIAGNOSTIC LIMITATIONS

Subsystem capability for receiving, passing, and denying priority (priority string logic) is not completely checked by this diagnostic. If the subsystem does not receive priority (i.e., PRH from the next lower select code) an error E014 NO INT will occur. To check this, remove an interface of a lower select code and run the Basic I/O test. The above mentioned error should occur. Checking the subsystem's ability to pass or deny priority is beyond the scope of this diagnostic.



### Section III

#### OPERATING PROCEDURE

##### 3-1. OPERATING PROCEDURES

A flowchart of the operating procedures for loading the Diagnostic Configurator and this diagnostic is provided in figure 3-1.

If an unconfigured Diagnostic Configurator is available start at entry point A on the flowchart.

If a configured Diagnostic Configurator is available start at entry point B on the flowchart.

If a combined configured Diagnostic Configurator and an unconfigured Diagnostic is available start at entry point C on the flowchart.

If a combined configured Diagnostic Configurator and a configured Diagnostic is available start at entry point D on the flowchart.

For Pseudo Opdesign instructions refer to paragraph 4-9.

##### 3-2. RUNNING THE DIAGNOSTIC

At the completion of each pass of the diagnostic, the pass count is output to the console for operator information. If Switch Register bit 12 was not selected, the computer will halt with 102077 (octal) in the Memory Data Register (T-register). At this point the A-register contains the pass count. The operator can press RUN to execute another pass.

If bit 12 is set it causes the diagnostic to loop. Bit 13, when set, is used to loop on a given test that is running at the time, as specified in table 3-1. Bit 15, if set, will halt the computer at the completion of a test.

If a trap cell halt occurs (106077 octal) the user must determine the cause of the interrupt or transfer of control to the location shown in the M-register. The program may need to be reloaded to continue.

When a halt occurs and/or a message is printed on the console device, the operator must refer to table 4-2 for the meaning of the halt.

