

**MANUAL SUPPLEMENT**  
**DIAGNOSTIC PROGRAM PROCEDURES**  
**for**  
**12606B**  
**DISC MEMORY INTERFACE KIT**

Note

Effective 1 July 1970 this preliminary manual supplement will be superseded by the HP 2770A/2771A Disc Memory Diagnostic Program Procedure (document part no. 12606-60013). The replacement text will be contained in the Manual of Diagnostics.

This supplement is part of, and should be attached to, the 12606B Drum Memory Interface Kit Operating and Service Manual.

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## SECTION I

### GENERAL INFORMATION

#### 1-1. INTRODUCTION.

1-2. This is a diagnostic test program. It contains a series of routines that test the reliability of all programmable features of a Hewlett-Packard 12606B Disc Memory Interface Kit and an HP 2770A/-001/-002/-003 or 2771A/-001/-002/-003 Disc Memory.

#### 1-3. EQUIPMENT REQUIRED.

##### 1-4. INSTRUMENTS:

- a. Computer: HP computer with DMA option.
- b. Teleprinter: HP 2752A or equivalent.
- c. Punched Tape Reader: HP 2737A or equivalent.
- d. Disc Memory: HP 2770A/-001/-002/-003 or 2771A/-001/-002/-003.
- e. Disc Memory Power Supply: HP 2772A.

##### 1-5. ACCESSORIES:

- a. Teleprinter Interface Kit, HP 12531B.
- b. Punched Tape Reader Interface Kit, HP 12532A.
- c. Data Channel Interface Card, HP 12606-6001.
- d. Command Channel Interface Card, HP 12606-6002.
- e. Interface Cable, HP 12606-6004.
- f. Main Power Cable, HP 8120-0078.

g. AC Power Interconnecting Cable, HP 02770-6003.

h. DC Power Interconnecting Cable, HP 02772-6003.

#### 1-6. DIAGNOSTIC TAPE AND PROGRAMS.

##### Note

The part number of a program tape includes a suffix letter which identifies a particular revision of the tape. The first issue of a tape is identified by the letter A. Subsequent revisions are identified in alphabetical sequence as B, C, D, etc. If revision of a tape requires changes of associated documentation, an updating supplement for the documentation is supplied when the new tape is furnished. Always use the latest revision of a program tape, even if different from that specified in this manual, together with all updating documentation.

- a. Diagnostic Tape, HP 20346C.
- b. SIO Buffered Teleprinter Driver:
  - 4K Memory — HP 20322A
  - 8K Memory — HP 20323A
  - 16K Memory — HP 20330B
- c. SIO Buffered Punched Tape Reader Driver:
  - 4K Memory — HP 20303A
  - 8K Memory — HP 20306A
  - 16K Memory — HP 20319A

## SECTION II

### PREPARATION

#### 2-1. INTRODUCTION.

2-2. This section contains instructions for assembling a complete disc memory system of Hewlett-Packard components.

#### 2-3. PRINTED CIRCUIT CARDS.

##### CAUTION

Turn off computer power before removing or inserting cards to prevent damage to cards, computer, or both.

#### 2-4. PUNCHED TAPE READER CARD.

2-5. Insert punched tape reader interface card into an appropriate I/O slot in the computer.

#### 2-6. TELEPRINTER CARD.

2-7. Insert teleprinter interface card into an appropriate I/O slot in the computer.

#### 2-8. DISC CONTROLLER CARDS.

2-9. Insert the data channel and command channel interface cards into any two adjacent I/O slots with the 12606-6001 card in the higher priority location of the two. The track-protect switch will be located between the interface cards when they are correctly inserted. Interrupt priority to the disc controller interface cards is not necessary.

#### 2-10. CABLES.

##### 2-11. INTERFACE CABLE.

2-12. Connect the Interface Cable (12606-6004) from the interface cards to the disc memory.

##### CAUTION

Do not connect the AC Power Interconnecting Cable (02770-6003) to a power source other than the disc memory power supply (connector J2).

##### 2-13. POWER INTERCONNECTING CABLES.

2-14. Connect the DC Power Interconnecting Cable (02772-6003) and the AC Power Interconnecting Cable (02770-6003) between the disc memory and the disc memory power supply.

##### 2-15. MAIN POWER CABLE.

2-16. Connect the Main Power Cable (8120-0078) from the disc memory power supply to 115 volts ac.

##### 2-17. DISC MEMORY.

2-18. Turn on the disc memory power supply and the computer.

2-19. Adjust the helium pressure to the disc memory as follows:

a. Read the low pressure gauge on the regulator, visible from the right side of the disc memory; pressure should be 1/4 psi to 1/2 psi, cold.

b. If necessary, adjust the helium pressure by bleeding; bleed by pulling down on the plunger valve located on the chassis, above and in front of the low pressure gauge. Helium pressure will rise as the disc warms up.

## SECTION III

### TEST INFORMATION

#### 3-1. INTRODUCTION.

3-2. This section contains general instructions and tables to be used with the test procedures in Section IV.

#### 3-3. NUMBER OF TRACKS.

3-4. Data is stored on the disc in parallel on double-circle tracks. Each track contains 90 (132 octal) sectors and each sector 64 words. Each word has 16 bits plus a parity bit. To determine the number of tracks in a given disc memory, note the HP Model number on the back of the top plate, next to the pressurized housing, and compare it to those listed in table 3-1.

Table 3-1. Table of Disc Memory Tracks

HP MODEL NUMBER	NUMBER OF TRACKS
2770A	32 (40 octal)
2770A-001/-002/-003	64 (100 octal)
2771A	64 (100 octal)
2771A-001/-002/-003	128 (200 octal)

#### 3-5. DATA TRANSFER BLOCK SIZES.

3-6. Table 3-2 lists the capacity of various core memories to store data en bloc. This characteristic of a core memory limits the quantity of data that can be written into the disc memory or read out of it in a single block.

Table 3-2. Table of Core Memory Data Transfer Block Capacity

CORE MEMORY SIZE	DATA TRANSFER BLOCK SIZE
4096 (4K) 16 bit words	11 (13 octal) sectors or 704 words
8192 (8K) 16 bit words	74 (112 octal) sectors or 4,736 words
16,384 (16K) 16 bit words	90 (132 octal) sectors or 5,760 words

#### 3-7. CORE REQUIREMENTS FOR TEST PROGRAM.

3-8. Table 3-3 lists the core locations that will be used by the diagnostic test program.

#### 3-9. OCTAL NOTATION.

3-10. While this diagnostic test program is running, all numbers contained in input parameters or output messages are expressed in octal notation.

