ABSOLUTE BINARY PROGRAM 12732-16003

HP 12732A/12733A FLEXIBLE DISC SUBSYSTEM DIAGNOSTIC

reference manual

NOTICE

The absolute binary code for this diagnostic is contained on one or more media (e.g., paper tape, cartridge tape, disc, and magnetic tape). The binaries also exist on single as well as multiple files. For the current date code(s) associated with these media, refer to appendix A in the *Diagnostic Configurator Manual*, part no. 02100-90157, dated August 1976 or later.

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MANUAL PART NO. 12732-90003
MICROFICHE PART NO. 12732-90004

Printed: DEC 1977

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 outer margin of the page. Original pages do not include a change number and are indicated as change number 0 on this page. Insert latest changed pages and destroy superseded pages.

All pages contained in this manual are original issue.

Library Index Number
12732.070.12732-90003

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INTRODUCTION

1-1. GENERAL

The HP 12732A Flexible Disc Subsystem Diagnostic verifies proper operation and tests for faults of the HP 12732A Flexible Disc Subsystem used with the HP 21MX M-Series and E-Series Computers. The program consists of 11 standard tests, two optional tests, and an Operator Design Section (OPDSN) which includes a disc formatting subprogram. Test options are selected in the S Register which is monitored for halt conditions and message outputs. Standard tests are covered in section four and OPDSN is covered in section five.

1-2. REQUIRED HARDWARE

The required hardware consists of the following:

a. An HP 21MX M-Series or E-Series Computer with at least 8K-words of memory. Notes: Disable Remote Program Load (RPL) feature of HP 21MX E-Series Computer. DCPC (DMA) is required for the HP 21 MX M-Series and is optional for the HP 21MX E-Series.

b. An HP 12732A Flexible Disc Subsystem consisting of:

   (1) An HP 9885M Flexible Disc Controller/Drive.

   (2) An HP 12735-60001 Microcircuit Interface Card (control channel).

   (3) An HP 12735-60002 Microcircuit Interface Card (data channel).

   (4) An HP 12735-60003 Dual-hooded Connecting Cable.

c. A program loading device.

d. A console device.

Optional hardware consists of the following:

a. A line printer.

b. One to three HP 12733A Slave Flexible Disc Drives including:

   (1) An HP 9885S Slave Flexible Disc Drive.

   (2) An HP 09885-61617 Chaining Cable.

1-3. SOFTWARE REQUIREMENTS

The following software is required:

a. The Diagnostic Configurator, absolute binary program, part no. 24296-60001. Reference Manual, part no. 02100-90157, is optional.

b. HP 12732A Flexible Disc Subsystem Diagnostic, absolute binary program, part no. 12732-16003. Furnished on paper tape, initialized flexible disc (part no. 12732-13401)*, and cartridge tape (part no. 24396-13308).

The diagnostic serial number (DSN) for this diagnostic is 111104 (octal) and is contained in memory location 126 (octal).

1-4. TEXT CONVENTIONS

All halt codes, select codes, and addresses used in this manual are octal unless specifically shown otherwise. The abbreviations used are listed below:

DCPC — Dual Channel Port Controller (same as DMA).
DMA — Direct Memory Access (same as DCPC).
DSN — Diagnostic Serial Number.
I/O — Input/Output.
OPDSN — Operator Design Section.
Input Buffer — Software buffer input to computer (output from disc drive).
Output Buffer — Software buffer output from computer (input to disc drive).

*The Initialized Flexible Disc contains files %DSKET and !MFLEX which can be transferred by the File Manager STORE command (consult the appropriate RTE manual for operating instructions). The file !MFLEX cannot be read directly by the Diagnostic Configurator, therefore it must be transferred to a diagnostic input medium (e.g., a magnetic tape cartridge) before use.

PROGRAM ORGANIZATION

SECTION II

2-1. ORGANIZATION

This diagnostic program consists of Initialization and Control sections, 11 standard tests, two optional tests, and an operator design section (OPDSN). The Initialization and Control sections accept the select codes and options entered in the S-Register and provide halts and message outputs. The standard and optional tests are described in section IV and the OPDSN in section V.

2-2 TEST CONTROL AND EXECUTION

The diagnostic outputs a title message "HP 12732 FLEXIBLE DISC DIAGNOSTIC" to the console device and then executes the tests according to the options selected on the S-Register. The diagnostic keeps count of the number of passes that have been completed and will output the pass count at the completion of each pass (if S-Register bit 10 is clear). At the end of each pass the computer will halt (displaying 102077) and the pass count will be in the A-Register (if S-Register bit 12 is clear). Press RUN to execute another pass. The count is cleared whenever the program is restarted.

Standard tests (0, 1, 2, and 4-11) are run sequentially in each diagnostic pass (bits 3 and 9 clear). User selection of tests is with bit 9 set. The computer halts displaying 102075 and then desired tests are selected by setting corresponding bits in the A-Register. User test selection allows Test 03 (Verify) and Test 12 (Non-DMA Modes) to be executed.

The OPDSN test programming section is selected by setting S-Register bit 3 (bit 9 clear). The console device responds with the message H030 OPDSN. OPDSN programming is similar to programming in the BASIC language using sequentially numbered statements and non-numbered immediately executable commands. Test program routines are entered statement-by-statement into the console device and they are executed as a program by entering the command GO. Statements can be altered, deleted, or inserted by integer line numbers as in BASIC programming.

OPDSN also allows the selection of the standard and optional tests from 0 through 12 through the console device by programming TEST XX, where XX is the desired test number, for one or more tests. Format altering operations in the OPDSN and standard tests require that S-Register bits 0, 1, 4, and 5 remain set while the test is in progress.

2-3. MESSAGE REPORTING

There are two types of messages: error and information. Error messages are used to inform the operator when the subsystem fails to respond correctly to a given control command or test sequence. Information messages are used to inform the operator of the progress of the diagnostic, or to instruct the operator to perform some operation related to the function

of the unit. In the latter case, an associated halt will occur to allow the operator time to perform the function. To continue the operator must press RUN. The printed or displayed message will be preceded by the letter E for error and the letters H or I for information. The letter is followed by a printed message number which corresponds to the octal halt code according to the following scheme:

HALT CODE	PRINTED MESSAGE NO.
102000 to 102067	000 to 067
106000 to 106067	100 to 167
103000 to 103067	200 to 267
107000 to 107067	300 to 367

The two least-significant digits of this message number are the same as the last two octal digits of an associated halt code.

Example — Error with halt

Message: E020 PRESET DID NOT SET FLAG

Halt Code: 102020 (Display Register)

Example — Information with halt

Message: H056 TURN OFF MASTER, PRESS RUN

Halt Code: 102056 (Display Register)

Example — Information without halt

Message: H101 NO DMA

Halt Code: None

Error messages can be suppressed by setting S-Register bit 11 and error halts can be suppressed by setting S-Register bit 14. Information messages prefixed by H are suppressed by setting S-Register bit 10. Information messages prefixed by I cannot be suppressed.

2-4. PROGRAM LIMITATIONS

Subsystem capability for receiving, passing, and denying priority (priority logic string) is not completely tested by this diagnostic. If the subsystem does not receive priority (i.e. PRH for the next lower select code) an error E014 NO INT will occur. To check this, remove an interface of a lower select code and run TEST 00 (CARD). The above error should occur. Checking the subsystem's ability to pass or deny priority is beyond the scope of this diagnostic.

Exact timing of I/O operations and flags is not implemented in this diagnostic. However, a worst-case time limit is always established for each operation. If this limit is exceeded before the device flag signals a completion, a time-out error message (*TO*) will occur.

The ability of the disc drive controller to report two error conditions is not tested by the Error Status Test (ERRR routine), since these errors cannot be forced programmatically (they only exist when the disc is physically damaged). These errors are:

a. Data checkword Error.

b. Verify Error.

The status bits for these errors are given in Appendix A.

The Error Status Test (Test 04) assumes that a Slave Drive is present. Therefore, if a Slave Drive is not present, an error message E100 will be given. Ignore this message if there is no Slave Drive and press RUN to continue

The interface card test (OPDSN program statement CARD) does not check all functions of the cards. More thorough testing can be accomplished with the General Purpose Register (GPR) Diagnostic, part no. 24391-16001. Instructions for the GPR diagnostic are covered in the *General Purpose Register Diagnostic Reference Manual*, part no. 24391-90001. (Note: The GPR diagnostic requires changing card jumpers. Be sure to replace them for HP 12732A subsystem operation as described in the *HP 12732A/12733A Flexible Disc Operating and Service Manual*, part no. 12732-90005.)

OPERATING PROCEDURE

SECTION III

3-1. OPERATING PROCEDURE

Before running the diagnostic, check to be sure that the computer interfaces are properly installed. Also check that the interface cable, part no. 12732-60003, is installed and firmly attached to the two interface cards and the HP 9885M Flexible Disc Drive. To configure the diagnostic prior to running the tests, follow the flowchart provided in figure 3-1. The configuration procedure uses the Diagnostic Configurator, part no. 24296-60001. If additional information is required on the diagnostic configurator, refer to the *Diagnostic Configurator Reference Manual*, part no. 02100-90157.

3-2. RUNNING THE DIAGNOSTIC

The program configuration S-Register setting is given in table 3-1 for entering the Select Code of the Control Interface PCA (FLEX DISK I/F1 LOWER SEL) into bits 0-5. Then PRESET, RUN. After halt 102074, the program options listed in table 3-2 are entered into the S Register. These options are discussed below.

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

Setting bit 12 loops the diagnostic and suppresses operator intervention in tests 0 and 4. Setting bit 8 suppresses operator intervention without causing the diagnostic to loop. If bit 13 is set while the test is running, that test will loop until bit 13 is cleared. If bit 15 is set while the tests are running, the computer will halt at the completion of the current test with the test number in the A Register. If the Diagnostic Configurator was configured for a line printer, the setting of S-Register bit 7 will cause all information printed on the console to also be output to the line printer.

If a trap cell halt occurs (106077) the user must determine the cause of the unexpected interrupt or transfer of control to the location shown in the M Register. The program may need to be reloaded to continue. Refer to Appendix B for information on halts and messages.

No format altering operations are permitted unless S-Register bits 0, 1, 4, and 5 are all set. Refer to table 3-3 for the standard tests and OPDSN statements which are affected.

3-3. TEST SELECTION BY OPERATOR

For a standard test sequence of one pass, none of the S-Register bits are set. Press PRESET, and RUN.

To select only certain tests, set S-Register bit 9 when the program options are to be selected (halt 102074). Press PRESET, and RUN. The computer halts with 102075 displayed. Enter the desired tests by bit number in the A Register. Setting bits XX of the A Register will cause standard test XX to be executed. Press PRESET, and RUN. Setting S-Register bit 9 while a test is running will abort that test, and the computer will halt 102075 to allow test selection. (The A Register will contain the last selected set of tests.) The standard tests run only on the drive selected as drive 0. Any drive (master or slave) may be selected as drive 0 by setting a rear panel control as described in the *HP 12732A/12733A Operating and Service Manual*, part no. 12732-90005. (For programmed operation of any drive number from 0-3, go to the OPDSN section of the diagnostic.)

To enter the OPDSN program when program options are to be selected, set S-Register bit 3 (bit 9 clear), press PRESET and RUN. Setting S-Register bit 3 while a test is running will abort that test. The message H030 OPDSN will be output to the console, and OPDSN statements may be entered.