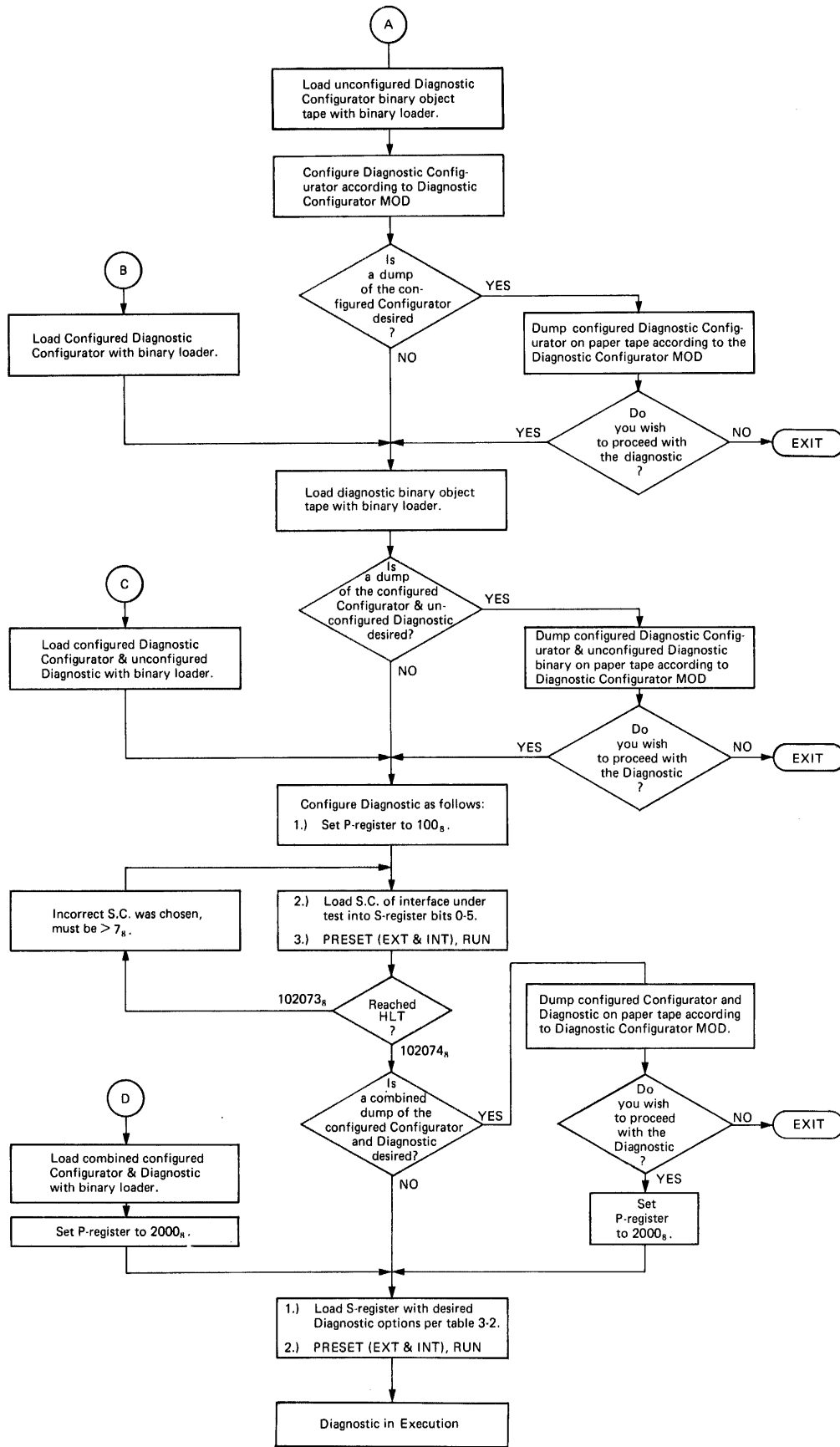


Figure 3-1. Operating Procedure Flowchart

### 3-3. TEST SELECTION BY OPERATOR

The Control portion of the program provides the operator with a method to select a single test or sequence of tests to be run. The operator sets Switch Register bit 9 to indicate that a selection is desired. If the computer is halted press RUN. The computer will come to a halt 102075 (octal) to indicate ready for selection. If the diagnostic is running, the test in progress will be completed, then the program will halt. After the halt, the operator may load the A-register with the test selections. Bit 0 of the A-register represents Test 00, bit 1 represents Test 01, and so on through bit 7, which represents Test 07 (octal). The operator must then clear Switch Register bit 9 and press RUN. The operator-selected test(s) will then be run. If the operator clears all bits of the A-register, all tests defined in table 3-1 will be executed except Test 07, Pseudo Opdesign.

Table 3-1. Test Selection Summary

A-REGISTER BIT	IF SET WILL EXECUTE
0	Test 00 - Basic I/O (BI-0) Test
1	Test 01 - Status and Buffer Clear Test
2	Test 02 - Cyclic Pattern Test
3	Test 03 - Triangle Print and Over Buffer Full
4	Test 04 - Non-printing Characters Test
5	Test 05 - Worst Case Pattern Test
6	Test 06 - DMA/DCPC Test
7	Test 07 - Pseudo Opdesign
8 thru 15	Reserved

Note: B-register is reserved.

Table 3-2. Switch Register Options

BIT	MEANING IF SET
0	Reserved
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Suppress messages on the line printer.
8	Suppress tests requiring operator intervention.
9	Abort current diagnostic execution and halt (102075); the user may specify a new group of tests in the A-register (see table 3-1), then clear bit 9 of the Switch Register, and then press RUN. This can also be used after E030 and E031 to abort the test.
10	Suppress non-error messages.
11	Suppress error messages.
12	Repeat all selected tests after diagnostic run has completed without halting. Message "PASS XXXXXX" will be output before looping unless bit 10 is set or a teleprinter is not present. Also, those tests requiring operator intervention will be suppressed.
13	Repeat last test executed (loop on test).
14	Suppress error halts.
15	Halt (102076) at the end of each test; the A-register will contain the test number in octal.

#### 3-4. RESTARTING

The diagnostic may be restarted by setting the P-register to 2000 (octal), loading the Switch Register with the desired diagnostic options per table 3-2, then pressing PRESET (EXTERNAL and INTERNAL), then pressing RUN.

