PAPER TAPE NO. 12960-16001

CARTRIDGE DISC
MEMORY
DIAGNOSTIC

for

hp-12960/12961 (7900/7901/13210)

reference manual

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LIST OF EFFECTIVE PAGES

Changed pages are identified by a change number adjacent to the page number. Changed information is indicated by a vertical line in the margin of the page. Original pages (Change 0) do not include a change number. Insert latest changed pages and destroy superseded pages.

Change 0 (Original) .... AUG 1976

All pages in this edition are original.

Contents

Tables

This diagnostic test program confirms proper output, input and control functions for the Cartridge Disc Memory, providing rapid checkout of the controller and exhaustive testing of the drive. The test operator runs the program under the default mode or defines his own tests with console and switch register options. Up to four drives can be checked serially. Interaction between drives is also tested. This diagnostic does not check more than one controller.

1-1. PROGRAM ORGANIZATION

1-2. CONFIGURATION

This diagnostic requires the diagnostic configurator (HP 24296). The diagnostic configurator manual (02100-90157) contains the operating instructions.

1-3. TEST CONTROL AND EXECUTION

The diagnostic configurator is loaded and configured first, then this diagnostic is loaded and configured. The diagnostic execution is primarily controlled by the switch register.

1-4. MESSAGES AND HALTS

All messages are prefixed by a letter and a number. If the letter is an H, the message is an operating instruction or comment. If the letter is an E, the message is an error condition. The number prefix is the condition code.

Messages to the operator are output via location 102_8 (slow output device). Disc errors are reported via location 103_8 (fast output device). Disc error reports include current operation, error and current disc address.

Location 130_8 contains the starting address of the current step.

See paragraph 3-5 for a list of messages and halts.

1-5. TEST SELECTION

The diagnostic contains six sections. Each section is divided into steps. Sections 1 through 5 are always selected when section 6 (OPDSN) is not selected. Additional control is available by switch option. See paragraph 3-3 for switch options.

1-6. HARDWARE REQUIREMENTS

This diagnostic program requires an HP 2100 series computer with DMA and at least 8192 words of core. The Cartridge Disc Memory has two parts: the HP 7900A or 7901A Disc Drive and the HP 13210A Disc Drive Interface Kit. A console is required. A line printer is recommended for the fast output device but the console can be used.

1-7. SOFTWARE REQUIREMENTS

The diagnostic configurator must be configured for at least an 8K system.

1-8. LIMITATIONS

Unexpected interrupts form a special class of errors; no message is output. Each interrupt trap contains $1060XX_8$ where XX is the trap location. Analysis of these errors is beyond the scope of this diagnostic. No recovery mechanism is provided.

The following interface lines are not tested: PON, status bits 1 and 11.

Interrupt chain is not tested on the interface. This may be tested by testing interrupts on a lower priority (higher numbered) interface.

Whenever the heads load on any unit, an interrupt occurs (the command channel flag sets). This interrupt is not expected by the diagnostic and is reported as an error. The diagnostic program normally recovers after a few error reports. Message 42 identifies which unit interrupted unexpectedly. Note: Step 15 does expect the heads to load.

2-1.   PERFORMANCE TEST

2-2.   LOADING

If a paper tape copy of the configured disc diagnostic is available skip to step h below. To configure the diagnostic program, start at step a.

a.   Use the Binary Loader to load the HP 2100 Series Diagnostic configurator. Configure the configurator by following the procedure in the HP 2100 Series Diagnostic Configurator manual. The system console may be used for all four I/O devices but a line printer is recommended for the fast output device. Memory size must be at least 8K.

b.   Use the Binary Loader to load the unconfigured diagnostic program.

c.   Set a starting address of 100_8.

d.   Set switch register to select code for the I/O channel containing the data interface for the disc. The command channel interface is the next higher select code. Set switch register bit 14 to test DMA channel 7. Clear switch register bit 14 to test DMA channel 6.

e.   Press the PRESET button(s), then press run.

f.   The program will halt with 102074 in the T-register.

If a configured tape is desired start at step g below, otherwise skip to paragraph 2-3.

g.   Using procedures described in the HP 2100 Series Diagnostic Configurator manual dump memory onto paper tape. This new tape is the configured diagnostic mentioned above.

h.   Use the Binary loader to load the configured diagnostic tape.

i.   Set a starting address of 2000_8.

2-3.   TEST PROCEDURES

An unused disc pack or fixed disc (7900 only) is required to thoroughly test the controller and disc drive. If an unused disc pack or fixed disc (7900 only) is available skip to paragraph 2-5. A minimal subsystem verification (each sector is cyclic checked for proper parity) can be run against any disc pack or fixed disc (7900 only). This verification may even be run against protected discs and discs with flagged cylinders. To run the verification start at paragraph 2-4.

2-4. VERIFICATION TEST

a. Set the switch register to 10_8 (just bit 3 on).

b. Press run. The program will print its title (message 0) and ask for instructions (message 55). Enter the following instructions on the system console:

SD,X(CR) (LF)
Vz(CR) (LF)
EN(CR) (LF)

where   X   =   unit number (0 is most common)
           (CR) =   carriage return key
           (LF) =   Line feed key
            z   =   U for upper disc (pack) or L for lower disc (fixed — 7900 only)

c. When the program repeats its request for instructions (message 55), the program has verified each sector of the disc pack or fixed disc once. If any error message is reported the subsystem has failed this minimal test. Return to start, paragraph 2-3.

