R80
Disk Drive

Pocket Service Guide

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CONTENTS

TABLES

1 INTRODUCTION

1.1 GENERAL

This book contains a brief synopsis of servicing information for the R80 Disk Drive and is written for field service personnel who maintain this equipment. If more comprehensive information on this subject is needed, refer to the documents listed in Table 1-1.

Table 1-1 Related Documentation

Document	Number
R80 Disk Drive User's Guide	EK-00R80-UG
R80 Technical Description	EK-00R80-TD
R80 Disk Drive Service Manual	EK-00R80-SV
RM80 Field Maintenance Print Set	MP-00875

1.2 FIELD REPLACEABLE UNITS (FRUs)

Table 1-2 contains a list of FRUs and service reference data. A reference number has been assigned to each item in the FRU/Service Reference table. These numbers are used in Figure 1-1 and again in Table 3-6. In the figure, the reference numbers identify major FRUs. In the table, the reference numbers identify possible causes of error codes and faults within the drive. Figure 1-1 shows the relationship between major FRUs.

Table 1-2   FRU/Service Reference Table

Ref. No.	Item	PN/Reference
1	Drive power supply, 120 V, 60 Hz	H766A
2	Drive power supply, 220 V, 50 Hz	H766B
3	Motor start capacitor, 115 V, 60 Hz	10-16924-00
4	Motor start capacitor, 220 V, 50 Hz	10-17217-00
5	Drive power supply fan, 117 Vac	12-09403-02
6	Front bezel fan, 117 Vac	12-10719-03
7	Adapter fan, 115 Vac	12-11714-00
8	Belt, 60 Hz	12-12635-03
9	Belt, 50 Hz	12-12635-04
10	ID 0/READY switch cap	12-12691-00
11	ID 1/READY switch cap	12-12691-01
12	ID 2/READY switch cap	12-12691-02
13	ID 3/READY switch cap	12-12691-03
14	ID 4/READY switch cap	12-12691-04
15	ID 5/READY switch cap	12-12691-05
16	ID 6/READY switch cap	12-12691-06
17	ID 7/READY switch cap	12-12691-07
18	RUN/STOP switch cap	12-12714-00

Table 1-2   FRU/Service Reference Table (Cont)

Ref. No.	Item	PN/Reference
19	WRITE PROT switch cap	12-12714-01
20	FAULT switch cap	12-12714-02
21	STAT 1 switch cap	12-12714-30
22	STAT 2 switch cap	12-12714-31
23	Wedge lamp, 6.3 V	12-12716-00
24	Belt tension micro-switch	12-14011-00
25	HDA speed sensor (optical switch)	12-16817-00
26	HDA thermal switch	12-16870-00
27	Gas spring assembly	12-17072-00
28	Spare parts case	29-23187-00
29	Read/write module	54-13596-00
30	Operator control panel module	54-13641-00
31	Microprocessor module	54-14012-00
32	I/O cable assembly	70-18783-00
33	Brush ground assembly	70-16215-00
34	Head disk assembly (HDA)	70-16225-00
35	Wing pivot assembly	70-16230-00
36	Motor/brake assembly, 115 V, 60 Hz	70-16723-00

Table 1-2   FRU/Service Reference Table (Cont)

Ref. No.	Item	PN/Reference
37	Motor/brake assembly, 220 V, 50 Hz	70-16723-01
38	Motor actuator assembly	70-16724-00
39	Logic dc power cable assembly	70-16732-00
40	Logic ac power harness assembly	70-16733-00
41	Servo preamp cable	70-16735-00
42	40-conductor data cable (personality module)	70-16737-00
43	40-conductor data cable (servo module)	70-16737-01
44	20-conductor data cable (personality module)	70-16738-00
45	20-conductor data cable (read/write module)	70-16738-01
46	50-conductor read/ write cable	70-16739-00
47	Operator control panel cable	70-16740-00
48	Shock mount assembly	70-16742-00
49	Personality module with stiffener	70-16975-00
50	Servo module with stiffener	70-16976-00

Table 1-2   FRU/Service Reference Table (Cont)