Using OPDSN, tests may be executed in any order by setting up a program with statement numbers for TEST XX through TEST YY. For example the following program runs tests 7, 4 and 11 in that order:

```
10 TEST 7
20 TEST 4
30 TEST 11
GO
```

There are four default conditions which occur when executing each standard test not under OPDSN and on GO under OPDSN. These are the following:

a. Drive 0 is selected.

b. Mode is set to DCPC (DMA) Channel 6 with interrupts off.

c. Retry count is set to one.

d. Input buffer is filled with zeros.

These actions are not taken when OPDSN statement TEST is executed; therefore, any of them may be changed by the OPDSN program. If changed they will remain valid as the test is executed; i.e., the drive can be changed by the SD command, a different retry count may be selected by the RTRY command, and the interrupts may be turned on (or non-DCPC operation selected) by the MODE command.

3-4. RESTARTING

The program may be restarted by setting the P Register to 2000. Then select the desired program options by setting the S-Register bits according to table 3-2, and press PRESET and RUN. The disc I/O instructions can be reconfigured by setting the P Register to 100, setting the S Register according to table 3-1, and pressing PRESET and RUN.

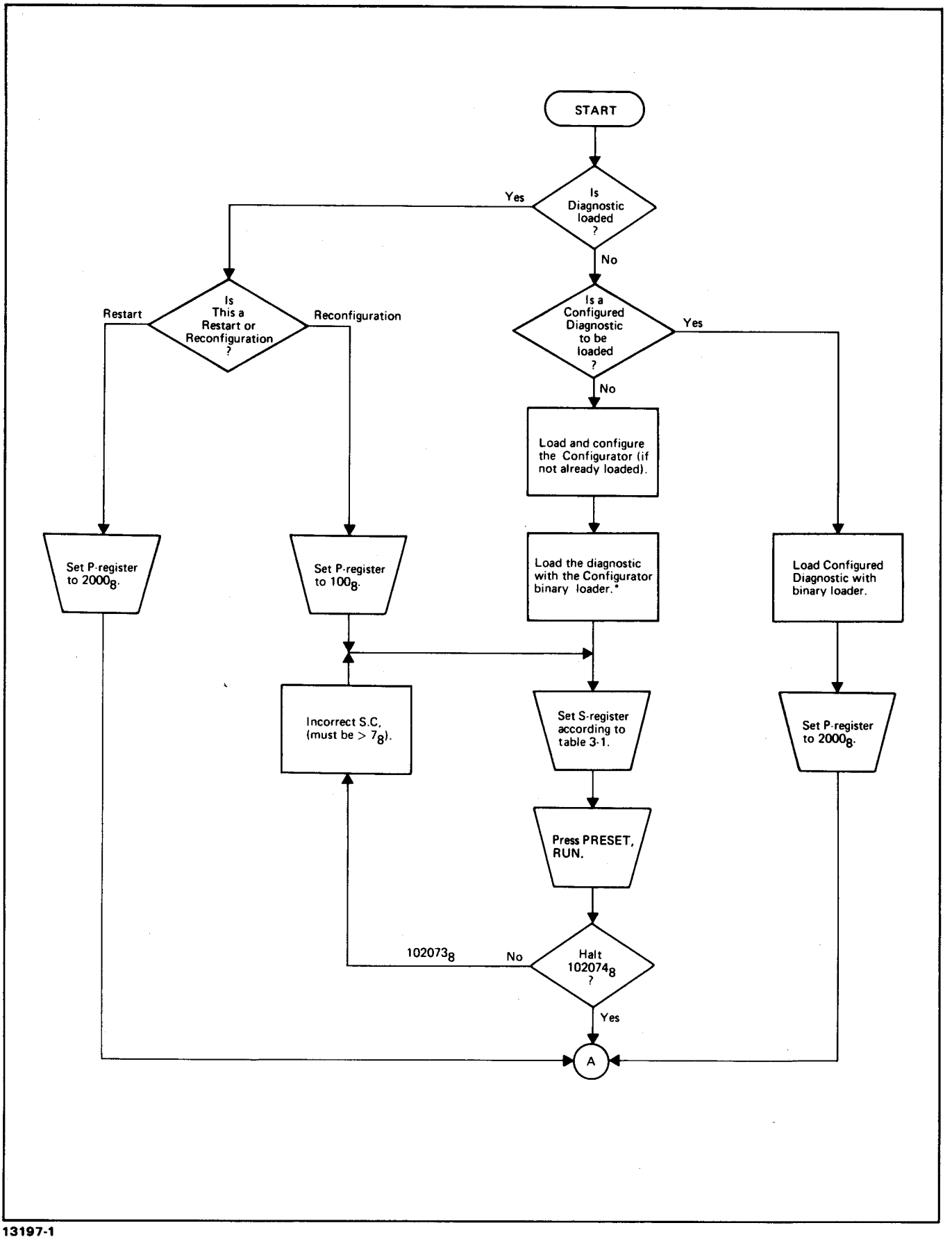
3-5. EXPECTED FREQUENCY OF ERRORS

The normal soft error rate for a flexible disc subsystem is 1 per 100 million bits transferred during non-verify operations (read,write,dump), and 1 per 1 million bits transferred during verify operations. A standard pass without formatting (S-Register bits 0-15 set to 0) transfers 13.9 million bits in the non-verify mode and 5.5 million bits in the verify mode. Therefore, less than 1 error per 7 passes is expected during standard operations and less than 5 errors per pass is expected during verify operations.

Formatting of the disc transfers 5 million bits in the verify mode for *each* test pattern. Therefore, less than 5 errors per pattern is statistically predicted for Test 1. This becomes a statistical prediction of less than 15 errors for the three patterns.

3-6. EXECUTION TIME

Time to execute a pass will depend on operator intervention, error retries, message suppression, and sector offset. A Standard pass with no operator intervention, no errors, a sector offset of five, and no formatting requires approximately 20 minutes.



13197-1

Figure 3-1. Operating Procedure Flowchart (Sheet 1 of 2)

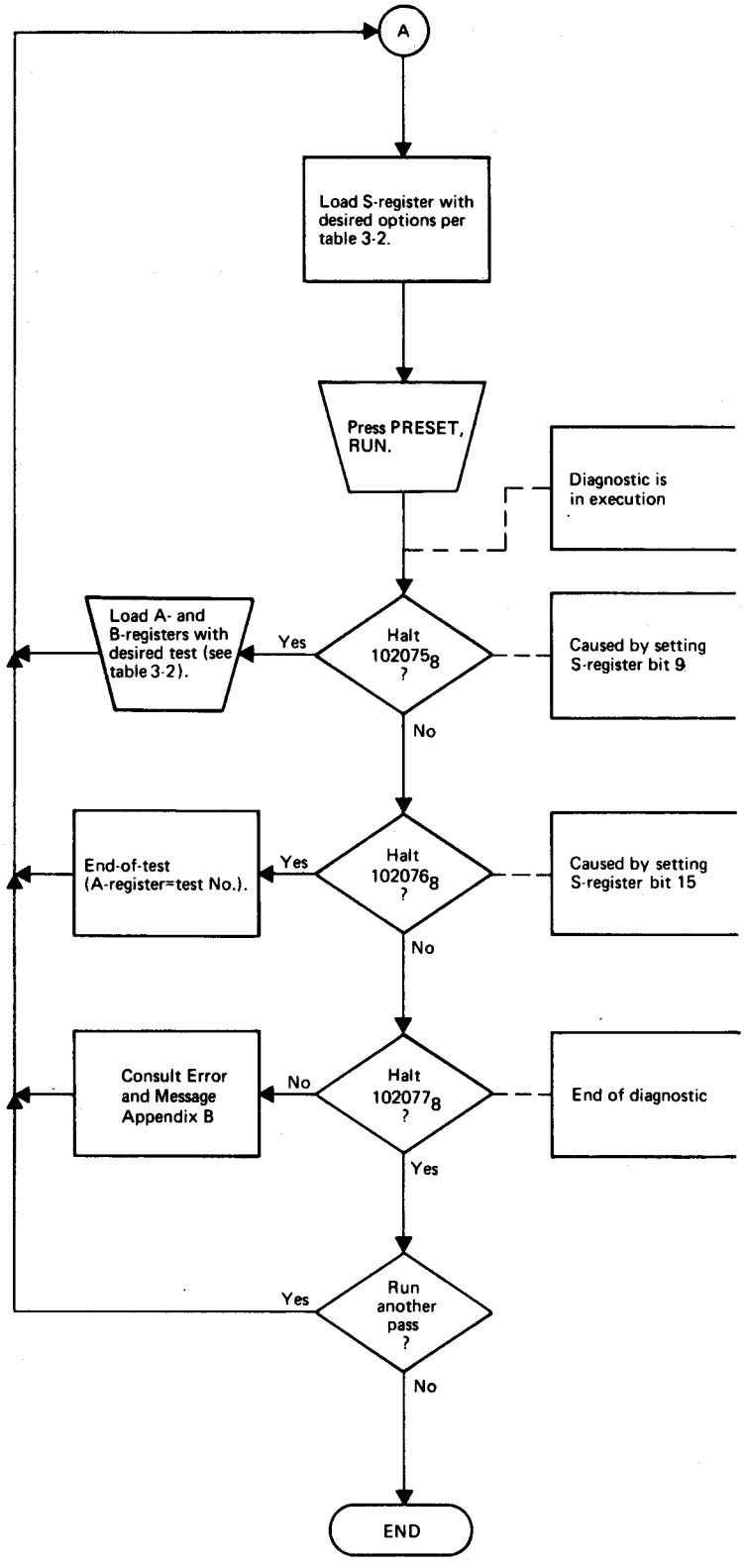


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Figure 3-1. Operating Procedure Flowchart (Sheet 2 of 2)

Table 3-1. Initial S-Register Settings

BITS	FUNCTIONS
5-0	Enter octal select code of control card (interface 1).
15-6	Reserved

Table 3-2. S-Register Options

BITS	MEANING IF CLEAR
15-6	Standard tests in sequence one pass, no options, and no formatting unless 0, 1, 4, and 5 are set.
BITS	**MEANING IF SET**
0, 1, 4, 5	Enable format-altering operations (see Table 3-3).
2	Alter patterns for TRAK test (see Table 5-2).
3*	Abort current operation and go to OPDSN input section (see paragraph 3-3).
6	Spare.
7	Echo console on line printer (see paragraph 3-2).
8	Suppress operator intervention in TEST 0 (CARD test) and TEST 4 (ERRR test).
9*	Abort current operation and go to user control section. Set A-Register bits to desired test numbers (see paragraph 3-3).
10	Suppress non-error messages (see paragraph 2-3).
11	Suppress error messages (see paragraph 2-3).
12	Loop on diagnostic and suppress operator intervention in TEST 0 (CARD test) and TEST 4 (ERRR test).
13	Loop on last test (see paragraph 3-2).
14	Suppress halt on error (see paragraph 2-3).
15	Halt at the end of each test (see paragraph 3-2).

*Setting bits 3 or 9 during a format operation may leave the disc improperly or partially formatted.