Table 3-3. Table of Core Requirements for Test Programs

CORE MEMORY SIZE	LOCATIONS
All Sizes	000100 – 001726
All Sizes	002000 – 005737
PLUS ONE OF THE FOLLOWING	
4096 (4K) 16 bit words	007235 – 007677
8192 (8K) 16 bit words	017235 – 017677
16,384 (16K) 16 bit words	037235 – 037677

#### 3-11. LOOPING READ OR WRITE ROUTINES.

3-12. Since some errors may not appear until after the disc has been running for several minutes, both read and write routines should be set to loop for at least 10 minutes when conducting any test (see table 3-4). The status of both read and write routines is shown by indicator lights on the computer. Indicator lights 6 through 15 in the B-register remain on steadily during a write routine. Indicator lights 6 through 15 in the B-register blink on and off during a read routine.

Table 3-4. Table of Control Settings for Looping Routines

SWITCH REGISTER BIT SET TO LOGIC "1"	REACTION UNTIL SWITCH REGISTER BIT SET TO LOGIC "0"
Bit 2	Read routine loops
Bit 1	Write routine loops
Bit 0	Both read and write routines loop

#### 3-13. VARIED TEST PATTERNS.

3-14. Several binary test patterns should be tried during the read or write routines; for example, all ones, all zeros, an even number of ones, an odd number of ones, etc. The total test running time should be at least 30 minutes.

#### 3-15. EXECUTION MESSAGE SUPPRESSION.

3-16. During execution of the read or write routines, switch register bit 3 set to logic "1" suppresses all execution error messages except "DISC NOT READY".

**3-17. READING OR WRITING BLOCKS.**

3-18. If it is desirable to read or write selected blocks of tracks or sectors, they may be specified in the following manner:

T000-001, T020-007, T040-010, T070-002

3-19. The above statement would read or write the following octal track addresses:

000, 020 021 022 023 024 025 026, 040  
041 042 043 044 045 046 047, 070 071

3-20. Sector block S020-004 would write the following sector addresses:

020 021 022 023

**3-21. PARAMETER SPLIT BETWEEN LINES.**

3-22. A virgule( / ) is used to continue a statement on the next 72 column line. It must appear prior to or in column 72. No parameter may be split between two lines, as shown in the following example:

T000-001- - - - - T060-/  
001 etc.

3-23. If such a split is encountered, the following message is printed:

“WRITE PARAMETER INCOMPLETE”.

3-24. The correct format for continuing a statement on the next line is as follows:

T000-001- - - - - T060-001 /  
T061-003 etc.

**3-25. COUNTING ERRORS WITHOUT THE TELE-PRINTER.**

3-26. To run the diagnostic test program for long periods with the teleprinter off and still keep a record of accumulated word errors, it is only necessary to set switch register bits 0 and 3 to logic “1”. Bit 0 set to logic “1” enables read and write routines to loop. Bit 3 set to logic “1” inhibits the teleprinter and enables each word error to increment an error counter, comprising memory locations 001700 and 001701. After 65,536 increments location 001700 overflows and each subsequent word error increments location 001701. When the total count of word errors is 131,072, the counter is reset and counting continues.

3-27. When switch register bits 0 and 3 are reset to logic “0”, the teleprinter prints “BINARY TEST PATTERN?”. The error counter (locations 001700 and 001701) must be read before entering a new binary test pattern. Entering a new pattern will reset the error counter.

**3-28. RETURNING TO “BINARY TEST PATTERN?”.**

3-29. After the messages “DMA OCTAL CHANNEL #?” and “HIGH PRIORITY OCTAL ADDRESS?” have been initiated, address 002042 can be used at any time to return the program to the point where the teleprinter prints “BINARY TEST PATTERN?”.

**3-30. GLOSSARY OF DIAGNOSTIC MESSAGES.**

3-31. “DISC NOT READY”

3-32. After this message is printed, the routine halts and allows the user to ready the disc memory for data transfer. If RUN is pressed before the disc memory is ready, the teleprinter will continue printing the message. This message usually indicates a malfunction of the “disc ready” status bit. This message has the same meaning for both the write and read routines.

3-33. “ERROR BUSY STATUS BIT DURING WR/RD”

3-34. After this message is printed, the routine does not halt and the current operations are completed normally. The “busy” status bit is checked just before the initiation of a write or a read operation for a “not busy” condition. If either condition is false at the appropriate time, this message is printed.

3-35. “WRITE (or READ) ABORT—TRACK”  
020 (000-177)

3-36. This message indicates one or more of the following: a malfunction of disc power, overheating of the disc unit, helium pressure low, a power failure has occurred, or a write or read was attempted on either a protected or a nonexistent track address.

3-37. “WRITE (or READ) INTERRUPT MISSING”  
“DMA WORD COUNT = ” 16777

3-38. This message indicates that, after a write operation is initiated, no interrupt occurred within approximately 100 ms. By inspecting the DMA word count, the user can determine whether any words were transferred and, if so, how many prior to time-out. The DMA word count is output in 2s complement form. The routine does not halt after printing this message.

3-39. “READ PARITY ERROR”

3-40. This message indicates that a parity error occurred while reading a word.

3-41. “READ (or WRITE) SECTOR BUFFER OVERFLOWED”

3-42. This message occurs when more than 92 entries into the write or read sector buffer are specified for any series of “S” parameters.

## 3-43. "READ PARAMETER INCOMPLETE"

3-44. This message occurs if an illegal character is used in, or a character is missing from, any read parameter.

## 3-45. "WR/RD WORD COUNT EXCESSIVE"

3-46. This message occurs if a data transfer block size greater than available core memory is specified by single "S" parameter.

## 3-47. "IMPROPER CHARACTER IN WR/RD PARAMETER"

3-48. This message occurs when a character in a write or a read parameter is missing or has been replaced by an illegal character.

## 3-49. "CHARACTER IN OCTAL PARAMETER ILLEGAL"

3-50. This message occurs when any character other than numerals 0 through 7 is used in an octal parameter. One example of an illegal character is the symbol @.

## 3-51. "WR/RD PARAMETER EXCEEDS 72 CHARACTERS"

3-52. This message occurs when a line has exceeded 72 columns.

## 3-53. "WRITE PARAMETER INCOMPLETE"

3-54. This message occurs when a parameter entry has been split between two lines.

## 3-55. "BINARY PARAMETER EXCEEDS 72 CHARACTERS"

3-56. This message occurs when a binary test pattern parameter contains an excessive amount of leading blanks. This usually happens while using a punched tape reader input.

## 3-57. "ILLEGAL CHARACTER IN TEST PATTERN PARAM"

3-58. This message occurs when a binary test pattern parameter contains a syntax error.

**3-59. SWITCH REGISTER CONTROL SETTINGS.**

3-60. Table 3-5 lists the various switch register settings that control execution of the diagnostic test program.