Ref. No.	Item	PN/Reference
51	26-conductor I/O cable (top half only)	70-16978-00
52	60-conductor I/O cable (top half only)	70-16979-00
53	Belt tension switch/ HDA positioner motor harness assembly	70-16980-00
54	Disk drive power cord assembly, 60 Hz	70-17335-00
55	Disk drive power cord assembly, 50 Hz	70-17335-01
56	Motor tension spring	74-22440-00
57	Air filter	74-22816-00
58	Belt tension adjustment	See Chap. 3 of Service Manual
59	Servo adjustments	See Chap. 3 of Service Manual
60	Drive I/O cables not connected properly	See Figure 1-1
61	HDA positioner lock in wrong position	Refer to Service Manual
62	Belt tension lever in wrong position	Refer to Service Manual
63	Spindle motor over-heated	Refer to Service Manual

Table 1-2   FRU/Service Reference Table (Cont)

Ref. No.	Item	PN/Reference
64	Ambient room temperature too high	Decrease temperature
65	Speed transducer cable not connected	See Figure 1-1
66	Read-only test failed	Refer to Service Manual
67	Positioner motor going too slow	See Chap. 3 of Service Manual
68	Positioner motor going too fast	See Chap. 3 of Service Manual
69	Spindle not spinning	Refer to Service Manual
70	Cables not connected properly	See Figure 1-1
71	Drive-unsafe condition	Refer to Service Manual
72	Recalibration failure	Refer to Service Manual
73	Test inhibited by drive fault caused by previous error	Refer to Service Manual

Table 1-2   FRU/Service Reference Table (Cont)

Ref. No.	Item	PN/Reference
74	Starting and ending address same as for seek test	Enter correct address
75	Jumper for read-only cylinder formatter utility missing	Refer to Service Manual
76	Cylinder address greater than 560 has been entered	Enter correct address
77	Wrong procedure used or wrong value entered	Refer to Service Manual
78	Software problem	Check programming
79	Terminator	7009938-00
80	Cables	Refer to Service Manual
81	Operator error	Refer to Service Manual
82	Low ac power input	Refer to Service Manual

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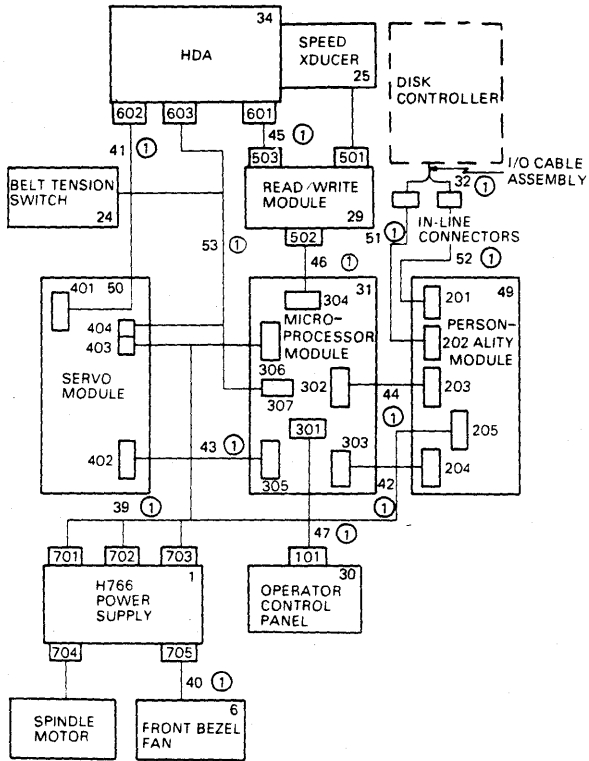
NOTE:

(1)   REFER TO REFERENCE NUMBER IN
       TABLE 1-2 FOR DESCRIPTION.

Figure 1-1   Major FRUs

2 FRONT PANEL SWITCHES AND INDICATORS

2.1 OPERATOR CONTROLS AND INDICATORS

Table 2-1 lists the R80 Drive controls and indicators.

Table 2-1   Control and Indicator Functions

Control/ Indicator	Indicator Lamp	Action or Indication
RUN/STOP	On in RUN position	Spin-up sequence begins if no faults are detected
RUN/STOP	Off in STOP position when spindle stops	Power to the spindle motor is turned off
FAULT	On	Indicates a device unsafe or error condition in drive
READY	On	Indicates a successful (fault-free) spin-up sequence. Indicator goes off during seek operations.
WRITE PROTect	On	Disables write circuits to prevent data from being written.
STATus	On or Off	Used in fault code displays

2.2   FRONT PANEL   FAULT   IDENTIFICATION CODES

When the FAULT light comes on, pressing the FAULT switch once causes all of the indicator lamps to light up momentarily as a means of verifying that the lamps are functioning. Then, all lamps except those displaying the fault code go off.