2-5. DISC SUBSYSTEM TEST

If the unused disc pack or fixed disc has been used before in a 7900/7901 and has no flagged cylinders skip to paragraph 2-6, step e.

2-6. FORMATTING

a. Set the switch register to 10_8 (just bit 3 on).

b. Protect/Override switch must be set (to override). Switch is located behind the air filtration screen.

c. Press run. The program will print its title (message 0) and ask for instructions (message 55). Enter the following instructions on the system console:

SD,X(CR) (LF)
Fz(CR) (LF)
EN(CR) (LF)

where   X   =   unit number (0 is most common)
           (CR) =   carriage return key
           (LF) =   line feed key
            z   =   U for upper disc (pack) or L for lower disc (fixed — 7900 only)

NOTE: *The user is cautioned that unless the drive and disc are good when using this formatting program to format a pack, subsequent use of the disc pack may produce errors and erroneous data.*

d.   When the program repeats its request for instructions (message 55), the program has formatted each sector of the disc. No cylinders are flagged. No error messages are expected. Set switch register to next desired setting (with bit 3 set to 0) by looking at the next step and then input EP (CR) (LF).

e.   If any disc drive needs to be thoroughly tested skip to paragraph 2-9. If any disc pack or fixed disc (7900 only) needs to be thoroughly tested skip to paragraph 2-8. To thoroughly test the disc controller proceed to paragraph 2-7.

2-7.   DISC CONTROLLER TEST

a.   Set the switch register to 140_8 (bits 5 and 6 on). If the disc drive is not unit 0 or the fixed disc is to be tested set the switch register to 144_8 (bits 2, 5 and 6).

b.   Press RUN. If switch bit 2 was set, a series of requests appear on the system console. Answer the first two with NO. Enter A to select the disc pack, B to select the fixed disc (7900 only) or C to select both discs (7900 only) for the third request. Answer the fourth request with NO. The fifth request is for unit number(s). Answer YES to change the unit assignment. Enter all unit numbers whose selected discs (from thrid request) may be used. The series of questions repeats until switch bit 2 is reset.

c.   Each short pass tests one disc (pack or fixed)/unit combination and takes about 30 seconds. Enough short passes to test all combinations completes the controller test. Return to start, paragraph 2-3.

2-8.   DISC MEDIA TEST

a.   Clear the switch register. Set bit 2 if the disc drive is not unit 0 or the fixed disc is to be tested.

b.   Press RUN. If switch bit 2 is set see paragraph 2-7, step b.

c.   Each long pass tests one disc (pack or fixed) /unit combination and takes about 18 minutes. Enough long passes to test all combinations completes the disc media test. Return to start, paragraph 2-3.

2-9.   DISC DRIVE TEST

a.   Set the switch register to 10020_8 (switches 4 and 12). Set bit 2 if the disc drive is not unit 0 or the fixed disc is to be tested.

b.   Press RUN. If switch bit 2 is set see paragraph 2-7, step b.

5

c.   Follow requests to test the drive switches. Timing message are printed during the long pass. Message 53 should report an average track-to-track seek time of no more than 7 ms for 7900 and 10 ms for 7901. Message 54 reports both a time in ms and a length in number of cylinders (tracks). When the time is divided by the length, a slope is determined. The slope should not average more than .448 for 7900 or .522 for 7901.

d.   Each pass tests one disc (pack or fixed) /unit combination and takes more than 20 minutes. Enough long passes to test all combinations completes the disc drive test.

3-1. OPERATING PROCEDURE

3-2. PREPARATION FOR USE

a. Load the HP 2100 Series Diagnostic Configurator.

b. Configure the HP 2100 Series Diagnostic Configurator.

c. Load this program using the Binary loader.

d. Load start address to 100_8.

e. See Table 3-1 for proper switch settings.

f. Push RUN.

g. The program will halt with 102074 in the T-register (Memory Data). Skip to paragraph 3-3, step b.

3-3. RUNNING THE DIAGNOSTIC

a. Load address 2000_8.

b. Select desired options from Table 3-2 by setting the appropriate bits of the switch register. If any pack being used is not formatted, use the operator design section described in Appendix A and in paragraph 2-6, step c.

c. Press RUN. The configuration portion is overlaid.

Table 3-1. Switch Register Characteristics During Configuration

BITS	FUNCTION
0-5	Select Code for the I/O channel containing the data interface for the disc (disc interface 1-PCA 13210-60003). The command channel interface board is the next higher select code (disc interface 2).
6-13	Spares
14	If DMA channel 6 is to be used, set OFF. If DMA channel 7 exists and is to be used, set ON.
15	Spare