Table 3-5. Table of Switch Register Control Settings

BIT NUMBER	LOGIC SETTING	REACTION
15	0	Input from teleprinter
	1	Input from punched tape reader
14	0	Normal sector buffer input
	1	Preset sector buffer input
11	0	Bypass or exit track address test
	1	Loop on track address test
3	0	Execute write/read test error printout
	1	Bypass all write/read test error printout
2	0	Normal execution of read test routine
	1	Loop on read test routine
1	0	Normal execution of write test routine
	1	Loop on write test routine
0	0	Normal execution of read/write test routine
	1	Loop on read/write test routine

## SECTION IV

### TEST PROCEDURE

#### 4-1. ENABLING AND LOADING.

4-2. Start the diagnostic test procedure as follows:

a. Turn on power to the entire system.

b. Allow several minutes for the disc to reach full speed, then check the three lamps on the left side of the disc memory.

c. When all three lamps are out, load and configure the SIO buffered teleprinter driver and the SIO buffered punched tape reader driver tapes if necessary.

d. Load the diagnostic tape. When loading is completed, check for HLT 77B, 102077 (octal) in the T-register. If the T-register does not read 102077 (octal) reload the diagnostic tape and check again.

e. When the T-register reads 102077 (octal), turn on the teleprinter.

#### 4-3. TRACK-PROTECT TEST.

4-4. Test the track-protect circuit as follows:

a. Set track-protect switch to the up position, away from the center of the card (PROTECTED). The switch is located on the Data Channel card (12606-6001). Load address 002000, set all switch register switches to "zero," press PRESET and RUN.

b. "DMA OCTAL CHANNEL #?" will be printed by the teleprinter. The answer input should be a two digit number 06 or 07 followed by pressing RETURN and LINE FEED. If inputs other than these two are given, the program repeats the inquiry message and waits for a proper input.

c. "HIGH PRIORITY OCTAL DISC ADDRESS?" will be printed by the teleprinter. The answer input should be the I/O Select Code of the Data Channel card (12606-6001). Each answer input must be followed by pressing RETURN and LINE FEED. "NO. OF PROTECTED TRACKS —" followed by a three digit octal number, should be printed by the teleprinter to indicate the total number of protected tracks.

d. Press HALT. Set the track-protect switch to the down position, toward the center of the card (no tracks protected).

e. Load address 002000.

#### 4-5. TRACK ADDRESS TEST.

4-6. This test routine checks all track heads for opens and shorts. It writes the self-address of each track, sector 000, and then reads each track, checking for self-address. The routine assumes the tracks start with 000 and end with the maximum number, in a sequential manner.

4-7. If switch register bit 11 is set to logic "0" before the program reaches this routine, when it does reach it the routine will be bypassed. If switch register bit 11 is set to logic "0" after entering the routine, the routine will be exited. Initialize this routine as follows:

a. Set switch register bit 11 to logic "1".

b. Press PRESET and RUN.

c. Enter the correct answer inputs in response to "DMA OCTAL CHANNEL #?" and "HIGH PRIORITY OCTAL DISC ADDRESS?" (see paragraph 4-4, "b" and "c").

4-8. The initial inquiry message printed by the teleprinter is:

"NO. OF TRACKS?"

4-9. The answer input should be a three-digit octal number representing the total number of tracks (see table 3-1), not the last track address.

4-10. If an error is encountered, a message similar to the following example is printed:

"TRACK ADDRESS ERROR  
EXPECTED TRACK—006 ACTUAL TRACK—014"

4-11. The octal values in the example mean track 006 was addressed, but track 014 was actually read; or when writing track 014, it was actually written on track 006.

4-12. Switch register bit 11 may be set to logic "0" immediately after the routine is entered into, since one execution of the routine provides a sufficient test. When the routine is exited, the following message is printed:

"TRACK ADDRESS CHECK COMPLETE"

#### 4-13. READ/WRITE TEST.

4-14. This is the main routine in the diagnostic test program. It writes and reads user-selected word patterns on any sector or group of sectors and on any track or group of

tracks. After reading word patterns from the disc, the routine compares them to the word patterns that were written. When errors are encountered, messages describing them are printed by the teleprinter. The user selects word pattern content and specifies write and read parameters in response to the following messages printed by the teleprinter: "BINARY TEST PATTERN?", "WRITE TRACKS?", "WRITE SECTORS?", "READ TRACKS?", and "READ SECTORS?".

4-15. The word patterns used in this routine are composed of 16-bit binary words in 64-word sector buffers. Any combination of sixteen logic "0s" and "1s" can be used in a word. A sector buffer can be formed in any of the following optional ways:

- a. A 64-word series of one 16-bit word repeated.
- b. A 64-word series of one 16-bit word and its complement repeated alternately.
- c. A 64-word series of any combination of 16-bit words.

4-16. The first two 64-word sector buffers, option "a" and option "b", are written into core memory from the teleprinter keyboard. The third, option "c", is written into core memory from the switch register.

4-17. If switch register bit 15 is set to logic "1", the punched tape reader will input answers to read and write parameter requests (such as "WRITE TRACKS?"). Errors encountered on the tape can be corrected via the teleprinter as follows:

- a. Set switch register bit 15 to logic "0".
- b. After the diagnostic message is printed, press RUN.
- c. Enter the corrected parameter from the teleprinter.
- d. Set switch register bit 15 to logic "1".
- e. Press RETURN or LINE FEED on the teleprinter.

4-18. The Read/Write Test routine starts by checking switch register bit 14. If bit 14 is a logic "0", the teleprinter prints the following initial message:

"BINARY TEST PATTERN?"

4-19. At this point the user can form either of two 64-word sector buffer options described in paragraph 4-15, option "a" or option "b". The answer input in response to this message is contained in an 18-character field, as shown in the following example:

1100110011001100CC

4-20. The first sixteen characters are any combination of logic "0s" and "1s". The last two characters can be either "Cs" or blanks. In the example, the first "C" (character 17) indicates every alternate word of the 64-word sector buffer

will be the complement of the initial word in the sector buffer (option "b"). The second "C" (character 18) indicates every sector will be the complement of the preceding sector. If both characters 17 and 18 are blanks, one 16-bit word will be repeated 64 times (option "a") and all sectors will be the same. Any syntax error in the binary test pattern parameter causes the teleprinter to print the following message:

"ILLEGAL CHARACTER IN TEST PATTERN PARAM"

4-21. When the Read/Write Test routine starts, if switch register bit 14 is a logic "1", the computer halts. At this point the user can form the third 64-word sector buffer option described in paragraph 4-15, option "c", as follows:

- a. Set in the switch register and load into core memory a 64-word series of any combination of 16-bit words.
- b. After sixty-four switch register words are loaded into memory, press RUN twice. The routine will proceed to request write and read parameters.

4-22. After the sector buffer is formed, the teleprinter prints the following message:

"WRITE TRACKS?"

4-23. The answer input depends on the number of tracks in the disc memory (see table 3-1). It consists of the character "T" followed by two groups of three digits each. For example, T000-200. The character "T" identifies the instruction as a track location. The first three digits are the octal value of the starting track address (range 000-177). The second group of three digits is the octal value of the number of consecutive tracks to be written. The example, T000-200, would write 200 tracks (128 decimal) starting at track zero.