Table 3-3. Function of S-Register Bits 0, 1, 4, and 5

TEST	FUNCTION FORMAT ENABLED*	FUNCTION FORMAT NOT ENABLED
TEST 1 & FALL	Formats all of disc.	No action.
TEST 4 & ERRR	Checks error reporting capability of disc including ("track not found" and "sector not found") and then formats all of disc. Disc must be previously formatted.	Checks error reporting capability of disc (except "track not found" and "sector not found"). Disc must be previously formatted.
TEST 9	Marks all tracks defective, then formats all of disc.	Steps head from track 0 to track 66.
FTRK & FX	Formats a single track.	No action.
MARK	Marks a track defective.	No action.
TEST 5 & TRAK	Writes worst case patterns in track-0 sector-0, and then rewrites original contents (no. of good tracks and sector offset).	Only sectors 1-29 of track 0 are tested. Sectors 0-29 of other tracks are tested.
WD & WX	Track-0 and sector-0 may be overwritten.	Track-0 and sector-0 may NOT be overwritten.

*Bits 0, 1, 4, and 5 set in S-Register during execution of the OPDSN statements and standard tests listed.

DIAGNOSTIC TESTS

SECTION IV

4-1. INTRODUCTION

The standard diagnostic tests used in the HP 12732A Flexible Disc Subsystem diagnostic, part no. 12732-16003, are described in this section as well as the test options available to the operator. The operator selects the test options by entering S-Register bits as given in table 3-2. All standard tests can also be executed by calling the equivalent OPDSN subroutines as described in section V. There are three modes of test selection (default to standard tests, operator selected tests, or OPDSN) as described in paragraph 3-3. The elapsed time for each test and the number of bits passed in the test are given in table 4-1.

4-2. STANDARD TESTS

In the test descriptions below, the abbreviation "MAX" means "the maximum buffer size" (buffers are dynamically allocated to fill available memory), and "TR" stands for "the last good track."

TEST 00 — Interface PCA's and Interrupts. Tests the ability of the interface PCA's to set and clear flags, and tests interrupts. Test 00 is equivalent to OPDSN subroutine CARD.

TEST 01 — Format Entire Disc. The disc is formatted and tested for bad tracks. The number of good tracks is written on track 0, sector 0 and this number is printed on the console. The retry count is five. Test 01 is equivalent to OPDSN program sequence.

```
10 RTRY 5
20 FALL 3
```

S-Register bits 0, 1, 4 and 5 must be set to execute this test.

TEST 02 — Read-Only Media Test. Reads entire surface of formatted disc to test for soft media errors with a retry count of three. If excessive errors are encountered, the disc should be duplicated and then reformatted with the bad tracks marked defective. Test 02 is equivalent to OPDSN program sequence

```
10 RTRY 3
20 RD -MAX
```

Note: negative value of MAX means "all of disc" will be read.

TEST 03 — Verify Test. Reads entire surface of formatted disc using "tight margin" flux transitions and the retry count is four. The equivalent OPDSN program sequence is

```
10 RTRY 4
20 VRFY -MAX
```

Note: negative value of MAX means all of disc will be read. The Verify Command is not normally used to read data written on another drive because the variations in alignment between drives may cause unusually high error rates. Therefore, Test 3 is an optional test (see paragraph 3-3).

TEST 04 — Error Status Test. Tests the ability of the drive controller to recognize and report certain error conditions through status code reporting. The equivalent OPDSN program statement is ERRR. A slave drive is assumed to be present. If there is no slave, ignore the E100 message which is issued, and press RUN to continue.

TEST 05 — Pattern Test. Tests the ability of the disc drive to read and write worst case patterns at different recording densities. In this test, three sets of patterns are written and verified on all sectors of tracks 0, 33, and 66 (or the last good track). The equivalent OPDSN program sequence is

```
10 TRAK 0
20 TRAK TR÷2
30 TRAK TR
```

TEST 06 — Random Seek and Position. The head positioning mechanism is exercised by seeking random locations 256 times. No data is written or read in this test. Only preamble information is read. The equivalent OPDSN program statement is RAND 256 Z.

TEST 07 — Random Seek and Write. Writes random data in random sectors of the disc and then reads it and compares the input and output buffers. The equivalent OPDSN statement is RAND 256 W.

TEST 08 — Seek Test. Tests for correct positioning of the read/write head. The test writes sequential data in all sectors and tracks of the disc, verifies that the data was written correctly, and performs random seek and read 256 times. The equivalent OPDSN program sequence is

```
10 WD -1
20 VRFY -1
30 RAND 256 R
```

TEST 09 — Head Step-Mark Defective Test. The step-mark defective functions of the disc drive are tested. If S-Register bits 0, 1, 4, and 5 are set, the program first marks all tracks of the disc defective and then reformats the disc. If S-Register bits 0, 1, 4, and 5 are clear, the head steps from track 0 to track 66 without altering the format of the disc. The equivalent OPDSN program sequence is

```
10 PRST
20 MARK
30 GOSB 70 66
40 FALL 3
50 PRST
60 STOP
70 STEP
80 MARK
90 RTN
```

TEST 10 — DUMP TEST. This test writes random data in random sectors of the disc. The data is then dumped into memory and compared to the data that was written. The equivalent OPDSN program sequence is

```
10 MDIS
20 RAND 256 D
```

TEST 11 — DCPC Modes Test. Reads and writes data with interrupts both off and on and with both of the DCPC (DMA) channels. If a significant difference in performance is achieved between modes, then the DCPC or interrupt hardware, or both, should be tested. The equivalent OPDSN program sequence is

```
10 MODE D 6
20 RAND 20 W
30 MODE D 7
40 RAND 20 W
50 MODE DI 6
60 RAND 20 W
70 MODE DI 7
80 RAND 20 W
```

TEST 12 — Non-DCPC Modes Test. Reads and writes data with interrupts both off and on, without DCPC (DMA). If a significant difference in performance is achieved between modes, then tests should be made of the interrupt and DCPC hardware. The equivalent OPDSN sequence is

```
10 MODE N
20 RAND 20 W
30 MODE NI
40 RAND 20 W
```

Frequent data overrun errors are expected in the non-DCPC mode if the diagnostic is being run on an HP 21MX M-Series computer due to the diagnostic instruction execution speed. This does not indicate any device malfunction. For this reason, Test 12 is an optional test (see paragraph 3-3).

Table 4-1. Test Execution Times and Bits Transferred

TEST NO.	FORMAT DISABLED*	FORMAT ENABLED**	BITS TRANSFERRED	
			VERIFY	NON-VERIFY
0	0 min., 1 sec.	same	None	None
1	0 min., 0 sec.	8 min.	15M**	
2	1 min., 0 sec.	same		4.8M
3†	1 min., 0 sec.	same	4.8M	
4	0 min., 2 sec.	8 min.	15M**	
5	0 min., 20 sec.	25 sec.	0.7M	
6	1 min., 10 sec.	same		0.4M
7	5 min., 15 sec.	same		3.3M
8	4 min., 40 sec.	same	4.8M‡	3.0M‡
9	0 min., 5 sec.	8 min.	15M**	
10	4 min., 40 sec.	same		1.4M
11	1 min., 40 sec.	same		1.0M
12†	0 min., 50 sec.	same		0.5M

* S-Register bits 0, 1, 4, and 5 clear.
** S-Register bits 0, 1, 4, and 5 set (format enabled).
† Optional tests.
‡ 7.8M bits total.

OPERATOR DESIGN SECTION

SECTION V

5-1. INTRODUCTION

The Operator Design Section (OPDSN) is entered by setting S-Register bit 3. OPDSN gives the operator access to all tests from 0 through 12 as well as several utility routines. The tests are defined as a series of calls to the OPDSN routines. The purpose of OPDSN is to allow the operator to design the diagnostic test which will be most useful in solving a current problem.

Many of the OPDSN subroutines facilitate use of the oscilloscope to observe the behavior of the subsystem at a component level. Further simplification of testing may be possible by using specially written routines to analyze a particular operation. To assist in writing such routines, a minimal disc control routine program is provided in Appendix E as an example. The OPDSN statements and utility commands are summarized in table 5-1.

5-2. PROGRAMMING LANGUAGE

OPDSN uses a programming language similar to BASIC. All program statements begin with a line number which is used for sequencing. The statements include a mnemonic statement of two to four characters and two parameters. The parameters may be in ASCII, an integer, or an octal number depending on the statement.

5-3. PARSING NOTES AND LABELING

The following parsing notes are for OPDSN programming in its BASIC like language:

a. Input blocks are separated by any number of spaces, or a single comma.

b. Parameters not given will default to zero (except as noted in the description of OPDSN program statements below).

c. Checking is done for correct parameter type (ASCII, integer, octal) and value.

d. Statements may be entered in any order. They will be sorted automatically by line number. (Line numbers must be in the range from 1 to 9999.)

e. Each line of input is terminated by a carriage-return/line-feed (CR-LF).

f. A line may be deleted prior to the CR-LF by striking RUBOUT or DELETE.

g. After a statement has been entered, it may be deleted by typing the line number, then CR-LF, or it may be replaced by a new statement with the same number.

h. ASCII parameters may contain only letters (A-Z), digits (0-9), and hyphens (-).

i. Integer parameters must be in the range from −32768 to 32767.

j. Octal parameters must be in the range from 0 to 177777.

The following labeling conventions are used:

a. *A* equals an ASCII parameter, 2 characters, the first is not a space.

b. *S* equals an ASCII parameter, 2 characters, the first is not a space.

c. *I* equals an Integer parameter, positive or negative.

d. *N* equals an Integer parameter, positive or negative.

e. *K* equals an Octal parameter.

f. *B* equals an Octal parameter.

5-4. OPDSN PROGRAM

OPDSN commands provide the same functions which are used in the standard test programs. The user can employ most of the OPDSN commands for immediate execution by omitting the program line number, or as a program statement by including a program line number. However, some commands can only be used one way or the other. For example, "GO" is an immediate command only, and "STOP" can only be used as a program statement with a line number. OPDSN commands described below are for both program statements and immediate execution unless otherwise noted. When entering an OPDSN program, be sure to comply with the parsing and labeling conventions given in paragraph 5-3.

Error conditions cause messages and status reports to be output to console. All error conditions that can be forced programmatically are tested with the ERRR statement. Status words and masks, and operation command codes are listed in Appendix A. Error messages are listed in Appendix B. The OPDSN program statements and commands are described below. (Refer to paragraph 5-5 for Special OPDSN statements.) TO USE A MNEMONIC AS A PROGRAM STATEMENT, IT MUST BE PRECEDED BY A LINE NUMBER. Unnumbered mnemonics are executed immediately upon CR-LF.

CARD. Tests the computer's interrupt system and both interface cards, first the control channel and then the data channel (equivalent to TEST 0)*. The tests on both cards are identical evoking error messages E000 through E023 and E026, and information messages H024 and I025.

There are eight tests as follows:

a. Subtest 1 checks the ability to clear, set and test the interrupt system, using the following instruction combinations:

```
CLF 0 SFC 0
CLF 0 SFS 0
STF 0 SFC 0
STF 0 SFS 0
```

Errors in these instruction checks produce error messages **E000 through E003.**

*If more thorough testing of the interface cards is desired, use the General-Purpose Register Diagnostic as described in paragraph 2-4 of this manual.

(CARD Continued)

b. Subtest 2 checks the ability to clear, set and test the interface flag using the following instruction combinations:

```
CLF SC SFC SC
CLF SC SFS SC
STF SC SFC SC
STF SC SFS SC
```

Errors in these interface flag checks produce error messages **E005 through E010.** SC is the Select Code for the disc drive interface being tested.

c. Subtest 3 checks that the test select code does not cause an interrupt with the flag and control set on the interface and the interrupt system off, using the following sequence:

```
STF SC
STC SC
STF 0
CLF 0
```

The CLF 0 instruction should inhibit an interrupt from occurring due to the interface. Error message **E004** occurs if CLF 0 fails in this.