Table 3-2. Switch Register Characteristics Following Configuration

BITS	FUNCTION
0	Spare (used by CE in Appendix A).
1	Skip to end of section when set. (Also used by CE in Appendix A).
2	If set to one, alter cylinder table and/or pattern table and/or select heads and/or change unit removal threshold and/or alter unit table. Reset to terminate requests.
3	If set to one, execute operator design program (OPDSN or Section 6).
4	If set to one, execute interactive part of S1. (Also used by CE in Appendix A).
5	If set to one, shorten test in S2, S3, S4 and S5. (Also used by CE in Appendix A).
6	If set to one, restrict cylinder selection.
7	If set to one, repeat last section.
8	If set to one, suppress spaces, print message 65 independent of bit 10 when an error occurs.
9	If set to one halt after each section of the program.
10	If set to one, all non-error messages will be suppressed, except current operation messages, message 51 and message 65 when bit 8 is set and an error occurred.
11	If set to one, all messages are suppressed.
12	If set to one, print timing messages in Sections 2 and 4. (See paragraph 2-9, step c.)
13	If set to one, loop on last step.
14	If set to zero, program will halt after each error.
15	If set to one, program will come to an orderly halt at the end of the current step.

NOTES:

1. When all switches are set to zero, disc drive 0 is tested in the long mode (18 minutes per pass). The program will halt on each error and will test the entire removable disc pack.

2. To restrict cylinder selection to a different set of values than are initially in the cylinder table (0, 1, 2, 4, 8, 16, 32, 64, 128, 202) set switch 2 at step b, paragraph 3-3. These are the only cylinders used when switch 6 is set (and switches 3 and 4 are reset). The cylinder table is a push-through stack.

3. To use other patterns then the ten initially in the pattern table (octal: 0, 177777, 125252, 52525, 7417, 170360, 162745, 163346, 155555, 22222) set switch 2 at step b, paragraph 3-3. The pattern table is used to write and read back ten patterns in each word of the pack in Section 2. The pattern table is a push through stack.

4. To test the fixed disc or both discs, set switch 2 at step b, paragraph 3-3. If heads 0 and 1 are selected, the removable pack is tested. If heads 2 and 3 are selected, the fixed pack is tested. Both discs may be tested alternately by selecting the third option. This selection is reset to heads 0 and 1 in Section 6. (7901 contains only the removable disc).

Table 3-2. Switch Register Characteristics Following Configuration (cont.)

NOTES: (cont.)

5.   Units that have made 20 errors in one pass are removed from the unit table. This unit removal threshold may be changed by setting switch 2 at step b, paragraph 3-3. If no units remain in the unit table the program halts then restarts with only the last unit in the table.

6.   To test other drives or multiple drives, switch 2 may be set at step b, paragraph 3-3. One drive will be tested each pass. The multiple drive test (Section 5) is performed after each drive has been tested.

7.   If the user is running the operator designed section (Section 6) and executing a program he has created, he may regain control by resetting switch 3 (return to Section 1) or by quickly resetting switch 3, then setting it again (return to operator design program). This method is valid whenever the program is running (neither halted nor reporting an error).

8.   Switch 4 causes the interactive part of Section 1 to be executed. These tests are not performed anywhere else in the program since they require user assistance. Switch 12 permits timing messages to be printed in Sections 2 and 4.

9.   Any time switch 5 is set, Sections 2, 4, and 5 are shortened. Section 3 is also shortened if switch 5 is set when Section 3 starts.

10.   When switch 6 is set, H53 is never printed. Switch 6 does not affect Section 1.

11.   There are two options at the end of each section: First if switch 9 is set to one, the program will halt; if switch 7 is set to one, the section is repeated.

12.   To run the tests without error reporting, set switches 11 and 14 to one.

13.   Switch 13 allows the program to loop. It should be used when errors are occurring.

14.   Switches 0, 1, 4 and 5 are used by the customer engineer to help align the heads and assure drive compatibility.

d.   The diagnostic will output its preamble (message 0) and then run a short test on each of the two I/O channels being used.

e.   If bit 2 of the switch register is set the operator is shown the cylinder table (the ten cylinders used when switch register bit 6 is set) and allowed to change it, shown the pattern table (the ten patterns used in Section 2) and allowed to change it, asked to select heads (0, 1 = removable disc; 2, 3 = fixed disc — 7900 only), shown the unit removal threshold and allowed to change it, and shown the unit table and allowed to change it. The requests repeat until bit 2 is reset. The cylinder and pattern tables are pushed through stacks, therefore as little as one new entry may be added at a time. The unit table must be totally reconstructed with each change.

f. If bit 3 of the switch register is set to one, control is given to the operator design program (see Appendix A).

g. The program will execute Sections 1 through 5. If multiple units are present, each unit will be tested serially (one per pass) before the multiple unit tests (Section 5) are run. Each drive is therefore initialized by Section 4. The program then verifies the overlap of seek commands functions properly.

h. The cycle count is incremented after each pass and output via message 65. The middle of step d above is entered next.

3-4. TEST SECTIONS

Subroutine	Description
INIT	This routine configures each I/O instruction. The I/O channel select codes are obtained from the configuration switch register.
START	This routine outputs the preamble, initializes trap cells and variables, tests the ability to set and clear flags and control bits and performs a screen test on both disc interface boards, tests interrupt operation of the command channel interface board, waits for all units which are ready to be not busy, requests status from all possible units, issues a seek to units that are ready and an address record to the others, performs switch 2 dialogue, checks to see that the unit selected is present, controls section execution and outputs the pass message.