4-24. The next message printed by the teleprinter is the following:

"WRITE SECTORS?"

4-25. With a computer that has an 8K (8192 words) memory, one possible answer input is S000-100, S100-032. This will write sectors 0 through 77 octal, and then sectors 100 through 131. The character "S" identifies the instruction as a sector location. The first and second groups of three digits carry the same information as they do in the response to "WRITE TRACKS?". To cover the entire 132 sectors, the answer input must be made in two statements because the sector buffer can handle only 112 octal locations in one transfer. See table 3-2 for data transfer block capacities of other memory sizes.

4-26. The teleprinter next prints the following message:

"READ TRACKS?"

4-27. The answer input for this message is identical to the response to "WRITE TRACKS?". See paragraph 4-23.

4-28. The final read parameter message printed by the teleprinter is the following:

“READ SECTORS?”

4-29. The answer input for this message is identical to the response to “WRITE SECTORS?”. See paragraph 4-25.

4-30. After a read operation is executed, a comparison of input data is made and any error conditions are printed in the following format:

“TRACK” 000 “SECTOR” 000 “WORD NO.” 00  
“OUTPUT” 000000 “INPUT” 000001

4-31. “TRACK” will range from 000 to 177, “SECTOR” from 000 to 131, and “WORD” from 00 to 77. “OUTPUT” is the octal equivalent of a 6-digit word output from the computer to the disc. “INPUT” is the octal equivalent of a 6-digit word input to the computer from the disc (error).

#### 4-32. SECTOR TIMING TEST.

4-33. Write a pattern over the entire disc. Read the disc in overlapping blocks and sectors as in the following example of an overlapping test. (See paragraphs 3-18, 3-19, and 3-20 for further information.)

“BINARY TEST PATTERN?”  
111000001111000000  
“WRITE TRACKS?”  
T000-040  
“WRITE SECTORS?”  
S000-100, S100-032  
“READ TRACKS?”  
T000-040, T000-020, T020-020, T007-023  
“READ SECTORS?”  
S000-100, S100-032, S011-100

#### 4-34. POWER FAILURE TESTS.

4-35. Primary power to the disc memory should be turned off and back on during a read cycle and during a write cycle. When power is turned off during a read cycle, there must be no resulting errors. When power is turned off during a write cycle, the entire data transfer may have errors. This is the only time, however, during the entire diagnostic test program that errors are permissible. Every failure of primary power to the disc memory should result in the teleprinter printing one or more of the following: “DISC NOT READY”, “WRITE ABORT-TRACK”, “READ ABORT-TRACK”, “WRITE INTERRUPT MISSING”, “READ INTERRUPT MISSING”.

#### 4-36. POWER FAILURE, READ CYCLE.

4-37. To check the power failure circuits the binary test pattern must be identical for both the read and write cycles. Proceed with the test as follows:

a. On completion of the last binary test pattern check, set all switch register switches to logic “0”. When the teleprinter prints “BINARY TEST PATTERN?”, enter 1100110011001100CC.

b. When the teleprinter prints “WRITE TRACKS?”, enter the total number of tracks available (see paragraph 4-23).

c. When the teleprinter prints “WRITE SECTORS?”, enter the total number of sectors (see paragraph 4-25).

d. After the write statements have been executed, when the teleprinter prints “READ TRACKS?”, enter the same answer input as for “WRITE TRACKS?”.

e. When the teleprinter prints “READ SECTORS?”, set switch register bit 2 to logic “1” and enter the same answer input as for “WRITE SECTORS?”.

f. While the read routine is looping, turn off the power switch on the disc memory power supply.

g. Wait for the teleprinter to print “DISC NOT READY”, then turn on the power switch.

h. Allow the disc to reach full speed, then press RUN.

i. Wait 2 minutes, then set switch register bit 2 to logic “0”.

#### 4-38. POWER FAILURE, WRITE CYCLE.

4-39. To check the power failure circuits during a write cycle proceed as follows:

a. When the teleprinter prints “BINARY TEST PATTERN?”, enter 1100110011001100CC.

b. When the teleprinter prints “WRITE TRACKS?”, enter one track address, for example, T050-001.

c. When the teleprinter prints “WRITE SECTORS?”, set switch register bit 1 to logic “1” and enter one sector address, for example, S050-001.

d. While the write routine is looping on one track and one sector, turn off the power switch on the disc memory power supply.

e. With the computer halted, wait for the teleprinter to print “DISC NOT READY”, then turn on the power switch and allow the disc to reach full speed.

f. Set switch register bit 1 to logic “0”, load address 002042, then press PRESET and RUN.

g. Enter the binary test pattern:  
1100110011001100CC.

h. When the teleprinter prints "WRITE TRACKS?" and "WRITE SECTORS?", the answer input for both should be SPACE, RETURN, and LINE FEED. Do not enter a track or a sector address.

i. When the teleprinter prints "READ TRACKS?",

enter the total number of tracks available (see paragraph 4-23).

j. When the teleprinter prints "READ SECTORS?", enter the total number of sectors available (see paragraph 4-25). Errors must be confined to a chosen track and sector, for example, Track 50, Sector 50.

# HP 2100A FIXED HEAD DISC/DRUM DIAGNOSTIC

DB,,052525

Order No. HP 24207



11000 Wolfe Road  
Cupertino, California 95014

Manual of Diagnostics  
Diagnostic Program Procedure  
HP 5951-1384

July 1971

# HP 2100A FIXED HEAD DISC / DRUM DIAGNOSTIC

This diagnostic program tests input, output and control functions of either the HP 2773, 2774, or 2775 Drum, or the HP 2770, 2771 or 2766 Disc device with the HP 2100A computer.

The program rapidly checks the interface and exhaustively tests the disc device itself. The user may also design his own tests for specific functions. (This diagnostic does not check more than one disc or drum at one time.)

## HARDWARE CONFIGURATION

The program runs on an HP 2100A computer with Direct Memory Access (DMA) and at least 8192 words of core. The diagnostic checks any of the following devices:

- || HP 2773 or 2774 Drum with the HP 12610B Interface and HP 2776 Power Supply,
- || HP 2775 Drum with the HP 12610B Interface and HP 2777 Power Supply,
- || HP 2770 or 2771 Disc with the HP 12606B Interface and HP 2772 Power Supply,
- || HP 2766 Disc with the HP 12610C Interface and HP 2772 Power Supply.

A teleprinter is required to report errors and messages and to accept typed instructions from the user.

## FUNCTIONAL AND OPTIONAL CHARACTERISTICS

The teleprinter driver is loaded and configured first. The diagnostic program is then loaded and configured. To configure the diagnostic after it is loaded, the switch register is set according to Table FH-1 then the program is started. The program halts with  $107077_8$  displayed.

To avoid having to reconfigure the driver and diagnostic at later times, the SIO System Dump program is used to punch a paper tape copy of the configured driver and the configured diagnostic program.