The diagnostic may be reconfigured by setting the P-register to 100 (octal), loading the select code of the interface under test into Switch Register bits 0 through 5, pressing PRESET (INTERNAL and EXTERNAL), then pressing RUN.

Section IV  
DIAGNOSTIC PERFORMANCE

4-1. TEST DESCRIPTION

Tests 0 through 07 (octal) are described below. Refer to table 4-2 (comments on halt codes) for additional details on the content of each test. Prior to the beginning of each test, the test title will be output to the line printer for reference by the operator. These title messages can be suppressed by setting Switch Register bit 7.

4-2. BASIC I/O TEST 00

Note that there are eight subtests in Test 0, as follows. Error messages E000 through E023 and E026 (octal) can be produced during Test 0. Information messages H024 and H025 will occur.

Subtest 1 - Checks the ability to clear, set, and test the interrupt system. The following instruction combinations are tested:

CLF 0 - SFC 0  
CLF 0 - SFS 0  
STF 0 - SFC 0  
STF 0 - SFS 0

Errors in the above sequences produce error messages E000 through E003 as shown in table 4-2.

Subtest 2 - Checks the ability to clear, set and test the interface flag. The following instruction combinations are tested:

CLF CH - SFC CH  
CLF CH - SFS CH  
STF CH - SFC CH  
STF CH - SFS CH

Errors in the above sequences produce error messages E005 through E010 as shown in table 4-2.

Note: "CH" (channel) and "SC" (select code) are synonymous for the purpose of this diagnostic discussion.

- Subtest 3 - Checks that the test select code does not cause an interrupt with the flag and control set on the interface and the interrupt system off. The sequence of instructions is shown below:

```
STF 0
STF CH
STC CH
CLF 0
```

The CLF 0 instruction should inhibit an interrupt from occurring from the interface. Error message E004 occurs if CLF 0 fails.

- Subtest 4 - Checks that the flag of the interface under test is not set when all other select code flags are set. Error message E011 occurs if a flag is set incorrectly.

- Subtest 5 - Checks the ability of the interface to interrupt. With the flag and control set and the interrupt system on, the interface should interrupt. If the interrupt is missing error message E014 occurs.

Checks that the interrupt occurred where expected. The interrupt should not occur before a string of priority-affecting instructions are executed. The following instructions are used to check the hold off operation:

```
STC 1
STF 1
CLC 1
CLF 1
JMP *+1,I
DEF *+1
JSB *+1,I
DEF *+1
NOP
```

Error messages E012 and/or E015 will occur if the hold off failed. If a second interrupt is encountered after the interrupt system has been turned back on error message E013 will occur.

Checks that no instruction was missed during the interrupt (E026 INT EXECUTION ERROR).

- Subtest 6 - Checks that with the interrupt system on and the CH control and flag set, there is no interrupt following a CLC CH instruction. The following sequence of instructions are used:

```
STC CH
STF CH
STF 0
CLC CH
```

If the CLC CH fails to inhibit an interrupt, error message E016 will occur.

- Subtest 7 - Checks that the CLC 0 instruction inhibits interrupts when the CH control and flag are set. The following sequence of instructions is used.

```
CLF CH
STC CH
STF CH
STF 0
CLC 0
```

If the CLC 0 fails to inhibit an interrupt, error message E017 will occur.

- Subtest 8 - Checks that the PRESET (EXTERNAL and INTERNAL as applicable) switch(es) on the operator panel performs the following actions. Error messages E020 through E023 can occur.

Sets the interface flag (EXTERNAL).

Clears interface control (EXTERNAL).

Turns off the interrupt system (INTERNAL).

Clears the I/O data lines (EXTERNAL).

Clears the data register in the interface (INTERNAL).



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#### 4-3. STATUS AND BUFFER CLEAR TEST 01

This test consists of having the operator remove the paper to check the Out-of-Paper status. The status should be true (bit 0 equals 1). The operator is then instructed to reload the paper. Error messages E032 or E033 can occur. Information messages H100 and H101 will occur.

The program then outputs the message "NEXT LINE SHOULD BE BLANK" to the line printer. The program will fill the buffer with the character A and then clear the buffer by using the Buffer Clear Command (outputs bits 7 and 15 to the interface). A print command is then issued which should cause a line feed. No characters are printed. See figure A1 in the appendix. Error messages E027 through E031 can occur.