	0	All of START has this step number.

SECTION 1	This section tests most controller functions using short writes and reads. The interactive tests (which run when switch 4 is set) check operations that relate to pack addressing. The tests occur in the following sequence:

STEP	DESCRIPTION
1	Get and check status for 0.
2	Seek to cylinder 0.

NOTE: Skip to step 21 if bit 4 is clear.

STEP	DESCRIPTION
3	Ask operator to set override switch.
4	Place write lockout bit on cylinder zero, read cylinder zero (checking for flagged cylinder indication) and cyclic check cylinder zero (checking for flagged cylinder indication).
5	Place defective cylinder bit on cylinder one.
6	Ask operator to clear override switch.

STEP	DESCRIPTION
7	Read cylinder one (checking for address error, flagged cylinder and any error indications).
8	Write cylinder zero (checking for flagged cylinder and any error indications).
9	Write address on cylinder zero (checking for flagged cylinder and any error indications).
10	Ask operator to set override switch.
11	Initialize entire pack.
12	Ask operator to clear override switch.
13	Ask operator to UNLOAD drive.
14	Check for not-ready and any error indications. Issue a write command and check status. Issue a seek to check that the controller sets the command flag immediately if the disc drive is not ready. This step reports a seek check error when looped.
15	Ask operator to set data protect switch and ready drive. Test attention bits when heads load.
16	Perform a seek operation and test for first seek bit. This step reports a first seek error when looped.
17	Attempt to write data on the disc and then verify that no data transfer took place. Check status.
18	Ask operator to clear data protect switch.
19	Test POPIO line with preset switch(es).

NOTE: Step 20 does not exist.

21	Seek to cylinder 0, then seek to cylinder 1 and check status for busy.
22	Seek to cylinder 203 and check status for seek-check and any error indications.
23	Seek while a seek is in progress, then check status for seek-check and any error indications.
24	Seek to first cylinder in cylinder table and write one sector at sector zero.
25	Write two sectors at sector 7.

Subroutine   Description

STEP	DESCRIPTION
26	Read one sector at sector zero and check against data that was written.
27	Read two sectors at sector 7 and check against data that was written.
28	Refine one sector at sector seven. Read and verify sector seven.
29	Write four sectors at sector 21, causing a track change.
30	Perform a cyclic check on groups of sectors starting at head zero, sector zero. (One sector, then 2 sectors then 4, 8, 16, 32, 48 and 49 sectors). The last one results in end-of-cylinder indication.
31	Read four sectors at sector 21 and verify the data against that which was written.
32	At sector seven, lower track force overrun following write of two words.
33	Write four sectors at sector 21, lower track. The end-of-cylinder and any error conditions are expected.
34	Test command bit 14. If missing, cyclic check becomes read and end-of-cylinder won't occur.
35	At sector seven, lower head; read thirty words and force overrun. Check zero fill and verify that the word causing the previous overrun was not written on the disc.
36	Read four sectors at sector 21, lower track. The end-of-cylinder and any error indications are expected. The three sectors read are checked against those written.
37	Seek to last cylinder. Read one sector at cylinder 0. Address error and any error are expected. Forces worst case recalibrate.
38	Seek to cylinder 202 (or 0 if first entry is 202) and then seek to first entry in cylinder table. At head 1, sector 21 read one sector and verify contents. The read command is issued before the seek is complete.

NOTE: *Steps 39-44 do not exist.*

Subroutine	Description

SECTION 2 This section writes and reads back patterns checking for bad packs or marginal heads. The tests occur in the following sequence:

STEP	DESCRIPTION
45	Select cylinder according to switch register bit six. Perform seek operation.

NOTE: *Skip next two steps if switch register bit five is set.*

NOTE: *Perform steps 46 and 47 ten times (once for each pattern).*

46	Fill write buffer with one pattern from pattern table. Write on first, last and second thirds of each track.
47	Read first, last and second thirds of each track. The data is checked against that written following each read.

NOTE: *Select next cylinder according to switch register bit six. Skip to step 45 until all cylinders to be tested have been tested.*

SECTION 3 This section writes and reads back random data from random locations to check seek and data transfer operations. The tests occur in the following sequence:

Perform steps 48 through 50, 1024 times (or 64 times if switch register bit 5 is set).

Generate random cylinder, head, sector and word count. Prevent end of cylinder error by reducing the word count if necessary.

Generate a buffer of random data and store a word of zero in the first unused word.

48	Perform seek.

NOTE: *Repeat next two steps twice.*

49	Write data.

NOTE: *Repeat next step twice.*

50	Read and verify the data just written.

Subroutine	Description

SECTION 4

This part fills the pack full of checksummed data for the next part. Each sector is checksummed separately. The entire sector sums to zero. The first two words sum to the cylinder number. The next two words sum to the head/sector number. Each track is written following the same scheme used to read back patterns in Section 2 on the previous page.

STEP	DESCRIPTION
51	Seek to the next cylinder according to switch bit 6.
52	Write the data onto the disc.

This part reads one sector after a random seek and verifies checksum, cylinder, head and sector number. The operation is repeated 8192 times (or 256 times if switch register bit 5 is set).