To start a run of the diagnostic after the configuration procedures are complete or after a configured tape has been loaded, the computer is set to the starting address  $100_8$ , the program options are selected as specified in Table FH-2 and the program is started.

At the end of each diagnostic section, the user has two options: if program option bit 9 is set on, the program halts at the end of the section; then if program option bit 7 is set on, the section is repeated.

If an error is detected, the program types out one or more messages on the teleprinter and, if appropriate, halts with a MEMORY DATA value in the DISPLAY REGISTER. For most errors involving disc (or drum) operation, three messages are reported -- the current operation, the specific error and the current disc address. (See Table FH-3, message H44.)

If a trap cell halt occurs, the computer contains  $1060xx_8$  in the DISPLAY REGISTER ( $xx$  = the trap cell location). The cause of a trap cell halt must be determined by the user; after the error is corrected, the diagnostic program is restarted.

## PROGRAM ORGANIZATION

The diagnostic performs the routines described below:

**INIT**           The initialization routine sets the I/O instructions to the select codes specified in Table FH-1, and saves the DMA channel number indication (bit 14), and the select codes for use during execution.

**START**           This routine prints a preamble message. (See Table FH-3, H0.)  
**(ST)**           If program option bit 6 is set off, or if program option bit 6 is set on but no valid value for the number of sectors per track has been found previously, parameter determination occurs in one of two ways. If program option bit 4 is set off, the number of sectors per track (HP 2770/1 have 90, others have 32), number of tracks and the number of protected tracks are reported on the teleprinter. (See Table FH-3, messages H12 and H14.) At this time, the program writes in the first sector of each track. If program option bit 4 is set on, the number of sectors per track and the number of tracks may be specified by the user responding to messages typed on the teleprinter by the START routine. (See Table FH-3, messages H50 and H51.)

START then checks to see that LOADER ENABLE is clear (the loader is protected), initializes trap cells and variables, then tests the teleprinter's ability to set and clear flags and control bits. START then tests the interrupt operation of the teleprinter interface. If the SCP flip-flop fails on HP 2770/1 devices, then message E3 is reported. If the track origin fails on HP 2770/1 devices, message E2 is reported.

After one pass of the diagnostic has been executed (all program options have been performed), the START routine restarts or, if program option bit 12 was set on, the program halts with 102077<sub>8</sub> displayed. When the routine restarts (either because program option bit 12 was set off or because the user pressed RUN), it does so at a program entry point named AGAIN, which bypasses the preamble

START (cont.)

message. START then performs the ability tests again. (Program control also restarts at entry point AGAIN after S6 is aborted.)

S1 This section tests most interface functions using short reads and writes. The test occurs in the following sequence:

- Checks status.
- Changes tracks and checks status for "busy" indication.
- If the device is an HP 2770 or HP 2771, checks status for "read inhibit" following a track change.
- Checks status for "sector address" for all sector values.
- Checks sector flag timing.
- Checks "sector address coincidence" for all sector values.
- At the first track listed in the track table, writes one sector at sector zero.
- At sector seven, writes two sectors.
- At sector zero, reads back one sector and checks against the data previously written there.
- At sector seven, reads back two sectors and compares against the data previously written there.
- If the device is an HP 2770 or HP 2771, skips the next four steps; otherwise, continues below.
- At sector twenty-nine, writes four sectors causing the track to change.
- Writes over sector zero.
- At sector 29, reads four sectors and compares against the data that was written there.
- Reads sector zero and verifies the contents.
- At sector zero, writes ten words.

- At sector zero, reads one sector and checks the data to verify proper sector fill.

S2

This section writes and reads back patterns checking for bad tracks and marginal heads. The device is alternately written forwards, then backwards. The test occurs in the following sequence:

- Checks program option bit 5, skips testing in S2 if it is set on.
- If program option bit 6 is set on, selects track in sequence from track table. If program option bit 6 is set off, selects track in normal sequence.
- Performs the next seven steps ten times (once for each pattern).
- Fills the write buffer (32 sectors) with one pattern from the pattern table.
- Writes sectors 0 to 31.
- Skips the next step if the device is other than an HP 2770 or HP 2771.
- Writes sectors 64 to 89 and 32 to 63.
- Reads sectors 0 to 31 and compares the data read to what was written.
- Skips the next step if the device is other than an HP 2770 or HP 2771.
- Reads sectors 32 to 63 and 64 to 89 and compares the data read with what was written.
- Checks to see if all tracks to be tested have been tested, and if not, selects the next track (from the track table if program option bit 6 is set on, or in sequence if program option bit 6 is set off).

This section verifies proper data transfer by reading and writing random data from random locations. The steps in S3 are repeated

S3 (cont.)

in order  $1024_{10}$  times if program option bit 5 is set off, or only  $64_{10}$  times if program option bit 5 is set on.

- Generates random track, sector and word count (greater than one but less than  $1024_{10}$ ). Word counts are reduced to avoid track boundary errors when necessary.
- Generates a buffer of random data and repeats the last word in the first unused word.
- Writes the data beginning at the random address.
- Reads back and verifies the data written.

S4

This section fills the device with checksummed data for use by S5. Each sector is checksummed separately and the entire sector sums to zero. The first two words sum to the track number and the next two words sum to the sector number. The device is written following the same scheme used to write data patterns in S2. The device is alternately written forwards then backwards.

S5

This section randomly (without violating program option bit 6 setting) reads one sector, then verifies track, sector and checksum. The operation is repeated  $8192_{10}$  times if program option bit 5 is set off, or  $256_{10}$  times if program option bit 5 is set on.

S6 (OPDSN)

This section is entered only after program option bit 3 is set on. It allows the user to design and execute his own program to test disc/drum functions. Upon entry to this routine the message "H37 ENTER INSTRUCTIONS" is printed on the teleprinter. The user then selects OPDSN instructions, enters them on the teleprinter and starts execution as described in Appendix A.

## IMITATIONS

Three instructions used in the OPDSN section, DB (define buffer), RD (read data) and IR (incremental read) may use a maximum buffer of  $1024_{10}$  words.

The configuration portion of this diagnostic is located in the write buffer. The configuration portion and memory location 2 are changed once the teleprinter has been tested in the START routine.

The parity error status bit (bit 1) must be set following write operations for the HP 2770 and the HP 2771, and clear for the other devices. For ease of programming the bit is set to zero for additional status checks (including those which result in message E35). Message E7 results if the bit is not set.

This diagnostic does not test status bit 1 after a read, nor status bit 3.

## PROGRAM TIMING

When the device is making many errors, run time can be reduced by setting program option bits 11 and 14 on to suppress error reporting.

Any time program option bit 5 is set on, S2 is skipped and S5 is shortened. S3 is also shortened, but only if program option bit 5 is set on when S3 starts.

Setting program option bit 6 shortens S2 and S4, but does not affect S1 in any way.

## OPERATING INSTRUCTIONS

- a. If a configured Fixed Head Disc/Drum Diagnostic tape is available, skip to step i.