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

e. Subtest 5 checks the ability of the interface to interrupt with the flag and control set and the interrupt system on. If the interrupt is missing **E014** occurs. It also checks that the interrupt occurs when expected and not ahead of the execution of instructions which affect priority. This hold-off operation is tested by the following sequence:

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

Error messages **E012 and/or E015** will occur if the hold-off failed. If a second interrupt is encountered after the first interrupt has been satisfied, an error message E013 will occur. This test also checks whether or not an instruction was missed during the interrupt, giving the message **E026 INT EXECUTION ERROR** in the event of an error.

f. Subtest 6 checks for no interrupt following a CLC SC instruction when the interrupt system is on, and the SC control and flag are set. The following sequence of instructions is used:

(CARD Continued)

```
STC SC
STF SC
STF 0
CLC SC
```

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

g. Subtest 7 checks that the CLC 0 instruction inhibits interrupts when the SC control and flag are set. This is provided by the following set of instructions:

```
CLF SC
STC SC
STF SC
STF 0
CLC 0
```

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

h. Subtest 8 checks that the PRESET switch on the operator panel performs as follows:

Sets the interface flag
Clears the interface control
Turns off the interrupt system
Clears the I/O data lines

Error messages **E020 through E023** may occur if any of these conditions are not achieved.

CB I N. Compare first I words of input and output buffers. I defaults to the size of the last data transfer. N equals maximum number of errors printed (defaults to 8) and remains valid for the subsequent commands RD C, VRFY C, and DUMP C, until the program is restarted from address 2000. Errors are listed on the console.

CBP I N. Same as **CB I N** except that errors are listed on the line printer.

DB. Fill the output buffer with random data. (FALL, TRAK, WD -1, RD -1, VRFY -1, RAND, and DBFK also modify the output buffer.)

DBFK K B. Fill the output buffer with an alternating octal pattern. K is stored in odd numbered words and B is stored in even numbered words of the buffer. (FALL, TRAK, WD -1, RD -1, VRFY -1, RAND, and DB also modify the output buffer.)

DBRK I N (Without Line Number). Replace words I to N of the output buffer with data from the console (I may not be zero). Operator enters values, any number per line, separated by spaces or commas. If too many values are input, the buffer size is output to the console. The input is terminated by a non-octal value.

DBSZ. Print the output buffer size.

DUMP A. A special data-recovery read operation which retrieves data from a sector whose format information has been destroyed. The drive seeks to the sector ahead of the current sector on the same track. Data is transferred from the current sector in blocks of 128 words. Setting parameter A to C will compare input and output buffers following transfer.

DLY I. Pause I milliseconds.

EP (Without Line Number). Erase Program.

ERRR. Test for error status including all error conditions that can be forced (equivalent to TEST 04). No error messages are output unless the appropriate error status is not achieved. Error status codes are listed in Appendix A.

a. If operator intervention is suppressed by S-Register bit 8 or bit 12, skip to step h.

b. "TURN OFF MASTER" message output with halt. Operator should turn off controller power and press RUN (PSTS line should go low). "RESTORE POWER" message output with halt. Operator should restore controller power and press RUN.

c. "TURN OFF SLAVE" message output with halt. Operator should turn off power of a slave drive if one is available, but ignore message if not available. (Status for "No Drive Power" is expected.) Press RUN. "RESTORE POWER" message output with halt. Operator should restore slave drive power and press RUN.

d. "OPEN DOOR" message output with halt. Operator should open drive door and press RUN. (Expected status is "drive door open" and "disc change".)

e. "REMOVE DISC, CLOSE DOOR" message output with halt. Operator should remove the disc, close the drive door, and press RUN. (Expected status is "no disc in drive" and "disc change".)

f. "INSERT PROTECTED DISC" message output with halt. Operator should place a write protected disc in the drive, close the door, and press RUN. (Expected status is "protected disc" and "disc change".)

g. "INSERT UNPROTECTED DISC" message output with halt. Operator should place a non-protected disc in drive and press RUN. (Expected status is "disc change".)

h. Output the following illegal commands (command codes are in octal):
100000 Write zero sectors
040000 Verify zero sectors
144640 Seek track 77 sector 0
147775 Seek track 127 sector 29
140037 Undefined command
147577 Undefined command

i. Output the below illegal commands if S-Register bits 0,1,4, and 5 are set:
144676 Format track 77
147776 Format track 127

j. Cause data overrun by not raising CTL0 on a partial sector read and write.

k. Exit if S-Register bits 0,1,4, and 5 are not set. Mark track 2 defective. Read zero sectors at track 2 on sectors 0,15, and 29 (expected status is "track not found"). Next read zero sectors at track 1 sector 29 and at track 3 sector 0 (expected status is "seek complete").

l. Format track 3, numbering all sectors 29. Read zero sectors at track 3 sectors 1, 15, and 29 (expected status is "sector not found"). Then read zero sectors at track 3 sector 0 (expected

(ERRR Continued)

status is "seek complete"). (The "read zero sectors" command reports sector found when the previous sector on the same track is found.)

m. Re-format the entire flexible disc (equivalent to FALL 3).

EX. Exit OPDSN. Return to standard test execution.

FALL I N. Format entire disc where I equals the number of patterns for track test (see TRAK test and table 5-2), and N equals the sector offset (defaults to 5). S-Register bits 0,1,4, and 5 must be set to enable command. Before execution, the message "FORMAT" is output to console. After successful completion, the message "GOOD TRACKS = #" is output to console. Operation of the test formats each track, then tests it for good format and media as under the TRAK test. The track is marked defective upon the occurrence of one of the following errors which has not been corrected within the retry count:

a. Sector not found (status E=0101).

b. Track not found (status E=0110).
Data checkword error (status E=0111).

d. Data overrun (status E=1000).

e. Verify error (status E=1001).

After testing the last track, the number of good tracks is written in the first word of track 0, sector 0 and printed on the console and the sector offset is written in the second word of the sector. Track 0, sector 0 can not be altered by any other command unless S-Register bits 0,1,4, and 5 are set. (An attempt to write in sector 0 causes message "E044 TR 0 SEC 0".)

A File Manager (FMGR) directory is written on the last good track.

FTRK I N. Format a single track where I is the track number and N is the sector offset (defaults to 5). The track number I will be written on the format portion of the track. No head movement results from this command.

GO (Without Line Number). Execute user program.

GOSB I N (With Line Number). Jump to subroutine (a block of statements beginning at line I and terminating at the statement RTN). Repeat subroutine N times (N defaults to 1).

GOTO I (With Line Number). Jump to line I where I is from 1 to 9999.

LI I N. List the input buffer from words I to N (I may not be zero).

LIP I N. List input buffer on line printer from words I to N (I may not be zero).

LO I N. List the output buffer from words I to N (I may not be zero).

LOP I N. List the output buffer on line printer from words I to N (I may not be zero).

LP (Without Line Number). List the user OPDSN program.

LPP (Without Line Number). List the user OPDSN program on the line printer.

MARK K B. Mark current track defective, without head motion. Precede this statement in a program with PRST and STEP statements to position the head at the defective track. If already positioned at the track, it may be used as an immediately executable command. K equals expected status (default= 0), and B equals status mask (default= 177773). Be sure to follow this statement with a PRST statement or command before proceeding with any data transfer operations.

MDIS I. Mount disc. I equals the number of good tracks. This command informs the diagnostic of the number of good tracks, and the sector offset of the flexible disc being tested. It should be executed each time a new disc is placed in the drive. If I equals 0, the number of good tracks and the sector offset are read from track 0, sector 0.

MODE A I. Set mode of I/O operations on disc where A equals ASCII character(s) and I equals DCPC(DMA) channel number (6 or 7). The characters for A are below:

```
DI=DCPC, interrupts on
D =DCPC, interrupts off
NI=no DCPC, interrupts on
N =no DCPC, interrupts off.
```

The DCPC instructions are initially configured to Channel 6. If no channel number is specified, the previous channel configuration is retained. If parameter A is not specified, MODE defaults to DCPC without interrupts. If DCPC is not available, DCPC requests will be automatically converted to equivalent non-DMA requests and the message "NO DMA" will be output to the console.

MOVE I. Seek I sectors forward or backward where I can be positive or negative. The seek command is not output to the disc controller and no head movement occurs until the next data transfer command (WRITE,READ,VERIFY, or DUMP). For example, if current location is track 10, sector 14, a statement *MOVE 12* is equivalent to *SK 10 26;* and *MOVE -3* is equivalent to *SK 10 11*. To make the current location the same as the starting location of the previous data transfer, omit I.

MSG A S. Output message to console where A and S are two ASCII characters each. For example, MSG TE XT appears as "*TEXT".

PRST. Preset controller and physically position the master and all slave drives to track 0, sector 0. Use this command after a STEP or MARK command before proceeding with data transfer statements. The disc change bit will be set in the next status word returned by the controller.

RAND I A. Random seek for read and write where I equals the iteration count which must be greater than zero. Set parameter A as follows:

S = generate random track and sector number and send to controller (no head motion expected).

Z = same as S followed by "read zero words" to physically position the head.

(RAND Continued)

R = same as S followed by read random length block of data (1 to octal 2000 words), fill the output buffer with sequential data, and compare buffers. Refer to statement "WD" for a definition of sequential data. NOTE: RAND with this parameter must follow a "WD -1" command.

W = same as S followed by filling output buffer with random data, then writing a random length block of data of 1 to 2000 (octal) words, and reading the data that was written into the input buffer. Next the output and input buffers are compared.

D = same as S followed by writing 128 words of random data, dumping the data, and then comparing the input and output buffers.

RD I A. Read I words from the disc into the input buffer. If I equals zero, the head will physically position to the sector preceding the current location with no data transfer. I may not exceed the input buffer size. The following occurs if I is a negative number:

a. The number of good tracks is read from track 0, sector 0 (equivalent to MDIS).

b. The entire disc is read into the input buffer, I words at a time where I is an absolute value (minus sign ignored).

c. Where I equals (−1), the output buffer is filled with *sequential data* prior to each read operation. Refer to statement WD (I−1) for a definition of *sequential data*. Setting the parameter A to C will compare input and output buffers after each read operation.

For example, the following program writes data on the disc from the output buffer, reads it into the input buffer, and checks for correct transfer:

```
10 WD 384
20 MOVE
30 RD 384 C
```

RTN (With Line Number). Return from subroutine. Continue execution at line following last executed GOSB when the last programmed GOSB repeated sequence is completed.

RTRY I. Retry any subsequent commands when the expected status is not achieved or if the disc drive times out. The retry count is checked after each try until the count exceeds I or the correct status is returned. An uncorrectable error will be retried I+1 times and I+1 error messages are expected. A soft error results in fewer error messages. I must be between 0 and 15.

SD I. Select drive I. All subsequent commands will access drive I where I is from 0 to 3.

SK I N. Seek track I, sector N. The seek command is not output to the disc controller and no head movement occurs until the next data transfer command (WRITE, READ, VERIFY, or DUMP).

ST K B. Status request command issued to the disc controller where K is the expected status and B is a mask for the returned status (refer to table A-2). The returned status is masked (logical AND) with B and compared to K expected status and is not printed unless the results are unequal. K defaults to 000000 (controller power on and no errors) and B defaults to 177777.

STAT. Print last status, expected status, operation, track and sector, and mode. This is the only command for printing non-error status.