53	Seek to a random cylinder according to switch bit 6.
54	Read and verify one sector.

SECTION 5

This section runs multiple unit test if at least two units are present. The seeks overlap. The read check is the same that Section 4 performs. The multiple unit test is not run until each unit under test has run through Section 4. Pack switching (between fixed pack and removable pack) occurs at the completion of this section.

55	Perform multi-seek and reads.
56	For mode C (both removable and fixed disc) and HEAD = 2, check one sector from HEAD 0 (written in Section 4 on some previous pass) to verify head select logic. This step is run once on each disc drive.

SECTION 6
(OPDSN)

This section is entered by setting switch 3 to 1. Special test routines are written and inserted. After running, or aborting, control is returned to the beginning of the diagnostic. (See Appendix A.)

57	This entire section has this step number.

3-5. DIAGNOSTIC MESSAGES AND HALTS

T-REGISTER	CONDITION CODE A-REGISTER	MESSAGE	TEST DESCRIPTION OR OPERATOR ACTION
1060XX	———	(none)	Trap cell interrupt. P = memory address when interrupted, XX = trap cell location.
10201X	———	(none)	Halt between sections (X = section number).
102004	———	(none)	Orderly halt.
102005	———	(See H1)	Push run to restart diagnostic.
102006	———	(See E50)	Push run to restart diagnostic.
102073	———	(none)	Illegal select code during configuration.
102074	———	(none)	Halt at end of configuration.
———	H0	7900/7901 CARTRIDGE DISC MEMORY DIAGNOSTIC	Preamble
(102005)	H1	UNIT X REMOVED FROM UNIT TABLE	Unit has been removed from the unit table. Removal results from number of errors exceeding threshold (see switch bit 2). Halt occurs if unit table is empty.
102001	E2	CLF OR SFS FAILED CHANNEL XX	Test the ability to clear flag and test the SFS instruction on channel XX.
102001	E3	SFC FAILED WITH FLAG CLEAR-CHANNEL XX	SFC instruction did not skip with flag clear.
102001	E4	STF OR SFC FAILED CHANNEL XX	Test the ability to set the flag and test the SFC instruction on channel XX.
102001	E5	SFS FAILED WITH FLAG SET-CHANNEL XX	Test the SFS instruction with the flag set.
102001	E6	NO INTERRUPT ON COMMAND CHANNEL	Test the interrupt capability.
102001	E7	WRONG RETURN ADDRESS USING COMMAND CHANNEL	Address stored during interrupt is incorrect.

T-REGISTER	CONDITION CODE A-REGISTER	MESSAGE	TEST DESCRIPTION OR OPERATOR ACTION
102001	E10	NO COMMAND FLAG	A flag expected on the command channel to indicate operation complete did not occur.
102001	E11	LATE DATA FLAG	A device flag was expected on the data channel and did not occur until after 90 micro-seconds.
102001	E12	NO DATA FLAG (GETTING STATUS)	This message is typed by the status routine when the device flag on the data channel was not set to indicate that the status was returned.
102001	E13	XXXX WORDS TRANS-FERRED YYYY EXPECTED	When the operation complete device flag occurred on the com-mand channel, the DMA trans-fer was not complete. If no words were written on a write, this message reports that one word was written.
102001	E14	NO COMMAND FLAG (USING DMA)	A transfer using DMA was in progress, and a command channel flag indicating operation complete did not occur.
———	H15	ADDRESS RECORD IN STEP X	Current operation is address record.
———	H16	OVERFLOW	Work space, between end of read buffer and end of 8K of core or beginning of diagnostic configu-rator which ever is less, is full.
———	H17	DUPLICATE LABEL	Last label input has previously been defined.
———	H20	UNDEFINED INSTRUCTION	Last instruction input is not valid.
102001	E21	MISSING OR DUPLICATE ATTENTION BIT	The attention bits have not been set in one of the correct sequences. The unit number in H51 is the best guess at which unit is bad.
———	H22	CYCLIC CHECK IN STEP X	Current operation is cyclic check.
———	H23	XXXXXX ERRORS/PASS ALLOWED	XXXXXX = unit removal threshold.

T-REGISTER	CONDITION CODE A-REGISTER	MESSAGE	TEST DESCRIPTION OR OPERATOR ACTION
———	H24	CYLINDER TABLE XXX,XXX,XXX,XXX, XXX,XXX,XXX,XXX, XXX,XXX	Contents of cylinder table.
———	H25	WISH TO CHANGE?	Operator types: Y or N.
———	H26	ENTER CYLINDERS SEPARATED BY COMMAS	Operator types, all on one line.
———	H27	PATTERN TABLE XXXXXX XXXXXX XXXXXX XXXXXX XXXXXX XXXXXX XXXXXX XXXXXX XXXXXX XXXXXX	Contents of pattern table. (XXXXXX = pattern in octal).
———	H30	ENTER PATTERNS SEPARATED BY COMMAS	Operator types, all on one line.
———	H31	INPUT ERROR	Bad input from teleprinter.
———	H32	ENTER ERRORS/PASS	(Unit removal threshold.)
———	H33	ATTENTION/SEEK-STATUS XXXXXX YYYYYY XXXXXX YYYYYY · · · · · ·	XXXXXX = attention bits following each seek complete. YYYYYY = status word following each seek. All values are octal. (If the attention bits are zero, no status is obtained.) Any error terminates process.
———	H34	ENTER UNIT NUMBERS (0-3) SEPARATED BY COMMAS	Operator types, all on one line.
———	H35	INITIAL STATUS IN STEP X	Current operation is first status command.
———	H36	INITIALIZE DATA IN STEP X	Current operation is initialize data (write address).
———	H37	UNIT TABLE/X DRIVE(s), A, B. . .	Contents of unit table. X = number of drives. A, B. . . = units selected.
———	H40	PROTECT X/D THEN READY UNIT Y	X = U or L. (Switches are located behind door).
102002	H41	CLEAR X/D PROTECT, LOAD, PUSH RUN	The disc drive must be ready before RUN is pushed.