Pushing the FAULT switch the second time stores the identify of the fault in the microprocessor, clears the fault to permit a command retry, and turns off the fault-code display (providing the fault no longer exists).

Some faults are corrected automatically, in which case the FAULT indicator will go off. If the FAULT lamp does not go off automatically, the FAULT switch must be used as described above.

Figure 2-1 contains the fault-code indications.

FAULT CONDITION	RUN STOP	FAULT	READY	WRITE PROT	STAT 1	STAT 2
H766 AND OR +P DC LOW	ON		ON	ON	ON	ON
SPIN UP	•	ON				ON
R W DIAGNOSTIC	•	ON			ON	
READ WRITE UNSAFE	•	ON			ON	ON
WRITE PROTECT	•	ON		ON		ON
SPINDLE MOTOR INTERLOCK	•	ON		ON	ON	
SPINDLE MOTOR SPEED	•	ON		ON	ON	ON
INVALID INTERFACE COMMAND	•	ON	ON			ON
HDA OR SERVO BOARD OVERTEMPERATURE	•	ON	ON		ON	
MICROCODE	•	ON	ON		ON	ON
SERVO DIAGNOSTIC	•	ON	ON	ON		ON
INITIAL RECAL	•	ON	ON	ON	ON	
MICROPROCESSOR HARDCORE TEST	ON	ON	ON	ON	ON	ON

Column indicators:
RUN STOP SWITCH AND INDICATOR (YELLOW); FAULT INDICATOR AND RESET SWITCH (RED); READY INDICATOR (WHITE); WRITE PROTECT SWITCH AND INDICATOR (YELLOW); STAT 1 INDICATOR (WHITE); STAT 2 INDICATOR (WHITE)

• THE INDICATOR STATE WILL BE THE SAME AS IT WAS BEFORE THE FAULT SWITCH WAS PUSHED

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Figure 2-1   Fault Identification Codes

3 DIAGNOSTIC FAULT ISOLATION AND TROUBLESHOOTING

3.1 INTERNAL DRIVE DIAGNOSTICS

Figure 3-1 shows the location of the maintenance controls and indicators inside the drive. Tables 3-1 through 3-3 show some procedures using these controls.
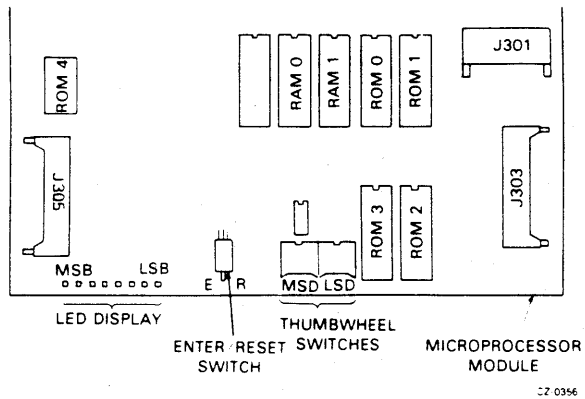
Figure 3-1   Location of Internal
Maintenance Controls and Indicators

Table 3-1 Off-Line Procedure to Run Diagnostics

Step	Action	Results
1	Set thumbwheel switches to FF	
2	Push enter switch	LEDs will blink FF
3	Push enter switch again	LEDs will display steady FF
4	Set thumbwheel switches to 00	
5	Push enter switch	LEDs will display steady 00
6	Push enter switch again	LEDs will display blinking EC until test-select code is entered.

Table 3-2 Procedure to Go Back On-Line

Step	Action	Results
1	Set thumbwheel switches to 1D	
2	Push enter switch	LEDs will momentarily display 1D and then E7
3	Set thumbwheel switches to 00	
4	Push enter switch	LEDs will display 00 and drive will be back on-line

Table 3-3   Sample Run Procedure (Static Logic Test)

Step	Action	Results
1	Go off-line as outlined in Table 3-1	LEDs will blink EC
2	Set thumbwheel switches to 22	
3	Push enter switch	LEDs will momentarily display 22. If no errors are encountered, LEDs will then display AA as a completion code. If anything other than AA is displayed, refer to Service Manual for corrective action.
4	Push enter switch	LEDs will blink EC until next test-select code is entered.