STEP K B. Physically steps head inward, one track at a time. (Seek or data transfer commands automatically step the head.) STEP and PRST are the only two commands which will position the head on an unformatted disc. K is the expected status (defaults to octal 40) and B is the status mask (defaults to octal 177763). Follow this statement with a PRST statement before proceeding with data transfer commands.

STOP (With Line Number). Stop execution of OPDSN program and return to OPDSN input after message. The message output to the console is "STOP (LINE XXXX)".

TEST I. Execute standard test I. Refer to section IV for a description of the tests and to paragraph 3-3 for alternate modes of test selection.

TRAK I N. Track I is tested by writing and verifying N pattern-pairs in all sectors. Refer to table 5-2 for the worst case bit patterns used and the methods of alteration. N may be from 1 through 7 (defaults to first 3 pattern pairs of table 5-2).

NOTE

If track 0 is selected, two conditions are possible depending on whether S-Register bits 0, 1, 4, and 5 are *set* or *not set*. If these bits are set, then all sectors are tested and the number of good tracks are rewritten in sector 0. If these bits are not set, then only sectors 1 through 29 are tested, skipping sector 0.

VRFY I A. Read with "tight margin" on flux transitions. "Tight margin" shortens the time allowed for a read such that a flux transition on the disc track has a narrower window than normal in which to be sensed by the read/write head. The parameters are exactly the same as for RD except that I is not allowed to be zero. The data is transferred to the input buffer.

WAIT (With Line Number). Output message "WAIT (LINE XXXX)" to console. Operator responds with "ST" to stop execution of the user program, or "CO I" to continue at line number I. "CO" without line number XXXX will cause the next line to be executed.

WD I. Write I words from output buffer to the disc (I = 0 is illegal). I must not exceed the output buffer size. If I is specified as a negative number, the following occurs:

a. The number of good tracks is read from track 0, sector 0 (equivalent to MDIS).

b. The entire disc is written with data from the output buffer, I words at a time where I is an absolute value (minus sign ignored).

c. For I = −1 the output buffer is filled with "sequential data" prior to each write operation. "Sequential data" is defined as an alternating pattern with the odd numbered locations containing the number of the sector to be written in bits 5-0 and the track to be written in bits 15-6, and the even numbered locations containing the complement of that number. For example, track 0, sector 15 is filled with octal numbers 000017,177760, 000017, 177760, etc.; and track 6, sector 1 is filled with octal numbers 000601, 177176, 000601, 177176, etc. The number of good tracks is read from track 0, sector 0 and the entire disc is written with the patterns.

NOTE

Track 0, sector 0 may be altered only if S-Register bits 0, 1, 4, and 5 are set.

5-5. SPECIAL OPDSN STATEMENTS

The special OPDSN statements are not used in any of the standard diagnostic tests. They are used in OPDSN programming to give the operator access to the basic disc drive commands without the error checking and command combinations which are typical of the other OPDSN statements. The special OPDSN statements are of value for component repair and error status checking.

These statements comply with the parsing and labeling conventions of paragraph 5-3; however, care should be taken when mixing these special statements and the other OPDSN statements due to the following differences:

a. SX command outputs a seek to the drive controller, but SK and MOVE commands do not.

b. WX, RX, VX, and DX do not output a seek to the drive controller, but WD, RD, VRFY, and DUMP do provide a seek.

c. WX, RX, and VX do not truncate requests that will overflow the last good track of the disc.

d. WX, VX, SX, FX, and UX allow an illegal command, or invalid track and sector, to be output.

e. Errors will not cause an automatic retry.

f. The status mask is 177777 except as noted below in the command description.

The special OPDSN statements must be preceded by a line number for programming but they may also be used without line numbers as commands for immediate execution. Refer to table A-2 to determine the default expected status and mask.

DX K B. Dump 128 words from the disc to input buffer where K is the expected status and B is the status mask (default = 177763). This command should be preceded by a seek to the sector physically preceding the desired sector, and by a read-zero sectors (RX 0) command for head positioning.

FX I K. Format a single track without head movement. In formatting, track I is written in the preamble of each sector and the first 30 words of the output buffer are written as sector addresses. When a sector address of over 29 is passed to the drive controller, an illegal command status is returned. Set S-Register bits 0, 1, 4, and 5 to enable this command. I must be from 0 to 127 (decimal). K is the expected status.

RX I K. Read I words from the disc to the input buffer where I may not exceed the input buffer size. If I is negative, control line CTL0 will be output to the disc controller (this indicates a partial sector). I may be zero and K equals the expected status.

SX I K. Output a seek command to the disc controller where I = [(track × 100) + sector]. The track number must be from 0 to 127 and the sector number must be from 0 to 29. K equals the expected status which is only returned for an illegal track number.

UX I K. Output an undefined command to the disc controller. The undefined command is the octal pattern 140037 with I added to bits 11-5 (the track field of the seek command) and the drive number added to bits 13-12. I must be between 0 and 123. K equals the expected status.

VX I K. Verify I words from the disc to the input buffer where I may not exceed the input buffer size. If I is negative, control line CTL0 will be output to the disc controller (this indicates a partial sector). I may be zero and K equals the expected status.

WX I K. Write I words from the output buffer to the disc where I may not exceed the output buffer size. If I is negative, control line CTL0 will be output to the disc controller (this indicates a partial sector). I may be zero and K equals the expected status.

Table 5-1. Summary of OPDSN Commands

COMMAND*	FUNCTION
CARD	Test interface cards and interrupts.
CB I N	Compare buffers (I = words, N = maximum errors).
CBP I N	Compare buffers, output errors on line printer (I = words, N = maximum errors).
DB	Fill output buffer with random data.
DBFK K B	Fill output buffer with octal alternating pattern. (K = odd word pattern, B = even word pattern).
DBRK I N**	Replace words I to N with octal data from console.
DBSZ	Print output buffer size.
DUMP A	Dump 128 words and compare buffers. (A = C to compare).
DLY I	Delay I milliseconds.
DX K B	Dump (K = expected status, B = mask).
ERRR	Force error status.
EP**	Erase program.
EX	Exit OPDSN.
FALL I N	Format entire disc (I = number of patterns, N = sector offset).
FTRK I N	Format track I (N = sector offset).
FX I K	Format track I (K = expected status).
GO**	Execute user program.
GOTO I†	Jump to line I.
GOSB I N†	Repeat subroutine starting at line I, N times.
LI I N	List input buffer from word I to word N.
LIP I N	List input buffer from word I to N on line printer.

Table 5-1. Summary of OPDSN Commands (Continued)

COMMAND*	FUNCTION
LO I N	List output buffer from word I to N.
LOP I N	List output buffer from word I to N on line printer.
LP**	List user program.
LPP**	List user program on line printer.
MARK K B	Mark track defective (K = expected status, B = mask).
MDIS I	Mount disc (I = number of good tracks).
MODE A I	Set mode of I/O AND DCPC (A = mode, I = DCPC channel).
MOVE I	Seek I sectors forward or backward.
MSG A S	Output four character ASCII message to console.
PRST	Preset controller and seek home.
RAND I A	I = iteration count. A = S, Z, R, W, or D for random seeks, writes, reads, or dumps.
RD I A	Read I words and compare buffers (A = C to compare).
RTN†	Return from subroutine.
RTRY I	Set up retry count.
RX I K	Read I words (K = expected status).
SD I	Set up drive number (0 to 3).
SK I N	Seek track I, sector N.
ST K B	Request status (K = expected status, B = mask).
SX I K	Seek (I = [track x 100] + sector, K = expected status).
STAT	Print last status.
STEP K B	Step head in one track (K = expected status, B = mask).
STOP†	Stop execution of OPDSN program.
TEST I	Execute standard diagnostic test I.
UX I K	Undefined command (I = "track", K = expected status).
TRAK I N	Pattern test of track I (N = number of patterns).
VRFY I A	Verify I words and compare buffers.
VX I K	Verify I words (K = expected status).
WAIT†	Wait for operator (operator enters ST or CO I).
WD I	Write I words (Negative I = write entire disc).
WX I K	Write I words (K = expected status).

* Command use requires line number for program statements and no line number for immediate execution upon CR-LF. Some commands can be used in only one of the two modes as footnoted (** = without line number, † = with line number).

** Use without line number for immediate execution.

† Use with line number in program statements.

STATUS WORDS, MASKS, AND DISC COMMAND CODES

APPENDIX A

Table A-1. Status Words

BIT NO.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CODE	P	0	0	0	E	E	E	E	0	T	S	R	W	C	D	D

BIT	CODE	MEANING	DATA (OCTAL)
0	D	Drive Number	000000 to
1	D		000003
2	C	Change bit. PRST executed or power restored, or door is open, or door was opened since last status return.	000004
3	W	Write Protected Disc	000010
4	R	Drive Not Ready (no drive power, door open, no disc in drive)	000020
5	S	Seek or Step Complete	000040
6	T	Transfer Complete (read, write, verify, dump, format)	000100
7	0	Not Used	
	E	No Error	000000
	E	No Drive Power	000400
	E	Drive Door Open	001000
8	E	No Disc in Drive	001400
9	E	Invalid Command	002000
10	E	Sector Not Found	002400
11	E	Track Not Found	003000
	E	Data Checkword Error	003400
	E	Data Overrun	004000
	E	Verify Error	004400
12	0	Not Used	
13	0	Not Used	
14	0	Not Used	
15	P	Controller Power Off or Current Operation Not Successful	100000

Notes: All disc controller commands, except seek, return status in bits 15-0 of the data channel. Status P, shown in bit 15, is signal PSTS (bit 15 of control channel) logically inverted.

Table A-2. Expected Status for Standard Tests

DEFAULT EXPECTED STATUS**	MASK*	CONTROLLER OPERATION
000000	177763	Status Request — no errors
000100	177773	Format
000040	177763	Step, Seek
000000	177773	Mark
000140	177773	Write
000140	177763	Read, Verify
000100	177763	Dump
102000	177763	Illegal Command
004040	177763	Data Overrun on Read or Write
103000	177763	Track Not Found on Read
102400	177763	Sector Not Found on Read
100420	177763	No Drive Power (Status Request)
001024	177777	Drive Door Open (Status Request)
001424	177777	No Disc in Drive (Status Request)
000014	177777	Protected Disc (Status Request)
000004	177777	Disc Change (Status Request)

* Bit patterns which are programmed in commands to eliminate unwanted status bits. Mask 177763 eliminates the C (change) bit and the W (Write protect) bit.

** Add drive number to the listed expected status.

Table A-3. Disc Command Operation Codes

COMMAND	OP CODE	AUGMENTED CODE AND LIMITATIONS
READ	00XXXX	XXXX = No. of Sectors (bits 11-0) from 0-4406 (octal)
WRITE	10XXXX	XXXX = No. of Sectors (bits 11-0) from 0-4406 (octal)
VERIFY	04XXXX	XXXX = No. of Sectors (bits 11-0) from 0-4406 (octal)
SEEK	14XXXX	XX (bits 11-5) = Tracks from 0-114 (octal) XX(bits 4-0) = Sectors from 0-35 (octal)
FORMAT	14XX36	XX plus bit 5 (bits 11-5) = Tracks from 0-114 (octal)
STEP	147637	
MARK	147677	
DUMP	147737	
STATUS	147777	

Notes:

1. The drive number is added to the above command codes in bits 13-12.
2. All commands except seek cause an automatic status return at completion of the operation.
3. The controller has two internal states, a command acceptance state, and an execution state. Presetting the controller (PRST) puts it in the command acceptance state. (A pulse on bit 0 of the control channel presets the controller.) Before any command will be recognized, the controller "password" (127207B) must be output to the data channel. The command is then output to the data channel, followed by the required data. The data channel flag will be set by the controller after every word of data. Most error conditions will cause the control channel flag to set and the automatic status to be returned.
4. Data transmission may be terminated after a partial sector by setting bit 1 of the control channel (CTL0) after the last word of data has been transferred. The automatic status is then returned by the controller.