When the diagnostic is in loop mode, or manual intervention is suppressed (Switch Register bit 12 or 8 set), the status test is skipped.

#### 4-4. CYCLIC PATTERN TEST 02

This test outputs all printable characters in a cyclic pattern starting with octal 40 and ending with octal 176. All lower case characters are printed as their upper case counter parts. The operator should verify that the characters are in octal order by referring to table 4-3. There will be 60 lines printed. See figure A1 in the appendix. Error messages E027 through E031 can occur.

#### 4-5. TRIANGLE PRINT AND OVER BUFFER FULL TEST 03

This test will print a triangle pattern with the character H. The first line consists of 80 H's then each succeeding line will be decreased by two characters and one space added before the H's. By decreasing the total count in the buffer, the blank fill function of the line printer is checked. The last line will contain 2 H's in columns 40 and 41. See figure A2 in the appendix. Error messages E027 through E031 can occur.

The over buffer full test consists of filling the buffer with 80 characters (ASCII "A") and then trying to output more characters (character H is used) before the print command. The result should be a line of all A's because the line printer rejects all characters after the 80th until a print command is received. The message "NEXT LINE SHOULD BE ALL A'S" is printed prior to execution. See figure A2 in the appendix.

## 4-6. NON-PRINTING CHARACTERS TEST 04

In this test all non-printing ASCII codes are output to ensure that they do not print. The program outputs the line (message) "THE NEXT LINE SHOULD BE BLANK" and then fills the buffer with non-printing ASCII codes (octal 0 through 37 and 177, except 12). A print command is issued which should cause a line feed but no characters should be printed. See figure A2 in the appendix. Error messages E027 through E031 can occur.

## 4-7. WORST CASE PATTERN TEST 05

This test outputs 10 lines each of the characters E, H, I, S, and #. This is done in an attempt to draw as much current from the power supply as possible, and also to heat the thermal drive transistors, and print every dot in the 5 by 7 matrix. These characters are also the most useful for alignment checks. See figure A3 in the appendix. Error messages E027 through E031 can occur.

## 4-8. DMA/DCPC TEST 06

In this test the program exercises the DMA/DCPC portion of the interface board. It also is the fastest transfer possible to check cable noise and the response of the printer. A cyclic pattern is used for printing characters and a total of 60 lines are printed. See figure A4 in the appendix. If DMA/DCPC is not present the test is skipped. Error messages E027 through E031 and/or E034 through E036 can occur.

## 4-9. PSEUDO OPERATOR DESIGN TEST 07

Test 07 is not part of the standard sequence of tests for this diagnostic and must be specifically selected to execute. The test is primarily used for trouble shooting by an operator. Refer to paragraph 3-3 for test selection instructions. When executed it allows the operator to select a given set of operations.

When first entered, information message H102 is output instructing the operator to select functions on the Switch Register and press RUN. The functions selected are executed sequentially from Switch Register bits 0 through 4. If Switch Register bit 4 is not selected the program will halt 106002 again for the operator to make any changes and press RUN. If no functions are selected, the program will exit the routine. Error messages can occur. The available functions are listed below.

<u>SWITCH REGISTER BIT</u>	<u>FUNCTION IF SET</u>
0	Output 80 cyclic characters*
1	Output 80 of the same character*
2	Output a Clear Buffer Command (bit 7)
3	Output a Print Command (octal 12)
4	Repeat functions

\* If bits 0 and 1 are set 1 line of each character is printed.

#### 4-10. ERROR INFORMATION MESSAGE/HALT CODES

A halt code summary appears in table 4-1. Complete explanations of individual error information messages and halt codes appear in table 4-2.

Table 4-1. Halt Code Summary

HALT	MEANING
TESTS 00 (OCTAL) THRU 07 (OCTAL)	
102000 thru 102036	Error (E) or information (H) messages 00 thru 36 (octal).
106000 thru 106002	Information (H) messages 100 thru 102 (octal).
CONTROL	
102073	Select code input error.
102074	Select code accepted.
102075	User selection request.
102076	End of Test (A-register contains test number).
102077	End of diagnostic run.
106077	Trap cell halt in locations 2 thru 77 (octal).