Table 3-4 contains a list of the various internal diagnostic tests and the corresponding test-select codes. Although these codes are listed alphanumerically, it is recommended that the entire unit test (initiated by test-select code 25) be run first. Table 3-5 lists the prompt codes that occur during diagnostic tests.

Table 3-4   Test-Select Codes

Test-Select Code	Test
01	Examine diagnostic extended-status area utility
02	Examine previous error utility
03	Examine drive-state utility
04	Examine seek-counters utility
05	Memory-examine up utility (refer to Service Manual for parameters)
06	Memory-examine down utility (refer to Service Manual for parameters)
07	Three-module bus test
08	Microprocessor module bus test
09	Microprocessor and personality module bus test
0A	Microprocessor and servo module bus test
0B	Personality module micro-sequencer test
0C	Sector/byte counter test
0D	Operator control panel test
0E	Head-select multiplexer test
0F	General purpose counter test
11	Track counter test
12	Read/write fault force test
13	Servo position loop test
14	Servo velocity loop test
15	Servo functional test
16	Random seek test
17	Seek – seek test with input parameters (refer to Service Manual for parameters)

Table 3-4   Test-Select Codes (Cont)

Test-Select Code	Test
18	Seek – seek test with fixed parameters
19	Incremental seek test with input parameters (refer to Service Manual for parameters)
1A	Incremental seek test with fixed parameters
1B	Read-only test
1C	Write/read test
1D	Return on-line
1E	Spindle control utility
1F	Head-select and seek utility (refer to Service Manual for parameters)
20	Maintenance controls and indicators test
21	Read-only cylinder formatter utility
22	Logic tests
23	Servo tests
24	Read/write tests
25	Entire unit test
26	Servo velocity adjustment utility
27	Static servo test
CF	Set loop mode utility (refer to Service Manual for parameters)
FF	Enter diagnostic mode

Table 3-5   Prompt and Steady State Codes

Code	Significance
Blinking EC (1110 1100)	Indicates that firmware is waiting for a test-select code.
Blinking 01, 02, 03, or 04	Indicates the number of the current input para-meter required by the diagnostic utility or test.
Blinking EE (1110 1110)	Indicates an invalid test-select code has been entered. Requires entry of a valid test-select code.
Steady state AA	Indicates test completion. Return to the EC prompt before running another test.
Steady state E7	Indicates that the firm-ware is actively executing a test.

3.2   FAULT ISOLATION

Table 3-6 provides a list of the LED error codes for the drive and the errors they represent. The numbers in the right-hand column correspond to reference numbers in Table 1-2 and denote the most likely causes of the error.

Table 3-6   LED Error Codes and Possible Cause(s)

Error Code	Error	Possible Cause(s)*
00	Microprocessor self-test error	31, 49, 42, 1
01	Spindle motor timeout error	8, 25, 31, 29, 46, 36, 3, 1, 39, 40
02	Spin-up too slow error	5, 36, 8, 25, 31, 34
03	Spindle not accelerating	5, 36, 8, 25, 31, 34
04	Spin-up too long error	5, 36, 8, 25, 31, 34
05	Sequence-hold/ sequence-pick error	60, 49
06	Microcode error	31
0A	Invalid inter-face command error	49, 31, 42
11†	Wrong peak entering detent error	50, 31, 43, 34
12	Servo active PLO error	50, 31, 43, 41, 34, 1
13	No fine track error	50, 31, 43, 34, 1
14†	Servo speed or direction error	50, 31, 43, 34, 1

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
15†	Seek/recal timeout error	61, 50, 31, 43, 53, 34, 1
16†	Guard-band error	50, 31, 43, 34, 1
17†	Track counter underflow error	50, 31, 43, 34, 1
1A	Invalid cylinder address error	49, 31, 42, 32, 52
23	Spindle motor interlock error	62, 31, 24, 53
24	Servo inactive PLO error	50, 31, 43, 41, 34, 1
25†	Servo detected off-track error	50, 31, 43, 34, 1
26	Spindle speed error	5, 64
27	HDA overtemperature error	5, 64, 65, 26, 29, 46, 31
28	Servo module overtemperature error	6, 64, 50, 43, 31
30	Write current and no write-gate error	29, 31, 46, 34
31	Read and write error	49, 31, 44, 32, 51, 52