MESSAGES AND HALT CODES

APPENDIX B

Table B-1. Error and Information Messages and Halt Codes

MESSAGE		HALT CODE	PROGRAM SECTION	COMMENTS
CODE	TEXT			
	HP 12732 FLEXIBLE DISC DIAGNOSTIC	None	Test Control	Introductory Message
	TEST XX	None	Test Control	XX-Test Number. Occurs before execution of each test.
E000	CLF 0—SFC 0	102000	Test 0	CLF/SFC 0 combination failed. CLF did not clear flag or SFC caused no skip with flag clear.
E001	CLF 0—SFS 0	102001	Test 0	CLF/SFS 0 combination failed. CLF did not clear flag or SFS caused skip with flag clear.
E002	STF 0—SFC 0	102002	Test 0	STF/SFC 0 combination failed. STF did not set flag or SFC caused skip with flag set.
E003	STF 0—SFS 0	102003	Test 0	STF/SFS 0 combination failed STF did not set flag or SFS caused no skip with flag set.
E004	CLF 0 DID NOT INHIBIT INT	102004	Test 0	With card flag and control set, CLF 0 did not turn off interrupt system.
E005	CLF CH—SFC CH	102005	Test 0	CLF/SFC CH (Select Code) combination failed. CLF did not clear flag or SFC caused no skip with flag clear.
E006	CLF CH—SFS CH	102006	Test 0	CLF/SFS CH (Select Code) combination failed. CLF did not clear flag or SFS caused skip with flag clear.
E007	STF CH—SFC CH	102007	Test 0	STF/SFC CH (Select Code) combination failed. STF did not set flag or SFC caused skip with flag set.
E010	STF CH—SFS CH	102010	Test 0	STF/SFS CH (Select Code) combination failed. STF did not set flag or SFS caused no skip with flag set.
E011	STF XX SET CARD FLAG	102011	Test 0	Select code screen test failed. A-Register contains XX (octal) where XX equals select code that caused card flag to set.
E012	INT DURING HOLD OFF INSTR	102012	Test 0	Interrupt occurred during an I/O instruction or a JMP/JSB indirect instruction.
E013	SECOND INT	102013	Test 0	Card interrupted a second time after initial interrupt was processed.
E014	NO INT	102014	Test 0	No interrupt occurred with card flag and control set and the interrupt system on.

Table B-1. Error and Information Messages and Halt Codes (Continued)

MESSAGE		HALT CODE	PROGRAM SECTION	COMMENTS
CODE	TEXT			
E015	INT RTN ADDR	102015	Test 0	Interrupt did not occur at the correct location in memory.
E016	CLC CH	102016	Test 0	CLC CH (Select Code) did not clear card control with the interrupt system on.
E017	CLC 0	102017	Test 0	CLC 0 did not clear the card control with the interrupt system on.
E020	PRESET DID NOT SET FLAG	102020	Test 0	PRESET did not set the card flag.
E021	PRESET DID NOT DISABLE INTS	102021	Test 0	PRESET did not disable the interrupt system.
E022	PRESET DID NOT CLEAR CONTROL	102022	Test 0	PRESET did not clear control.
E023	PRESET DID NOT CLEAR I/O LINES	102023	Test 0	PRESET did not clear I/O data lines.
H024	PRESS PRESET, RUN	102024	Test 0	Press PRESET, then RUN. (Occurs twice in test 0, once for each select code.)
I025	CARD (SC = XX)	None	Test 0	Precedes card test error message. XX = Select Code of interface card.
E026	INT EXECUTION	102026	Test 0	Interrupt was not processed correctly.
H030	OPDSN	None	OPDSN	Indicates that OPDSN section has been entered. @ is prompt character for input.
I031	STOP (LINE XXXX)	None	STOP	OPDSN statement "STOP" at line XXXX has been executed.
I032	INPUT ERROR	None	OPDSN	Undefined statement or invalid parameter has been entered.
I033	FULL	None	OPDSN	User program area full.
I034	LINE? (LINE XXXX)	None	GOTO GOSB WAIT RTN	Statement at line XXXX references an undefined line, or "RTN" statement executed without matching "GOSB" statement.
I035	GOSB (LINE XXXX)	None	GOSB	Nesting of "GOSB" calls has exceeded 16 levels. Return pointer stack overflow.
H036	CNT = XXXXX	None	DBSZ	Size of output buffer in words.
I040	WAIT (LINE XXXX)	None	WAIT	"WAIT" statement at line XXXX has been executed. Enter "ST" to stop execution of user program or "CO N" to continue execution at line N (next line if N omitted).

Table B-1. Error and Information Messages and Halt Codes (Continued)

MESSAGE		HALT CODE	PROGRAM SECTION	COMMENTS
CODE	TEXT			
H041	RAND R	None	RAND	Sequential data expected by RAND nnnR not achieved. (WD −1 must precede this statement.) Seek mechanism failure. See RAND and WD, Section 5.
I042	FORMAT	None	FALL	Indicates start of FALL command.
H043	GOOD TRACKS: XX	None	FALL,MDIS	Indicates number of usable tracks on this disc (written on track 0, sector 0).
E044	TR 0 SEC 0	102044	WD	An attempt was made to alter track 0, sector 0 (number of good tracks). S-Register bits 0, 1, 4, and 5 must be set, or the user program must be altered.
I044	TR 0 SEC 0	None	WD, TRAK	Track 0, sector 0 (number of good tracks) has been altered.
H045	END OF DISC	None	WD, RD VRFY, DUMP	An attempt was made to transfer data past the last good track of the disc (or to a negative numbered track, set up by MOVE-N). All available sectors will be used by a multiple-sector command.
H046	WORD NO. OUTPUT INPUT	None	RD, VRFY DUMP, CB	Heading for message E047. Comparison of input and output buffers failed.
E047	XXXXX YYYYYY ZZZZZZ	None	RD, VRFY, DUMP, CB	Comparison of input and output buffers failed. First number is the decimal position of the pair of values. Second number is the value of the output buffer (octal). Third number is the value of the input buffer (octal).
E050	TLOG = XXXXXX EXP = YYYYYY	102050	All data transfer commands	Incomplete data transfer operation. XXXXXX = log (number of words transferred). YYYYYY = expected log (number of words expected).
E051	*TO* DMA, CC	102051	DMA data transfer	Time out. DMA flag and command channel flags failed to set within time limit (8 sec.). (Controller will be preset before retry.)
E052	*TO* DC, CC-DMA LAST WORD	102052	DMA output (WD, FALL)	Time out. Data channel and command channel flags failed to set within time limit (0.5 sec.) after DMA flag set. (Controller will be preset before retry.)
E053	*TO* DC	102053	All disc commands	Time out occurred during automatic status return. Data channel flag failed to set within time limit (2 sec.). (Controller will be preset before retry.)
E054	*TO* DC, CC	102054	All disc commands	Time out occurred during one of the following: password output, command output, non-DCPC data transfer, and automatic status return. (Controller will be preset before retry.)
E055	*DC INTP -- DMA*	102055	DMA data transfer	Data channel interrupted during DMA transfer (controller will be preset before retry.)

Table B-1. Error and Information Messages and Halt Codes (Continued)

MESSAGE		HALT CODE	PROGRAM SECTION	COMMENTS
CODE	TEXT			
H056	TURN OFF MASTER, PRESS RUN	102056	ERRR	Turn off controller power. Press RUN.
H060	TURN OFF SLAVE, PRESS RUN	102060	ERRR	Turn off drive power (any drive except Master). Press RUN.
E061	PSTS HIGH	102061	ERRR	PSTS line should go low when controller power is off.
H062	RESTORE POWER, PRESS RUN	102062	ERRR	Turn on controller and drive power. Press RUN.
H063	OPEN DOOR, PRESS RUN	102063	ERRR	Open drive door. Press RUN.
H064	REMOVE DISC, CLOSE DOOR, PRESS RUN	102064	ERRR	Remove disc from drive, close drive door. Press RUN.
H065	INSERT PROTECTED DISC, PRESS RUN	102065	ERRR	Insert write-protected disc (or remove write-enable tape from current disc). Press RUN.
H066	INSERT UNPROTECTED DISC, PRESS RUN	102066	ERRR	Insert write enabled disc. Press RUN.
	None	102073	Configuration	I/O select code entered at configuration is invalid. Must be greater than 7 (octal). Re-enter a valid select code. Press RUN.
	None	102074	Configuration	Select code entered during configuration is valid. Enter program option bits in S-Register and press RUN.
	None	102075	Test Control	Test selection request resulting from S-Register bit 9 being set. Enter in the A-Register the desired group of tests to be executed. Press RUN.
	None	102076	Test Control	End of test halt resulting from S-Register bit 15 being set (A-Register equals test number). To continue, press RUN.
	PASS XXXXXX	102077	Test Control	All selected tests complete. (A-Register value equals pass count.) S-Register options may be changed. To continue, press RUN.
H100	STAT = XXXXXX EXP = YYYYYY OP = ZZZZZZ TR = XXXX SEC = YY MODE = ZZZZ	None	STAT	XXXXXX = last status returned by drive controller (see Appendix A). YYYYYY = Expected Status ZZZZZZ = Command Code XXXX = Track YY = Sector ZZZZ = Mode: DCPC/Non-DCPC, Interrupts on/off, DCPC channel SC (see paragraph 5-4, MODE).

Table B-1. Error and Information Messages and Halt Codes (Continued)

MESSAGE		HALT	PROGRAM	
CODE	TEXT	CODE	SECTION	COMMENTS
E100	STAT = XXXXXX EXP = YYYYYY OP = ZZZZZZ TR = XXXX SEC = YY MODE = ZZZZ	106000	All Disc Commands	Same as message H100 except that actual status does not equal expect-status. Control channel flag did not set. (A-Register = OP, B-Register = STAT.)
H101	NO DMA	None	Test Control, OPDSN	DCPC (DMA) not available. DCPC operations will automatically be converted to equivalent non-DCPC operations.
	None	106002	TRAK, FALL	Pattern table change request caused by setting S-Register bit 2 (see table 5-2).
E103	BAD FORMAT	106003	MDIS	Track 0, sector 0 contains an illegal number of good tracks (<1 or >67) or an illegal sector offset. Reformat disc.
I104	TR XX DEFECTIVE	None	FALL	Physical track XX has been marked defective. (Logical track no. = physical track no. + no. of bad tracks previously discovered.)
	None	106077	Test Control	Halt stored in locations 2 through 77 (octal) to trap interrupts which may occur unexpectedly because of hardware malfunctions. M-Register contains the I/O slot number of interrupt. Diagnostic may be partially destroyed if halt occurs. The program may have to be reloaded; the problem should be corrected before proceeding.
E200	STAT = XXXXXX EXP = YYYYYY OP = ZZZZZZ TR = XXXX SEC = YY MODE = ZZZZ	103000	All Disc Commands	Same message as H100 except that actual status does not equal expected status. Control channel flag set. (A-Register = OP, B-Register = STAT.)
E300	STAT = XXXXXX EXP = YYYYYY OP = ZZZZZZ TR = XXXX SEC = YYYY MODE = ZZZZ	107000	All Disc Commands	Same message as H100. Device timed out. Status displayed is not valid (it equals contents of interface register). Test will be aborted if retry count is exceeded.