Table 4-2. Error and Information Messages and Halt Codes

HALT CODE	PROGRAM SECTION	MESSAGE	COMMENTS
None	Test Control	HP9866 LINE PRINTER DIAGNOSTIC	Introductory message.
None	Test Control	TEST XX	Information message before error message (XX equals test number). Message occurs only once within a test and is suppressed for any subsequent messages within the same test.
102000	Test 0	E000 CLF 0 -SFC 0 ERROR	CLF/SFC 0 combination failed. CLF did not clear flag or SFC caused no skip with flag clear.
102001	Test 0	E001 CLF 0 -SFS 0 ERROR	CLF/SFS 0 combination failed. CLF did not clear flag or SFS caused skip with flag clear.
102002	Test 0	E002 STF 0-SFC 0 ERROR	STF/SFC 0 combination failed. STF did not set flag or SFC caused skip with flag set.
102003	Test 0	E003 STF 0-SFS 0 ERROR	STF/SFS 0 combination failed. STF did not set flag or SFS caused no skip with flag set.
102004	Test 0	E004 CLF 0 DID NOT INHIBIT INT	With card flag and control set, CLF 0 did not turn off interrupt system.
102005	Test 0	E005 CLF CH -SFC CH ERROR	CLF/SFC CH (SC) combination failed. CLF did not clear flag or SFC caused no skip with flag clear.
102006	Test 0	E006 CLF CH -SFS CH ERROR	CLF/SFS CH (SC) combination failed. CLF did not clear flag or SFS caused skip with flag clear.

Table 4-2. Error and Information Messages and Halt Codes  
(Continued)

HALT CODE	PROGRAM SECTION	MESSAGE	COMMENTS
102007	Test 0	E007 STF CH-SFC CH ERROR	STF/SFC CH combination failed. STF did not set flag or SFC caused skip with flag set.
102010	Test 0	E010 STF CH-SFS CH ERROR	STF/SFS CH combination failed. STF did not set flag or SFS caused no skip with flag set.
102011	Test 0	E011 STF XX SET CARD FLAG	Select code screen test failed. A-register contains XX (octal) where XX equals select code that caused card flag to set.
102012	Test 0	E012 INT DURING HOLD OFF INSTR	Interrupt occurred during an I/O instruction or a JMP/JSB indirect instruction.
102013	Test 0	E013 SECOND INT OCCURED	Card interrupted a second time after initial interrupt was processed.
102014	Test 0	E014 NO INT	No interrupt occurred with card flag and control set and the interrupt system on.
102015	Test 0	E015 INT RTN ADDR ERROR	Interrupt did not occur at the correct location in memory.
102016	Test 0	E016 CLC CH ERROR	CLC CH did not clear card control with the interrupt system on.
102017	Test 0	E017 CLC 0 ERROR	CLC 0 did not clear the card control with the interrupt system on.
102020	Test 0	E020 PRESET (EXT) DID NOT SET FLAG	PRESET (EXT) did not set the card flag.

Table 4-2. Error and Information Messages and Halt Codes  
(Continued)

HALT CODE	PROGRAM SECTION	MESSAGE	COMMENTS
102021	Test 0	E021 PRESET (INT) DID NOT DISABLE INTS	PRESET (INT) did not disable the interrupt system.
102022	Test 0	E022 PRESET (EXT) DID NOT CLEAR CONTROL	PRESET (EXT) did not clear control.
102023	Test 0	E023 PRESET (EXT) DID NOT CLEAR I/O LINES	PRESET (EXT) did not clear I/O data lines.
102024	Test 0	H024 PRESS PRESET (EXT & INT), RUN	Press PRESET (EXTERNAL/INTERNAL) then RUN.
None	Test 0	H025 BI-0 COMP	Basic I/O tests completed.
102026	Test 0	E026 INT EXECUTION ERROR	Interrupt was not processed correctly.
102027	Tests 1 thru 6	E027 FLAG TIME OUT (CHR)	During a character transfer the line printer did not respond within 1 millisecond.
102030	Tests 1 thru 6	E030 FLAG TIME OUT (CMD)	After issuing a print command the line printer did not respond within 300 milliseconds.
102031	Tests 1 thru 6	E031 LP OUT OF PAPER	Prior to an output the out-of-paper status bit was set.
102032	Test 1	E032 STATUS IS LOW AND SHOULD BE HIGH	Out-of-paper status bit was not set after removing paper.
102033	Test 1	E033 STATUS IS HIGH AND SHOULD BE LOW	After installing paper the out-of-paper status bit was still set.