- b. Use the Basic Binary Loader to load the SIO teleprinter driver, then configure the driver.
- c. Use the Basic Binary Loader to load the unconfigured Fixed Head Disc/Drum Diagnostic tape.
- d. Set the starting address  $2_8$ . *P*
- e. Set the switch register for program configuration according to Table FH-1. *m*
- f. Press INTERNAL and EXTERNAL PRESET.
- g. Press RUN. The program halts with  $107077_8$  displayed.
- h. [Optional] Load the SIO System Dump program tape using the Basic Binary Loader and punch a paper tape copy of the configured diagnostic and the configured driver.
- i. Use the Basic Binary Loader to load the configured diagnostic tape.
- j. Set the starting address  $100_8$ . *P*
- k. Set the switch register for the desired program options as listed in Table FH-2. *P 7-11*
1. Press RUN. The program types a preamble message.

1. If program option bit 6 is set off, or if program option bit 6 is set on but no valid value for the number of sectors per track has been found previously, then the following occurs:

If program option bit 4 is set off, the program reports the number of sectors per track on the teleprinter. Then the program types messages H11 and H10, to request that the TRACK PROTECT switch be set in the down, and then up position. Then the total number of tracks and the protected track numbers are reported. The program then requests the TRACK PROTECT switch be set in the down position. The first sector of each track is written over by the program.

If program option bit 4 is set on, the program requests the number of sectors per track (message H50) and the total number of tracks on the disc (message H51). Enter the correct response after each of these questions. If program option bit 4 is set on, the first sector of each track is not written into, thereby preserving any tracks the user wishes to protect.

If program option bit 6 is set on and valid parameters have been previously found, then parameter determination in START is suppressed.

2. If program option bit 2 is set on, the diagnostic prints the track table (the ten tracks used if program option bit 6 is set on) which may be changed by the user after it has been typed. The pattern table is then typed and may be changed by the user. New table entries are placed at the top of the table and the last entry of the table is automatically eliminated. Each table is reprinted every time it is changed. (The initial track table is 0, 1, 2, 4, 8, 12, 16, 20, 25, 31; initial pattern table is octal 000000, 177777, 125252, 052525, 007417, 170360, 162745, 163346, 155555, 022222.)
3. If program option bit 3 is set on, control passes to the S6 (OPDSN) routine, which requests the user-designed program. (See Appendix A.)
4. The program continues to execute routines S1 through S5. The cycle count is incremented and reported on the teleprinter. If program option bit 12 is set on, the diagnostic halts at the end of the pass. (Press RUN to continue.) If program option bit 12 is set off, then the program returns to the entry point AGAIN which restarts the diagnostic with the routine START, without printing the preamble message (HØ).

### MESSAGE ANALYSIS

Messages to the user are printed on the teleprinter. An H prefix indicates an operating instruction while an E prefix indicates an error message. All program halts display a MEMORY DATA value in the DISPLAY REGISTER.

The meaning of all teleprinter messages and halt displays are listed in Table FH-3. Refer to the table to analyze halt conditions then press RUN to resume program execution. Numbers printed are decimal unless otherwise indicated.

When an error halt occurs, location  $111_8$  contains the starting address of the current test.

Table FH-1

Program Configuration--Switch Register Settings

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

Bits

Function

- 0-5        Set to the select code of the teleprinter.
- 6-11      Select code of the device data interface board. (The program assumes that the device command interface board is located in the next higher I/O location.)
- 12-13     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 FH-2

## Program Options--Switch Register Settings

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

<u>Bits</u>	<u>Function</u>
0-1	Spares.
2	Set on to alter track table and/or pattern table.
3	Set on to execute the operator design program (OPDSN).
4	Set on to enter device parameters in START and protect tracks from being written into during execution of the START routine.
5	Set on to shorten tests in S2, S3 and S5.
6	Set on to restrict track selection (shorten S2 and S4) and to repress parameter determination in START (if a valid value for the number of sectors per track has been found previously either through user input (program option bit 4 on) or through examination of the hardware by the program (program option bit 4 off)).
7	Set on to repeat last section.
8	Set on to repeat the last operation ON ERROR five times before reporting.
9	Set on to halt after each section of the program.
10	Set on to suppress all non-error messages for the teleprinter except current operation messages and message H44.
11	Set on to suppress all messages on the teleprinter.
12	Set on to halt the diagnostic at the end of the current pass.
13	Set on to loop the current operation.
14	Set on to suppress program halt after each error. Set off to allow program halt after each error.
15	Set on to halt program after current operation.

Table FH-3

## Diagnostic Messages

<u>MEMORY DATA</u>	<u>Routine</u>	<u>Message</u>	<u>Comments</u>
*	START	H0 HP2100A FIXED HEAD DISC AND DRUM DIAGNOSTIC	Preamble.
102001	START	E1 CLEAR LOADER ENABLE	Precaution.
102001	START	E2 CLF OR SFS FAILED-CHANNEL xx	Test the ability to clear flag and test the SFS in- struction on channel xx. Will not print with bad teleprinter. This mes- sage is printed if the track origin fails on HP 2770/1 devices.
102001	START	E3 SFC FAILED WITH FLAG CLEAR-CHANNEL xx	SFC instruction did not skip with flag clear. This message is also printed if the SCP flip-flop fails on HP 2770/1 devices.
102001	START	E4 STF OR SFC FAILED- CHANNEL xx	Test the ability to set the flag and test the SFC instruction on channel xx.
102001	START	E5 WRONG RETURN AD- DRESS - CHANNEL xx	Address stored during interrupt is incorrect.
102001	START	E6 NO INTERRUPT ON CHANNEL xx	Test the interrupt capability.
102001	Any	E7 PARITY BIT ERROR	Bit one was incorrect following a write.
*	START	H12 DEVICE HAS xx SECTORS	User information during parameter determination. (xx is decimal.)
102001	Any	E13 xxxx WORDS TRANSFERRED yyyy EXPECTED	After sufficient time, the DMA transfer was not complete.

\* no halt

Table FH-3 (cont)

<u>MEMORY DATA</u>	<u>Routine</u>	<u>Message</u>	<u>Comments</u>
*	START	H14 DEVICE HAS xxxx TRACKS, THE FOLLOWING ARE PROTECTED:	User information during parameter determination; is followed by either H63 or H64.
*	Any	H15 ADDRESS TRACK IN Sx	Current operation is track select.
*	S6	H16 OVERFLOW	Work space, between end of read buffer and end of 8K of core or beginning of teleprinter driver, whichever is less, is full.
*	S6	H17 DUPLICATE LABEL	Last input has previously been defined.
*	S6	H20 UNDEFINED INSTRUCTION	Last instruction input is not valid.
*	S1	H21 SECTOR ADDRESS CHECK IN S1	Sector address portion of status word is checked.
*	S1	H22 SECTOR FLAG TIMING CHECK IN S1	Sector flag bit in status word is checked.
*	Any	H23 READ CHECK IN Sx	Current operation is software verification of data read previously.
*	START	H24 TRACK TABLE xxx,xxx,xxx,xxx,xxx, xxx,xxx,xxx,xxx,xxx	Contents of track table.
*	START	H25 WISH TO ALTER TABLE?	Type Y or N.
*	START	H26 ENTER TRACKS SEPARATED BY COMMAS	Type track numbers, all on one line.