DISC FORMAT AND ORGANIZATION

APPENDIX C

C-1. INTRODUCTION

The flexible disc has a diameter of 20 cm (7-7/8 inch). It is made with a mylar base which is coated with ferromagnetic iron oxide to provide a characteristic quite similar to that of magnetic tape. Information is stored on the disc in the form of binary digits represented by magnetized points on the disc. The information is stored and retrieved by a read/write head that comes in contact with the surface of the disc. Data can be recorded on one side only.

C-2. DISC FORMAT

The disc format is shown in figure C-1. Data is stored in concentric tracks on the disc where the outside track is track 0. Each disc has a maximum of 67 tracks numbered from 0 through 66. The number of available tracks is reduced by the number of bad tracks on the disc. For example, if there were two defective tracks, the available tracks would be numbered from 0 through 64.

The disc tracks are divided into 30 pie-shaped sections called sectors numbered physically from 0 through 29 numbered logically from 0 to 58 using even numbers only. Each sector can contain 256 bytes (or 128 words) of data. The disc sectors can be numbered in one of seven ways according to the sector offset specified in the FALL or FTRK statement. The "standard" format (sector offset equals 5) places four fill sectors between contiguously numbered sectors (i.e., 0, 6, 12, 18, 24, 1, 7, 13, 19, 25, 2, etc.).

The "standard" format optimizes single sector throughput by allowing 22 ms to elapse between reading or writing on one sector and reading or writing on the next. As each sector is scanned in 5.5 ms, including the scanned sector and four "fill" sectors, a read or write operation takes 28 ms per sector. The addition of the "fill" sectors provides the software operating system enough time to process the 128 words of the sector and be ready for the next 128 words. If the data processing has not completed before entering the next sector to be read from or written to, the disc must rotate a complete revolution of 167.7 ms, picking up the sector on the next pass. If no sector in the sequence is missed on the first pass, then one complete track can be read in five disc revolutions taking about 1 second.

The "fast format" (sector offset equals 1) disc has the 30 sectors sequentially numbered with no "fill" sectors. Thus, there is no processing time allowed between sectors and each sector is read from or written to in 5.5 ms. To take advantage of this increase in throughput rate requires the use of a buffer of substantial size to store the data until it can be processed. The recommended buffer size is 1000 words or greater. The diagnostic tests use a large buffer; therefore, the "fast format" will allow most tests to run faster.

Five other values are valid sector offsets as follows: 2, 3, 6, 10, and 15. The sector offset equals the number of revolutions required to read each track. Sector numbering for the available sector offsets are given in table C-1.

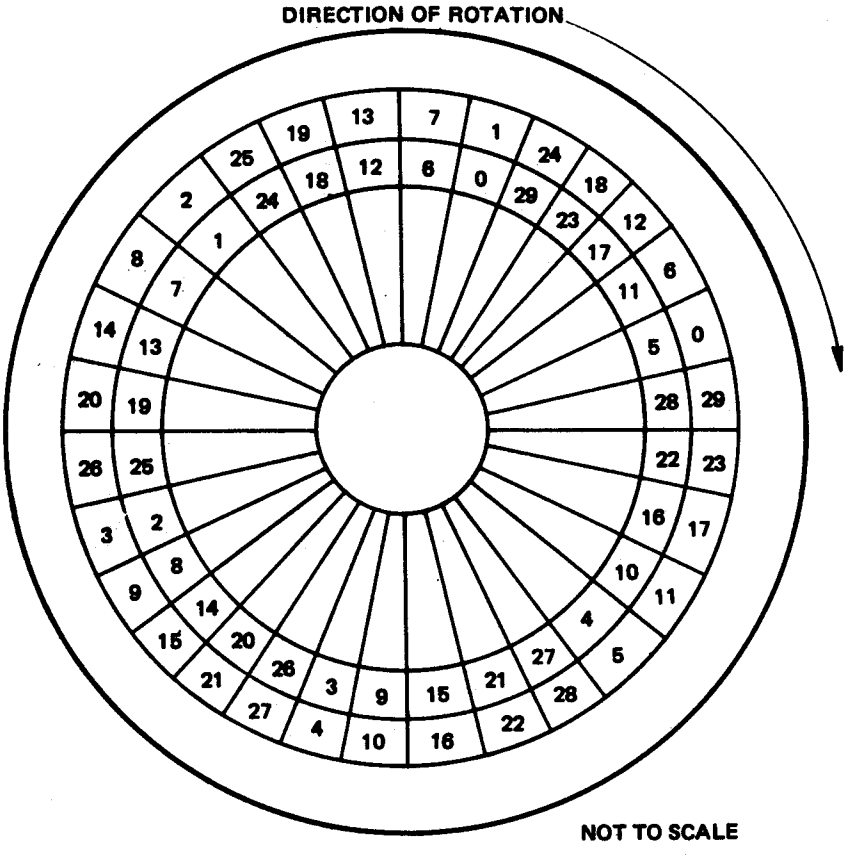

Figure C-1. Disc Format

Table C-1. Sequence of Sector Numbers for Available Offsets.

SECTOR OFFSET	SEQUENCE OF SECTOR NUMBERS (TRACK 0)
1	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
2	0 15 1 16 2 17 3 18 4 19 5 20 6 21 7 22 8 23 9 24 10 25 11 26 12 27 13 28 14 29
3	0 10 20 1 11 21 2 12 22 3 13 23 4 14 24 5 15 25 6 16 26 7 17 27 8 18 28 9 19 29
5	0 6 12 18 24 1 7 13 19 25 2 8 14 20 26 3 9 15 21 27 4 10 16 22 28 5 11 17 23 29
6	0 5 10 15 20 25 1 6 11 16 21 26 2 7 12 17 22 27 3 8 13 18 23 28 4 9 14 19 24 29
10	0 3 6 9 12 15 18 21 24 27 1 4 7 10 13 16 19 22 25 28 2 5 8 11 14 17 20 23 26 29
15	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29

Sectors on adjacent tracks are offset by "fill" sectors positioned opposite to the direction of rotation. The purpose of track-to-track "fill" sectors is to prevent missed sectors when seeking sequentially across track boundaries (e.g., from track 1, sector 29 to track 2, sector 0). The number of sectors in the track-to-track offset depends upon the sector offset as listed in table C-2. This scheme for the diagnostic disc format differs slightly from the DSKET program format.

Table C-2. Sector Offset vs Track-to-Track Offset

SECTOR OFFSET	TRACK-TO-TRACK OFFSET
1	4
2	4
3	4
5	5
6	6
10	10
15	15

DIAGNOSTIC PRINTOUT FOR A GOOD DISC

APPENDIX D

```
HP 12732 FLEXIBLE DISC DIAGNOSTIC

 TEST  00000
H024 PRESS PRESET, RUN
H024 PRESS PRESET, RUN

 TEST  00002
H043 GOOD TRACKS:  00067
H045 END OF DISC

 TEST  00004
H050 TURN OFF MASTER, PRESS RUN
H062 RESTORE POWER, PRESS RUN
H060 TURN OFF SLAVE, PRESS RUN
H062 RESTORE POWER, PRESS RUN
H063 OPEN DOOR, PRESS RUN
H064 REMOVE DISC, CLOSE DOOR, PRESS RUN
H065 INSERT PROTECTED DISC, PRESS RUN
H066 INSERT UNPROTECTED DISC, PRESS RUN

 TEST  00005

 TEST  00006

 TEST  00007

 TEST  00008
H043 GOOD TRACKS:  00067
H045 END OF DISC
H043 GOOD TRACKS:  00067
H045 END OF DISC

 TEST  00009

 TEST  00010
H043 GOOD TRACKS:  00067

 TEST  00011
 PASS 000001
```