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
32	Read/write while faulted error	31, 49, 29, 44, 46, 45, 34
33	Data separator/ encoder error	31, 29, 49, 46, 44
34	Write-precompen- sation error	31, 49, 42
35	Write and write- unsafe error	29, 46, 45, 31, 34
36	Head-short error	29, 46, 45, 31, 34
37	Write gate and no write-current error	29, 46, 45, 31, 49, 44, 32, 51, 34
38	Read and multi- chip-select error	29, 46, 45, 31, 34
39†	Write and off- track error	50, 31, 43, 41, 34
3A	Write and write- protected error	31, 30, 47
46	False drive fault condition	31, 50
51	Sector/byte counter error	31, 50, 43
53	Personality module micro- sequencer error	49, 31, 42

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
54	Multiplexer head-select error	31, 49, 29, 44, 46
57	RAM 1 general purpose counter error	31
58	RAM 0 general purpose counter error	31
60	Read/write head-select error	31, 49, 29, 44, 46, 45, 34
61	Data port preset error	49, 31, 42
62	Read-only test overall read error	29, 31, 49, 44, 46, 45, 34
63	Read-only test partial read error	29, 45, 34, 46, 31, 44, 49
64	Read/write test guard-band error	50, 31, 43, 34
65	Sector timeout error	50, 31, 43, 49, 44
66	Read-only test read and no enable error	59, 50, 34
67	Write test not executable error	66

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
6A	Write/read test overall read error	29, 31, 49, 44, 46, 45, 34
6B	Write/read test partial read error	45, 29, 46, 31, 44, 49
6E	Write/read test read and no enable error	59, 50, 34
70	Read/write control-select error	31, 49, 42
71	Utility head-select error	31
7C	Too slow seek error	67
7D	Bad seek count overflow error	50, 31, 43, 34, 1
7E	Too fast seek error	68
7F	Spindle not spinning error	69
80	ROM set error	31
85	RAM 0 error	31
86	RAM 1 error	31
87	ROM 0 checksum error	31

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
8A	Module interlock error	70
8B	Discrete port-enable error	31
8F	ROM 1 checksum error	31
97	ROM 2 checksum error	31
9F	ROM 3 checksum error	31
A0	Read and write safety error	31, 49, 29, 42, 44, 46, 45, 34
A3	Forced read and write error	31, 49, 45, 42
A4	Forced write current and no write gate error	31, 49, 42
A5	Forced write gate and no write current error	31, 49, 42
A6	Forced separa-tor/encoder error	31
A7	ROM 4 checksum error	31
AB+	Outer guard-band seek error	50, 31, 43, 34, 1

*See Table 1-2
+Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
B0	Three-module microprocessor bus error	31
B1	Three-module personality bus error	49, 31, 42
B2	Three-module servo bus error	50, 31, 43
B3	Microprocessor module bus error	31
B4	Personality module bus error	49, 31, 42
B5	Servo module bus error	50, 31, 43
C2	Fine-track status error	50, 31, 43
C3	Fine-track overrange error	50, 31, 43
C4	Fine-track underrange error	50, 31, 43
C5	Off-track status error	50, 31, 43
C6	Off-track overrange error	50, 31, 43
C7	Off-track underrange error	50, 31, 43

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

Error Code	Error	Possible Cause(s)*
CB	Acceleration-status error	50, 31, 43
CD	Track counter error	50, 31, 43
D0†	Recalibration error	50, 31, 43, 34
D1†	Outer guard-band status error	50, 31, 43, 34
D2†	Inner guard-band status error	50, 31, 43, 34
D3†	Seek into outer guard-band error	50, 31, 43, 34, 1
D4†	Outer guard-band status not true error	50, 31, 43, 34 1
D5†	Recal from outer guard-band error	50, 31, 43, 34, 1
D6†	Two-track seek to track 560 error	50, 31, 43, 34, 1
D7†	Seek into inner guard-band error	50, 31, 43, 34, 1
D8†	Inner guard-band status not true error	50, 31, 43, 34, 1
D9†	Recal from inner guard-band error	50, 31, 43, 34, 1