T-REGISTER	CONDITION CODE A-REGISTER	MESSAGE	TEST DESCRIPTION OR OPERATOR ACTION
———	H42	UNIT X ATTENTION SET	Interrupt was unexpected.
102001	E43	DMA MISSING	In 2100, board A9 may be missing.
———	H44	SEEK IN STEP X	Current operation is seek.
———	H45	WRITE IN STEP X	Current operation is write.
———	H46	READ IN STEP X	Current operation is read.
102001	E47	DATA WORD XXXX IS YYYYYY SHOULD BE ZZZZZZ	The data return on a read operation did not match the expected data. This message is typed only for the first erroneous word in the buffer (except for CB in Section 6).
102006	E50	UNIT X MISSING — PRESENT A, B ——— (NONE)	This message is output whenever the selected unit (x) is not ready. Any other units found to be ready are shown.
———	H51	CYL XXXX HEAD XX SECTOR XX WORD COUNT XXXX UNIT XX	This message appears with most error printouts. It reports the current contents of software variables.
102001	E52	BUFFER CHECKSUM XXXXXX CYL XXXXXX (YYYY) HD/S XXXXXX (H=YY S=YY)	The checksum should be zero and the address in parenthesis (decimal) should match the one typed out in the next H51. (XXXXXX = values in octal.) Either the wrong sector was read or a data occurred. See Note.

NOTE: *Each sector is checksummed separately. The entire sector sums to zero. This six-digit octal sum is reported as the buffer checksum.*

The first two words sum to the cylinder number. This six-digit octal sum is reported as the CYL. In addition, the four-digit decimal equivalent is shown in parenthesis. This equivalent is meaningless if the sum is an invalid cylinder number.

Words two and three sum to the head/sector number. The head is in the left half of the word and the sector is in the right half. This six-digit octal sum is reported as the HD/S. The decimal equivalent for each is shown in parenthesis. These values may also be meaningless for an invalid head or an invalid sector.

18

T-REGISTER	CONDITION CODE A-REGISTER	MESSAGE	TEST DESCRIPTION OR OPERATOR ACTION
———	H53	AVERAGE MINIMUM SEEK TIME XX.X	Time is in milliseconds. Seek covers one cylinder (length = 1).
———	H54	AVERAGE RANDOM SEEK TIME XXXX.X, LENGTH XX.XX	Time is in milliseconds and length is in cylinders.
———	H55	ENTER INSTRUCTIONS	Request for input in Section 6. (See Appendix A.)
———	H56	UNDEFINED LABEL XX	Operator must define label or erase reference.
102001	E57	SCREEN TEST ERROR-CHANNEL X	The flag on channel X sets when some other STF Y (Y ≠ X) is issued.
———	H60	REFINE IN STEP X	Current operations is refine record.
———	H61	———	Used to report current operation messages. (Not seen by user.)
———	H62	TYPE A FOR HEADS 0, 1; B for 2, 3; C for ALTERNATELY 0, 1 THEN 2, 3	Select heads. (A = disc pack, B = fixed disc, C = both.) Always use A for 7901.
102001	E63	NO DATA FLAG	A device flag was expected on the data channel and did not occur.
102001	E64	STATUS IS XXXXXX SHOULD BE XXXXXX	The status operation did not return the expected status. Values are in octal.
———	H65	LONG (SHORT) PASS XXX, HEADS Y/Y, UNIT Z, AAAA ERRORS (,MULTI-DRIVE)	Short replaces long if switch bits 1, 5 or 6 have been set during pass. Multi-drive is added if step 55 is run. A pass is once through Sections 1 to 5.
102002	H66	SET OVERRIDE SWITCH, PUSH RUN	Operator request in Section 1.
102002	H67	CLEAR OVERRIDE SWITCH, PUSH RUN	Operator request in Section 1.
102002	H70	UNLOAD UNIT XX, PUSH RUN	Operator should place the indicated unit off-line.

T-REGISTER	CONDITION CODE A-REGISTER	MESSAGE	TEST DESCRIPTION OR OPERATOR ACTION
102002	H71	PRESS PRESET(s) THEN PRESS RUN	To test POPIO line.
102002	E72	UNIT X NOT READY	Not ready bit in status word indicates drive is not ready for one of the following reasons:

Not ready bit in status word indicates drive is not ready for one of the following reasons:

a.   Drive not on line.

b.   Drive not up to speed and heads not yet loaded.

c.   Drive fault.