Table 4-2. Error and Information Messages and Halt Codes (Continued)

HALT CODE	PROGRAM SECTION	MESSAGE	COMMENTS
102034	Test 6	E034 DMA TIMED OUT	After initiating a transfer with DMA (DCPC) it failed to complete.
102035	Test 6	E035 L.P. INTERRUPTED BEFORE DMA	Line printer caused an interrupt before it should have when using DMA transfer.
102036	Test 6	E036 L.P. TIMED OUT AFTER DMA TRANSFER	After a DMA (DCPC) transfer was complete the line printer did not respond to the last character (Print Command) within 300 milliseconds.
102073	Configuration	None	I/O select code entered at configuration is invalid. Must be greater than 7 (octal). Re-enter a valid select code and press RUN.
102074	Configuration	None	Select code entered during configuration is valid. Enter program option bits in Switch Register and press RUN.
102075	Test Control	None	Test selection request resulting from Switch Register bit 9 being set. Enter the desired group of tests to be executed in the A-register then press RUN.
102076	Test Control	None	End of test halt resulting from Switch Register bit 15 being set (A-register equals test number). To continue press RUN.

Table 4-2. Error and Information Messages and Halt Codes  
(Continued)

HALT CODE	PROGRAM SECTION	MESSAGE	COMMENTS
102077	Test Control	PASS XXXXXX	Diagnostic run complete. (A-register value equals pass count.) Switch Register options may be changed. To continue, press RUN.
106000	Test 1	H100 REMOVE PAPER FROM L.P.	Operator should remove paper from the line printer and press RUN.
106001	Test 1	H101 LOAD L.P. PAPER	Operator should install paper in the line printer and press RUN.
106002	Test 7	H102 MAKE SWR SELECTION FOR PSEUDO OPDESIGN	Operator should make a selection of a function on the Switch Register as described in paragraph 4-9.
106077	Test Control	None	Halt stored in locations 2 through 77 (octal) to trap interrupts which may occur unexpectedly because of hardware malfunctions. M-register contains the I/O slot number of interrupt. Diagnostic may be partially destroyed if halt occurs. The program may have to be reloaded; the problem should be corrected before proceeding.

NOTE: Test numbers and error halt codes are in octal.



Table 4-3. Printer Character Octal Codes

CHARACTER	OCTAL EQUIV	CHARACTER	OCTAL EQUIV	CHARACTER	OCTAL EQUIV
SPACE	040	@	100	@	140
!	041	A	101	A	141
"	042	B	102	B	142
#	043	C	103	C	143
\$	044	D	104	D	144
%	045	E	105	E	145
&	046	F	106	F	146
' (apost.)	047	G	107	G	147
(	050	H	110	H	150
)	051	I	111	I	151
*	052	J	112	J	152
+	053	K	113	K	153
, (comma)	054	L	114	L	154
-	055	M	115	M	155
.	056	N	116	N	156
/	057	O	117	O	157
0	060	P	120	P	160
1	061	Q	121	Q	161
2	062	R	122	R	162
3	063	S	123	S	163
4	064	T	124	T	164
5	065	U	125	U	165
6	066	V	126	V	166
7	067	W	127	W	167
8	070	X	130	X	170
9	071	Y	131	Y	171
:	072	Z	132	Z	172
;	073	[	133	[	173
<	074	\	134	\	174
=	075	]	135	]	175
>	076	'	136	'	176
?	077	- (minus)	137		

APPENDIX  
SAMPLE PRINT OUTS

Four sample printouts for line printer tests are included here. The tests are described in section IV. Note that these sample printouts from the line printer have been slightly reduced to provide binding edges in this manual.