MINIMAL DISC CONTROL ROUTINES

APPENDIX E

```
      THE FOLLOWING PROGRAM IS ONLY AN EXAMPLE OF THE
      MACHINE-LEVEL INTERACTION BETWEEN THE COMPUTER
      AND THE FLEXIBLE DISC CONTROLLER.  THIS CODE IS
      NOT PART OF THE DISC DIAGNOSTIC PROGRAM.  IT IS
      INCLUDED IN THIS MANUAL ONLY AS AN AID TO UNDER-
      STANDING THE FLEXIBLE DISC, AND TO FACILITATE THE
      CREATION OF A SPECIAL TEST PROGRAM, SHOULD THE
      NEED ARISE.

      OPERATING PROCEDURE:
                  SET P REGISTER TO ADDRESS AT LEFT
                  SET A- AND B-REGISTERS AS INDICATED AT RIGHT
                  PRESS RUN
                  OPERATION WILL COMPLETE WITH STATUS IN S-REGISTER
                       (SEEK AND PRST SET S-REG TO 0)
                  PRESS RUN AGAIN TO DO 'READ ZERO SECTORS' COMMAND

 00100          P      EQU PRST
 01000          R      EQU READB      A=COUNT, B=ADDRESS
 01100          V      EQU VRFYB      "        "
 00600          W      EQU WRITB      "        "
 00500          S      EQU SEEKB      A=TRACK, B=SECTOR
 00700          F      EQU FTRKB      A=TRACK, B=ADDRESS
 00300          T      EQU STEP
 00400          M      EQU MARK
 01200          D      EQU DUMPB      B=ADDRESS
 00200          ?      EQU STAT
                       END
NO ERRORS *TOTAL **RTE ASMB 750420**

                ASMB,A,B,L

 00100                 ORG 100B
 00010          CC     EQU 10B
 00011          DC     EQU CC+1
 00002          DMAL   EQU 2B
 00006          DMAH   EQU 6B
 00000          INTP   EQU 0B
 00000          A      EQU 0B
 00001          B      EQU 1B
 00001          SW     EQU 1B

     FLEXIBLE DISC COMMAND CODES:

 00100 147777  STATC OCT 147777    STATUS REQUEST

 00101 140000  SEEKC OCT 140000    SEEK

 00102 147637  STEPC OCT 147637    STEP HEAD IN ONE TRACK

 00103 147677  MARKC OCT 147677    MARK A TRACK DEFECTIVE

 00104 100000  WRITC OCT 100000    WRITE DATA ON FLEXIBLE DISC

 00105 140036  FTRKC OCT 140036    FORMAT A TRACK

 00106 000000  READC OCT 000000    READ DATA FROM FLEXIBLE DISC

 00107 040000  VRFYC OCT 040000    READ WITH CLOSE FLUX TRANSITION TOLERANC

 00110 147737  DUMPC OCT 147737    DUMP - READ FROM SECOND SECTOR
```

```
00006                   ORG DMAH
00006 024202            JMP STTUS       GET STATUS WHEN DMA INTERRUPTS

00010                   ORG CC          GET ERROR STATUS
00010 024210            JMP ESTAT        WHEN CONTROL CHANNEL INTERRUPTS
00011 124112            JMP STC,I       RETURN FROM 'STC' SUBROUTINE
                                          WHEN DATA CHANNEL INTERRUPTS
00100                   ORG 100B

    PRESET CONTROLLER
    SEEK HOME ON ALL DRIVES
    SET DISC CHANGE BIT IN STATUS WORD

00100 002404  PRST  CLA,INA         PRESET CONTROLLER
00101 102610        OTA CC
00102 002400        CLA
00103 102601        OTA SW          CLEAR S-REGISTER
00104 102610        OTA CC
00105 102100        STF INTP        TURN ON INTERRUPTS
00106 103710        STC CC,C        ENABLE ERROR INTERRUPT
00107 014112        JSB STC         CLEAR DATA CHANNEL & WAIT FOR COMPLETION
00110 102004        HLT 4
00111 024201        JMP R0          READ ZERO SECTORS IF RESTARTED


00112 000000  STC   NOP             OUTPUT A-REGISTER AND SET CONTROL ON DC
00113 102611        OTA DC
00114 103711        STC DC,C
00115 024115        JMP *           WAIT FOR INTERRUPT

00200                   ORG 200B

    STATUS REQUEST COMMAND

00200 060100  STAT  LDA STATC       STATUS REQUEST COMMAND
00201 014226  R0    JSB COMND       OUTPUT COMMAND
00202 060225  STTUS LDA .2
00203 102610        OTA CC          OUTPUT CTLO TO TERMINATE PARTIAL SECTOR
00204 002006        INA,SZA         WAIT AT LEAST 32 MICROSECONDS
00205 024204        JMP *-1           TO MAKE SURE CTLO IS RECOGNIZED
00206 102311        SFS DC          WAIT FOR FLEXIBLE DISC COMPLETION (DMA W
00207 024206        JMP *-1
00210 103111  ESTAT CLF DC          INHIBIT INTERRUPT HERE
00211 106706        CLC DMAH        TURN OFF DMA (IN CASE OF ERROR)
00212 102106        STF DMAH
00213 002400        CLA
00214 103710        STC CC,C        ENABLE CONTROL CHANNEL INTERRUPT
00215 014112        JSB STC         REQUEST STATUS
00216 102511        LIA DC          INPUT STATUS
00217 102601        OTA SW          OUTPUT TO S-REGISTER
00220 002400        CLA
00221 102610        OTA CC          CLEAR CONTROL CHANNEL
00222 014112        JSB STC         ACKNOWLEDGE STATUS
00223 102000        HLT
00224 024201        JMP R0          IF RESTARTED OUTPUT 'READ ZERO SECTORS'


00225 000002  .2    OCT 2


00226 000000  COMND NOP             OUTPUT PASSWORD AND COMMAND
00227 030240        IOR DRIV        ADD DRIVE NO. TO COMMAND
00230 070241        STA TEMP
00231 060242        LDA PASSW
00232 102100        STF INTP        TURN ON INTERRUPTS
00233 103710        STC CC,C        ENABLE ERROR INTERRUPT
00234 014112        JSB STC         OUTPUT PASSWORD
00235 060241        LDA TEMP
00236 014112        JSB STC         OUTPUT COMMAND
00237 124226        JMP COMND,I
```

```
00240 000000  DRIV  NOP           DRIVE NUMBER IN BITS 12 & 13
00241 000000  TEMP  NOP
00242 127207  PASSW OCT 127207    CONTROLLER PASSWORD

00300               ORG 300B

    STEP HEAD IN ONE PHYSICAL TRACK
    (MAY POSITION HEAD OVER DEFECTIVE OR UNFORMATTED TRACK)
    SHOULD BE FOLLOWED BY PRESET BEFORE CONTINUING
         WITH DATA TRANSFER COMMANDS

00300 060102  STEP  LDA STEPC     STEP HEAD IN 1 TRACK
00301 024201        JMP R0


00400               ORG 400B

    MARK A TRACK DEFECTIVE
    CONTROLLER WILL AUTOMATICALLY SKIP THIS TRACK ON SEEK

00400 060103  MARK  LDA MARKC     MARK TRACK DEFECTIVE
00401 024201        JMP R0


00500               ORG 500B

    SEEK TRACK AND SECTOR
    (TRACK IN A-REG, SECTOR IN B-REG)
    NO HEAD MOVEMENT OCCURS UNTIL DATA TRANSFER COMMAND IS OUTPUT

00500 074514  SEEKB STB SECTR     SECTOR IN B
00501 070513  SEEKA STA TRACK     TRACK IN A
00502 060513  SEEK  LDA TRACK     SEEK TRACK AND SECTOR
00503 001722        ALF,RAL
00504 030514        IOR SECTR
00505 030101        IOR SEEKC
00506 014226        JSB COMND     OUTPUT COMMAND
00507 002400        CLA
00510 102601        OTA SW        CLEAR S-REG
00511 102001        HLT 1
00512 024201        JMP R0        READ ZERO SECTORS IF RESTARTED


00513 000000  TRACK NOP
00514 000000  SECTR NOP

00600               ORG 600B

    WRITE DATA ON FLEXIBLE DISC
    (WORD COUNT IN A-REG, BUFFER ADDRESS IN B-REG)
    DMA CHANNEL 6

00600 074615  WRITB STB OTBF      BUFFER ADDRESS IN B
00601 070616  WRITA STA COUNT     WORD COUNT (POSITIVE) IN A
00602 060616  WRIT  LDA COUNT     WRITE DATA ON FLEXIBLE DISC
00603 014617        JSB DMAO      SET UP DMA WRITE
00604 060616        LDA COUNT
00605 006400        CLB
00606 101107        RRR 7         DIVIDE INTO SECTORS
00607 006002        SZB
00610 002004        INA           IF PARTIAL SECTOR, ROUND UP
00611 030104        IOR WRITC
00612 014226  FENT  JSB COMND     OUTPUT COMMAND
00613 103706        * STC DMAH,C  START DMA
00614 024614        JMP *         WAIT FOR INTERRUPT


00615 011000  OTBF  DEF OTBUF     ADDRESS OF OUTPUT BUFFER
00616 000200  COUNT DEC 128       ONE SECTOR
```

```
00617 000000  DMAO  NOP             SET UP DMA WRITE
00620 102702        STC DMAL
00621 003004        CMA,INA         NEGATE WORD COUNT
00622 102602        OTA DMAL        OUTPUT TO DMA REGISTER
00623 106702        CLC DMAL
00624 060615        LDA OTBF
00625 102602        OTA DMAL        OUTPUT ADDRESS
00626 060632        LDA DATCH
00627 030104        IOR SIGN        SET CONTROL AFTER EACH WORD
00630 102606        OTA DMAH        OUTPUT DC SELECT CODE
00631 124617        JMP DMAO,I

00632 000011  DATCH ABS DC          DATA CHANNEL SELECT CODE
00104         SIGN  EQU WRITC       SIGN BIT

00700               ORG 7008

    FORMAT A TRACK
    (TRACK IN A-REG, BUFFER ADDRESS IN B-REG)
    NO HEAD MOVEMENT OCCURS
    SECTORS MAY BE NUMBERED IN ANY ORDER BY ALTERRING
         THE FIRST 30 WORDS OF THE BUFFER

00700 074615  FTRKB STB OTBF        BUFFER ADDRESS IN B
00701 070513  FTRKA STA TRACK       TRACK IN A
00702 060615  FTRK  LDA OTBF        FORMAT A TRACK
00703 070241        STA TEMP
00704 006400        CLB
00705 060722        LDA M30         NO. OF SECTORS PER TRACK
00706 070617        STA TEMP2
00707 174241        STB TEMP,I      NUMBER SECTORS FROM 0 TO 29
00710 006004        INB
00711 034241        ISZ TEMP        BUMP ADDRESS
00712 034617        ISZ TEMP2
00713 024707        JMP *-4
00714 003004        CMA,INA         MAKE POSITIVE
00715 014617        JSB DMAO        SET UP DMA WRITE
00716 060513        LDA TRACK
00717 001722        ALF,RAL         POSITION TRACK BITS
00720 030105        IOR FTRKC       ADD FORMAT COMMAND
00721 024612        JMP FENT        GO OUTPUT COMMAND

00617         TEMP2 EQU DMAO
00722 177742  M30   DEC -30

01000               ORG 10008

    READ DATA FROM FLEXIBLE DISC
    (WORD COUNT IN A-REG, BUFFER ADDRESS IN B-REG)
    DMA CHANNEL 6

01000 075023  READB STB INBF        BUFFER ADDRESS IN B
01001 070616  READA STA COUNT       WORD COUNT (POSITIVE) IN A
01002 060106  READ  LDA READC
01003 071024        STA VFY         READ/VERIFY COMMAND
01004 060616        LDA COUNT
01005 002003        SZA,RSS
01006 024201        JMP RO          READ-ZERO-SECTORS
01007 015025        JSB DMAI        SET UP DMA READ
01010 060616        LDA COUNT
01011 006400        CLB
01012 101107        RRR 7           DIVIDE INTO SECTORS
01013 006002        SZB
01014 002004        INA             IF PARTIAL SECTOR, ROUND UP
01015 031024        IOR VFY         ADD COMMAND
01016 014226  DENT  JSB COMND       OUTPUT COMMAND
01017 002400        CLA
01020 103611        OTA DC,C        MAKE SURE FLAG IS CLEAR
01021 103706        STC DMAH,C      START DMA
01022 014112        JSB STC         START FIRST WORD TRANSFER & WAIT FOR INT
```

```
01023 002000  INBF  DEF INBUF     BUFFER ADDRESS
01024 000000  VFY   NOP           VERIFY OR READ COMMAND CODE


01025 000000  DMAI  NOP           SET UP DMA READ
01026 102702        STC DMAL
01027 003004        CMA,INA       NEGATE COUNT
01030 102602        OTA DMAL      OUTPUT TO DMA REGISTER
01031 106702        CLC DMAL
01032 061023        LDA INBF
01033 030104        IOR SIGN      SET INPUT BIT
01034 102602        OTA DMAL      OUTPUT BUFFER ADDRESS
01035 060632        LDA DATCH
01036 030104        IOR SIGN      SET CONTROL AFTER EACH WORD
01037 102606        OTA DMAH      SEND SELECT CODE OF DC
01040 125025        JMP DMAI,I

01100               ORG 1100B

    VERIFY -- READ WITH CLOSE FLUX TRANSITION TOLERANCES
    (WORD COUNT IN A-REG, BUFFER ADDRESS IN B-REG)
    DMA CHANNEL 6

01100 075023  VRFYB STB INBF      BUFFER ADDRESS IN B
01101 070616  VRFYA STA COUNT     WORD COUNT (POSITIVE) IN A
01102 060107  VRFY  LDA VRFYC     VERIFY DATA (READ TO INPUT BUFFER)
01103 025003        JMP READ+1


01200               ORG 1200B

    DUMP -- READ FROM SECTOR PHYSICALLY FOLLOWING CURRENT SECTOR
    USED TO RECOVER DATA FROM SECTOR WHOSE SECTOR ADDRESS IS UNREADABLE
    (BUFFER ADDRESS IN B-REG, ALWAYS READS 128 WORDS)
    NO HEAD MOVEMENT OCCURS

01200 075023  DUMPB STB INBF      BUFFER ADDRESS IN B
01201 061205  DUMP  LDA D128      DUMP 128 WORDS FROM SECOND SECTOR
01202 015025        JSB DMAI      SET UP DMA READ
01203 060110        LDA DUMPC
01204 025016        JMP DENT      GO OUTPUT COMMAND

01205 000200  D128  DEC 128


02000               ORG 20000B
02000 000000  INBUF BSS 7000B
11000 000000  OTBUF BSS 7000B
20000         NEXT  EQU *         END OF 8 K MEMORY
```

MANUAL PART NO. 12732-90003
MICROFICHE PART NO. 12732-90004
PRINTED IN U.S.A.

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Sales and service from 172 offices in 65 countries.
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