OPERATOR DESIGN PROCEDURE

1. Program will type "H55 ENTER INSTRUCTIONS"

2. Enter instructions in their execution sequence. Select instructions from the list in this Appendix. Commas separate fields. A field is defaulted if it is excluded from the instruction or skipped by the instruction.

    Example: "SR" seeks cylinder 0, head 0 and sector 0.

    "SR,,1" seeks cylinder 0, head 1 and sector 0.

    "SR,202,3,11" seeks cylinder 202, head 3 and sector 11.

    Complete the line with a CARRIAGE RETURN and a LINEFEED.

3. If any error has occurred, the message "H31 INPUT ERROR" will be typed. The erroneous entry has been rejected and should be typed again.

4. RUBOUT may be used to erase the present entry before the LINEFEED has been sent. EE (Erase Entry) erases the last line in the input string. The instruction may be repeated to erase multiple lines.

5. The AR, CD, DS, ID, IS, RD, RR, RS, SR and WD instructions include a software status check unless they are followed by a SC instruction. The expected status is zero. The SC instruction allows use of a different expected status.

6. Field limits are as follows:

    a. $0 \leqslant$ Cylinder $\leqslant 202$

    b. $0 \leqslant$ Head $\leqslant 3$

    c. $0 \leqslant$ Sector $\leqslant 23$

    d. $1 \leqslant$ Read or Compare Buffer Size $\leqslant 1024$

    e. $1 \leqslant$ Write Buffer or Check Data Count $\leqslant 6144$

    f. $0 \leqslant$ Unit Number $\leqslant 3$

    Except for type d, no limit checks are made on numerical fields. If the limits are exceeded, fields may merge and produce unusual results (especially cylinder, head and sector). All numerical fields are decimal unless specified as octal in the instruction list.

7. Any time bit 3 of the switch register is reset, control is given back to START when the next instruction is reached.

8. An EN or LP instruction will be rejected if undefined labels exist.

9. To initialize a pack on drive X, use the following input:

       SD,X
       FU   (or FL for fixed disc — 7900)
       EN

10. Labels are exactly two characters. All printing characters are legal. Spaces are skipped.

11. No facility is provided to restart programs.

12. Following an H16 overflow message, the program may be shortened by using the EE instruction or completely erased using the EP instruction. (Or by making sure that the diagnostic configurator is located outside of the first 8K of core.)

13. Sample Program

       SD,0   Select drive 0.

       DB,,127236   Form a 128-word write buffer using the octal pattern 127236.

       SR,97,1,4   Perform a seek operation to cylinder 97, head 1 and sector 4.

       WD   Transfer 128 words of the write buffer into one sector at the above address.

       LB,NN   Label

       SR,97,1,4   Perform a seek operation to cylinder 97, head 1 and sector 4.

       RD   Transfer 128 words from the above disc address into the read buffer.

       CB,,10   Compare the read and write buffer. The first ten words which do not compare are reported.

       GO,NN   Return to label.

       EN   End

NOTE: Brackets in the following instruction list indicate fields that may be omitted. The example above does not show brackets; it shows instructions as they would appear in a program.

OPERATOR INSTRUCTION LIST — S6

INSTRUCTION	FUNCTION

AR $\left[,\text{[CCC]}\ \left[,\text{[H]}\ [,SS]\right]\right]$

Address Record. This instruction sets up the RAR. Default condition sets RAR to zero. (CCC = cylinder, H = head, SS = sector.)

CB $\left[,\text{[XXXX]}\ \ [,YY]\right]$

Compare Buffers. The indicated number of words of the write buffer are compared with the read buffer. Default case is 128 words and 1 error printout. (XXXX = word count.) (YY = allowed number of error printouts.)

CD [,XXXX]

Check Data. A cyclic check of disc data is done on the largest integral number of sectors contained in the word count of this instruction. First sector checked is that one currently addressed by the RAR. Default case checks 128 words (1 sector). (XXXX = word count.) End of cylinder may occur.

CE

Seek and loop on cylinder 95, 100 or 105 if switch register bits 0 and 1 are 00, 01 or 10. If the bits are 11, continue.† HEAD = bit 5 * 2 + bit 4.

DB $\left[,\text{[XXXX]}\ \left[,YYYYYY[,C]\right]\right]$

Define Buffer. The write buffer has the indicated number of words filled with the indicated pattern. Default case fills 128 words. Default pattern causes each word to be random. (XXXX = word count, YYYYYY = pattern word in octal.)

If C is present and pattern is not random, the pattern is complemented in successive words. Maximum word count = 1024.

DS $\left[,\text{[CCC]}\ \left[,\text{[H]}\ [,SS]\right]\right]$

Decrement Seek. This instruction will do an initial seek to the location specified in this instruction and will decrement the cylinder by 1 each time it is executed until it reaches cylinder zero. Following cylinder 0, it will seek to cylinder 202. Default condition sets RAR to zero.

EE

Erase Entry. Last instruction entered by operator is erased.