\* no halt

Table FH-3 (cont)

<u>MEMORY DATA</u>	<u>Routine</u>	<u>Message</u>	<u>Comments</u>
*	START	H27 PATTERN TABLE xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx	Contents of pattern Table. (xxxxxx = pattern in octal).
*	START	H30 ENTER PATTERNS SEPARATED BY COMMAS	Type patterns, all on one line.
*	S6	H31 INPUT ERROR	Bad input from teleprinter.
*	S1	H33 SECTOR ADDRESS COINCIDENCE CHECK IN S1	Sector address coincidence flag in status word is checked.
*	Any	H34 INITIAL STATUS	Current operation is first status command.
102001	Any	E35 STATUS IS xxxxxxxxxxxxxxxxxx SHOULD BE xxxxxxxxxxxxxxxxxx	The status operation did not return the expected status. Each x is 1 (on), 0 (off) or D (don't care).
*	START	H36 PASS xxxx	Number of cycles completed. (One cycle is one pass through S1 to S5.)
*	S6	H37 ENTER INSTRUCTIONS	Request for input in S6. (See Appendix A.)
*	S6	H40 UNDEFINED LABEL xx	Define label or erase reference.
*	Any	H41 WRITE IN Sx	Current operation is write.
*	Any	H42 READ IN Sx	Current operation is read.
102001	Any	H43 DATA WORD xxxx IS yyyyyy SHOULD BE zzzzzz	The data returned 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 S6).

\* no halt

Table FH-3 (cont)

<u>MEMORY DATA</u>	<u>Routine</u>	<u>Message</u>	<u>Comments</u>
*	Any	H44 TRACK xxxx SECTOR xx WORD COUNT xxxx	This message appears with most error printouts. It reports the current contents of software variables.
102001	Any	E45 BUFFER CHECKSUM xxxxxx TRACK xxxx (yyyy) SECTOR xx (yy)	The checksum should be zero and the track and sector numbers should match the ones reported in the next H44. (xxxxxx = values in octal, yyyy = values in decimal.) Either the wrong sector was read or a data error occurred.

*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 track number. This six-digit octal sum is reported as the track. In addition, the four-digit decimal equivalent is shown in parenthesis. This equivalent is meaningless if the sum is an invalid track number.*

*Words two and three sum to the sector number. This six-digit octal sum is reported as the sector. The decimal equivalent is shown in parenthesis.*

*This value may also be meaningless for an invalid sector.*

*	START	H46 DEVICE PARAMETER DETERMINATION	Current operation is parameter determination in START.
102001	START	E47 UNABLE TO DETERMINE SECTORS PER TRACK	Trouble in START.
*	START	H50 ENTER NUMBER OF SECTORS PER TRACK (32 OR 90)	Type the number (decimal).

\* no halt

Table FH-3 (cont)

<u>MEMORY DATA</u>	<u>Routine</u>	<u>Message</u>	<u>Comments</u>
*	START	H51 ENTER TOTAL NUMBER OF TRACKS	Type the number (decimal).
*	S1	H52 BUSY CHECK IN S1	Current operation is busy check.
*	S1	H53 READ INHIBIT CHECK IN S1	Current operation is read inhibit check.
102001	S1	E54 NO SECTOR AD- DRESS COINCIDENCE	
102001	S1	E55 SECTOR xx MISSING IN STATUS	xx = sector number.
102001	S1	E56 SECTOR COUNTER CHANGED BY FIRST SECTOR CLOCK	
102001	S1	E57 SECTOR COUNT OR FLAG MISSING	Time out.
102001	S1	E60 SECOND SECTOR CLOCK TOO LATE	
102001	S1	E61 FIRST SECTOR CLOCK TOO SOON	
102001	S1	E62 INCORRECT SECTOR ADDRESS	
*	START	H63 xxxx TO yyyy	Either this message or H64 follows H14. (xxxx, yyyy = track numbers.)
*	START	H64 NONE	Either this message or H63 follows H14.
102002	START	H10 SET TRACK PRO- TECT SWITCH TO UP POSITION, PRESS RUN	Switch is on data channel interface card.
102002	START	H11 SET TRACK PRO- TECT SWITCH TO DOWN POSITION, PRESS RUN.	Switch is on data channel interface card.

\* no halt

Table FH-3 (cont)

<u>MEMORY DATA</u>	<u>Routine</u>	<u>Message</u>	<u>Comments</u>
102002	START	H32 RESET SWITCH 2	Set switch register bit 2 off.
102004	Any	(none)	Orderly halt.
102005	START	(none)	SFS failed with flag set on teleprinter.
10201x	Any	(none)	Halt between sections (x = section number).
102077	START	(none)	Halt at end of program.
1060xx	Any	(none)	Trap cell interrupt. M = memory address when inter- rupted, xx = trap cell location.
107077	INIT	(none)	Halt at end of configu- ration.

APPENDIX A  
THE OPDSN (S6) ROUTINE

The OPDSN (S6) routine starts by printing "H37 ENTER INSTRUCTIONS." Select instructions from Table FH-A1, and enter the instructions on the teleprinter keyboard in the desired execution sequence. Signal the end of each instruction entry by pressing the RETURN then LINEFEED keys.

If an instruction is incorrectly entered, the routine prints "H2Ø UNDEFINED INSTRUCTION" or "H31 INPUT ERROR" on the teleprinter and rejects the entry. Re-enter the instruction correctly. If the error is noticed before the LINEFEED key is pressed, press the RUBOUT key. Press the RETURN and LINEFEED keys and enter the instruction correctly.

The EE instruction erases the last instruction entered. For example, to erase the last five instructions entered, type EE (followed by RETURN and LINEFEED) five times. Any number of new instructions may then be entered, if necessary.

Execution of a user's program starts immediately after an "EN" or an "LP" instruction has been entered. (Either instruction is rejected if undefined label references exist.)

The number of instructions that can be entered in one user-designed program is 200 or more. This number is increased to at least 250 if core is greater than 8K and the teleprinter driver is loaded outside the first 8K of core. If the program exceeds available memory, the routine prints "H16 OVERFLOW." Either shorten the program by typing the appropriate number of "EE" instructions, or enter an "EP" instruction to erase the entire program.

The maximum buffer size for a "DB" (define buffer) instruction, an "RD" (read data) instruction or an "IR" (incremental read) instruction is  $1024_{10}$  words.