†NOTE: *A special alignment cartridge is provided by the manufacturer of the cartridge disc. Use of the alignment cartridge is described under "Maintenance" in Cartridge Disc Manual (HP 07900-90002).*

A-3

INSTRUCTION	FUNCTION

INSTRUCTION

EN [,LL]

EP

FL

                                        LB, NN
                                          IS,,2
                                          ID
                                          IS,,2
                                          CD,6144
                                          RT,NN,202

FU

                                          LB,NN
                                          IS
                                          ID
                                          IS
                                          CD,6144
                                          RT,NN,202

GO,LL

HT [,XXXXXX]

ID [, [XXXX] [$\frac{D}{P}$]]

FUNCTION

End. Terminates instruction entry. The label portion of this instruction is the start address. In the default case, the program will execute from the first instruction (LL = label). This instruction starts execution.

Erase program. S6 is restarted.

Format Lower Disc. 7900 only. This instruction is the same as the following:

Format Upper disc. This instruction is the same as the following:

GOTO. Go to label (LL = label).

Halt. This instruction halts and displays value in A-register. Zero is displayed in the default case. (XXXXXX = display value in octal.)

Initialize Data. This instruction requires that the override switch be ON to allow access to the sector address words on the disc. This command results in the contents of the record address register being placed in the sector the RAR currently references. If the defective cylinder indication (D) is added to this instruction, the sector is tagged defective. If the protect cylinder indication (P) is added to this instruction, the sector is tagged as protected. This process is repeated on as many sectors as the word count allows. The default case writes 6144 words. (XXXX = word count.)

INSTRUCTION	FUNCTION
IS [, [CCC] [, [H] [,SS]]]	Incremental Seek. This instruction will do an initial seek to the location specified in this instruction and will increment the cylinder by 1 each time it is executed until it reaches cylinder 202. Following cylinder 202 it will seek to cylinder 0. Default condition sets RAR to zero.
LB,LL	Label. Define location of label. (LL = label.)
LP [,LL]	Loop. (Similar to EN.) Program starts at LL, but loops back to beginning.
RD [,XXXX]	Read Data. Transfer the number of words indicated from the disc to the read buffer. Location on disc is determined by RAR. Default case is 128 words. (XXXX = word count.) Maximum word count is 1024. End of cylinder may occur.
RL	Reload. Reset RAR to last loaded value. Useful when using RS.
RR	Refine Record. A straddle erase* is performed on the sector currently contained in the RAR address.
RS	Random Seek. This command will cause a random cylinder-head-sector combination to be generated and will then seek to the random location.
RT,LL,X	Repeat. Return to the indicated label (LL = label) the indicated number of times (X = number of times to repeat in decimal.)
SC [,XXXXXX]	Status Check. The previous hardware status is compared against expected status. If the status does not compare, an error is printed. Default status is zero. This instruction does not change the current operation message. (XXXXXX = expected status in octal.)
SD,X	Select Drive. Indicated drive is selected. (X = drive number; $0 \leqslant X \leqslant 3$.)

STRADDLE ERASE — A special recovery procedure performed on sector to improve magnetic characteristic of data.

A-5

INSTRUCTION	FUNCTION
SR [, [CCC] [,[H] [,SS]]]	Seek Record. This instruction sets up the RAR. A seek is then performed to the disc location defined by the RAR. Default condition sets RAR to zero. (CCC = cylinder, H = head, SS = sector.)
ST	Status. A hardware status operation is performed.
VL	Verify Lower Disc. 7900 only. This instruction checks status except for bits 3 (flagged cylinder) and 10 (Write protected). This instruction is the same as the following:

        LB,NN
        IS,,2
        CD,6144   (Special Status Check)
        RT,NN,202

VU	Verify Upper disc. This instruction checks status except for bits 3 (flagged cylinder) and 10 (write protected). This instruction is the same as the following:

        LB,NN
        IS
        CD,6144   (Special Status Check)
        RT,NN,202

WD [,XXXX]	Write Data. Transfer indicated number of words from write buffer to disc. Location on disc is determined by RAR. Default case is 128 words. (XXXX = word count.) End of cylinder may occur.

APPENDIX B

STATUS WORD BIT DEFINITIONS

BIT	STATUS INDICATION

0   Any Error — The bit will be set whenever any of the following status word bits are on:

Bit 1:	Data Error
Bit 2:	Drive Busy
Bit 3:	Flagged Cylinder (when write operation attempted and override switch not on)
Bit 4:	Address Error
Bit 5:	End of Cylinder
Bit 6:	Not Ready
Bit 8:	Seek Check
Bit 10:	Write Protected (when write operation attempted)
Bit 11:	Drive Unsafe
Bit 13:	Overrun
Bit 14:	First Seek

1   Data Error — Access ready went low during data transfer or data error was detected by the error detection circuitry.

2   Drive Busy — Drive is in a seek mode or is not ready.

3   Flagged Cylinder — Cylinder being processed is write protected or defective or the initialize data command has been issued with the override switch off.

4   Address Error — The address read from the track does not compare with the contents of the RAR. Set for defective cylinder indication.

5   End of Cylinder — The CPU has attempted to extend a data command across a cylinder boundary.

6   Not Ready — Heads are not loaded on the select drive.

8   Seek Check — Drive has detected illegal cylinder or sector transfer or a cylinder transfer was attempted while drive was already accessing.

10   Write Protected — Write protect switch in the selected drive is on.

11   Drive Unsafe — Drive has detected unsafe condition in the Read/Write or servo system.

13   Overrun — A late data response has been detected.

14   First Seek — Drive has gone from not ready to ready.