When the user program execution is complete or if OPDSN routine is aborted by setting program option bit 3 off, the user program is discarded and control passes to the entry point AGAIN in the START routine. To rerun the program or design a new one, restart OPDSN by setting program option bit 3 off then on again and enter the instructions on the teleprinter keyboard. This is valid as long as the diagnostic program is running (is neither halted nor reporting an error).

#### A SAMPLE USER - DESIGNED PROGRAM

The following is an actual program that can be run during execution of the OPDSN routine.

*NOTE: Blanks may be used freely within any instruction.  
OPDSN ignores them.*

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
DB,,127236	Form a 64 word write buffer using the octal pattern 127236.
WD,,27,4	Transfer 64 words of the write buffer into one sector at track 27, sector 4.
LB,NN	Label this location in the program "NN."
RD,,27,4	Transfer 64 words from track 27, sector 4 into the read buffer.
CB,,10	Compare the read and write buffer contents and report the first ten words that do not compare.
GO,NN	Return to the point in the program labeled "NN."
EN	End of program.

## FIELD LIMITS

No limit checks are made except for read or compare buffer sizes (and the lower bound on write buffers). If the field limits are exceeded, fields may merge and produce unusual results. The field limits are listed as follows:

$0 \leq \text{Track} \leq 9999$

$0 \leq \text{Sector} \leq 31$  (or 89 for HP 2770/1)

$1 \leq \text{Read or Compare Buffer Size} \leq 1024$

$0 \neq \text{Write Buffer}$

$1 \neq \text{Write Buffer mod } 64$

Table FH-A1  
OPDSN (S7) INSTRUCTION LIST

*NOTE: Fields in brackets [ ] are optional and may be omitted. The Sample User-Designed Program (Page FH-A2) does not show brackets: the example is specific.*

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
AT [, [tttt] [,ss]]	Address Track. Device positions logically to the address specified and also reports the status <sup>if wrong</sup> from the indicated track/sector location. If either the track (tttt) or the sector (ss) is not indicated, then tttt = 0 or ss = 0 respectively. This instruction is useful for finding protected tracks.
CB [, [xxxx] [,yy]]	Compare Buffers. Compare the indicated number of words of the write buffer with the same number of words of the read buffer. If the word count (xxxx) or the allowed number of error printouts (yy) is not specified, xxxx = 64 and yy = 1 respectively.
DA [, [tttt] [,ss]]	Decrement Address. Device positions logically to the address specified and status is obtained from the track/sector location. The next use obtains the status from the next lower track, with the last track following track 0. tttt = 0 or ss = 0 if either is not specified.

Table FH-A1 (cont)

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
DB [, [xxxx] [, yyyyyy [, C]]]	Define Buffer. Fill the indicated number of words (xxxx) of the write buffer with the indicated octal pattern (yyyyyy). 64 words of the buffer are filled unless otherwise specified, and the pattern is random unless otherwise indicated. If ,C is present and the pattern is not random, then the pattern is complimented in successive words. Maximum word count = 1024.
EE	Erase Entry. Erases the last instruction entered on the teleprinter.
EN[, LL]	End. This terminates instruction entry. The user-designed program executes immediately after this instruction is typed, from the labeled point previously defined or from the beginning if no label is written.
EP	Erase Program. The entire program is erased and the S6 (OPDSN) routine is restarted with the message "H37 ENTER INSTRUCTIONS."
GO, LL	Transfer control to the label (LL). The label must be defined by an LB instruction. A label consists of any two non-blank characters.

Table FH-A1 (cont)

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
HT [,xxxxxx]	Halt. This instruction halts program execution and displays the octal value indicated (xxxxxx) in the A-Register. xxxxxx must be $\leq 177777_8$ ; otherwise, the program's interpretation is unpredictable. Zero is displayed if no value is indicated. Press RUN to continue execution of the user-designed program.
IA [, [tttt] [,ss]]	Increment Address. The device positions logically to the address indicated and status is obtained from the track/sector location. The next use obtains the status from the next higher track with track 0 following the last track. tttt = 0 or ss = 0 unless otherwise shown.
IR [, [xxxx] [, [tttt] [,ss]]]	Incremental Read. Reads the indicated number of words (xxxx) starting at the indicated address. Successive calls read in the next sector not read by the previous call of the instruction, with the first sector following the last sector. xxxx = 64, tttt = 0, ss = 0 unless otherwise shown. Maximum word count is 1024.
IW [, [xxxx] [, [tttt] [,ss]]]	Incremental Write. Writes the indicated number of words (xxxx) starting at the indicated address. Successive calls write in the next sector not written into by the previous call of the instruction, with the first sector following the last sector of the device. xxxx = 64, tttt = 0, ss = 0 unless otherwise shown.

Table FH-A1 (cont)

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
LB,LL	Label. Defines the current location by a two-character label.
LP [,LL]	Loop. The LP instruction acts as a program terminator (as does the EN instruction); the program starts execution immediately after the LP instruction is typed. If the label is included, the program starts from the label point but loops back to the beginning. If no label is included, the program starts from the beginning.
RD [, [xxxx] [, [tttt] [, ss]]]	Read Data. Transfers the indicated number of words (xxxx) from the specified location to the read buffer. xxxx = 64, tttt = 0, ss = 0 unless otherwise shown. Maximum word count is 1024.
RR	Random Read. This instruction reads a random number of words from a random location.
RS	Read Same. Reads the same number of words from the same location as noted in the last write instruction. This is useful when using the RW instruction. Word count is limited to 1024.
RT,LL,x	Repeat all instructions from label LL through this instruction "x" times (decimal). Label LL must be defined in a previous instruction. x must be $\leq 65536_{10}$ .

Table FH-A1 (cont)

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
RW	Random Write. Writes a random number of words into a random location.
SC [,xxxxxxxxxxxxxxxxxx]	<p>Status Check. The last hardware status is checked bit by bit against the expected status (indicated by xxxxxxxxxxxxxxxx). If they do not compare, an error message is typed. If the expected status is not indicated, then DDDDDDD10D00100<sub>2</sub> (D = don't care) is assumed. This instruction does not change the current operation message and cannot be looped using program option bit 13.</p> <p><i>NOTE: The AT,DA,IA,IR,IW,RD,RR,RS,RW,ST and WD instructions all obtain the hardware status and usually compare the hardware status against an expected status of DDDDDDD10D00100<sub>2</sub> (D = don't care).</i></p> <p><i>If the user wishes to compare the status with an expected status other than the above, follow these instructions with the SC instruction.</i></p>
SS	Suppress status checking until an ST instruction is executed.
ST	Status. Perform a hardware status operation (LIA) and save the status bits for the next SC instruction. Do not change the current operation message.

Table FH-A1 (cont)

<u>INSTRUCTION</u>	<u>DESCRIPTION</u>
WD [, [xxxx] [, [tttt] [, ss]]]	Write Data. Transfer the indicated number of words (xxxx) from the write buffer to the indicated location. xxxx = 64, tttt = 0, ss = 0 unless otherwise specified.