*See Table 1-2
†Indicates a servo problem

Table 3-6   LED Error Codes and Possible Cause(s) (Cont)

| Error Code	Error	Possible Cause(s)*
E0†	Random seek error	50, 31, 43, 34, 1
E1	Seek check error	71, 72
EA	Cannot run test, drive-faulted error	73
EE	Entry error	74, 75
EF	F.E. entered in-valid cylinder-address error	76
FE	Thumbwheel-switch error	31

*See Table 1-2
†Indicates a servo problem

3.2.1   Power Supply Fault Isolation

Power supply failure symptoms are listed in Table 3-7. Power supply voltages can be measured on the circuit modules at the connector pins indicated in Figure 3-2, and the tolerances for these measurements are given in Table 3-8.

Table 3-7   Power Supply Failure Symptoms

Symptom Check	Action
+5 volt indicators	Check that the operator control panel indicators and the internal LED display flash on momentarily when power is applied to the drive. The flash will indicate that +5 volts is present.
WRITE PROTect switch	Check that +5 volts is present at the operator control panel WRITE PROTect switch. The WRITE PROTect switch should light when pushed if +5 volts is present and the drive is on-line.
±12 volt LEDs	Check that the two 12 volt LEDs on the servo module (next to the heatsink) are on. When lit, they indicate that both +12 and −12 volts are present.
FAULT indicator off, all other operator control panel indicators on	Check to see if only the FAULT indicator on the operator control panel is off. This condition occurs only when the DC LOW signal is asserted.
	Possible causes could be the power supply, microprocessor module, or servo module.
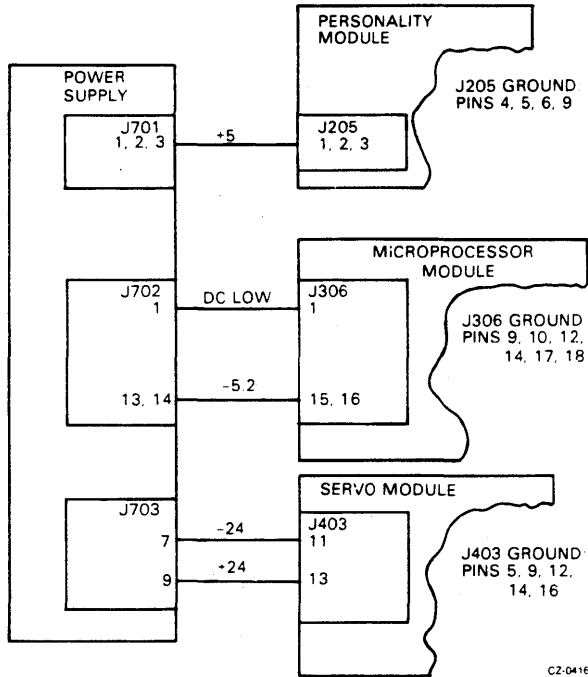
Figure 3-2   Voltage Test Points

Table 3-8   DC Voltage Tolerances

DC Voltages	Acceptable Tolerances	Test Points (See Figure 3-2)
+5	± 0.2 volts	Pins 1, 2, or 3 of J205
− 5.2	± 0.2 volts	Pins 15 or 16 of J306
+ 24	+ 3, − 1 volts	Pin 13 of J403
− 24	+ 1, − 3 volts	Pin 11 of J403
DC Low		Pin 1 of J306

4 SERVICING TIPS

4.1 TIPS AND REMINDERS

The following paragraphs describe some general trouble-shooting tips that may be useful when isolating faults in the R80. Reference to Digital Tech Tips will also prove helpful.

4.1.1 Testing the Write-Protect Function

The following procedure provides an easy means of checking the write-protect function while the drive is in the functional mode.

1. Spin-down the drive.

2. Push in the WRITE PROTect switch.

3. Spin-up the disk. If the write-protect function is working, the FAULT indicator will light and the internal LEDs on the microprocessor module will display an error code of 6A.

4. Push the FAULT switch to enter the fault display mode. The operator control panel will display a R/W diagnostic fault code. Both the FAULT and STAT 1 indicators should be on.

5. Push the FAULT switch again to clear this fault condition.

6. Release the WRITE PROTect switch.

4.1.2 Checking Firmware Revision and ROM Set Numbers

The firmware revision and ROM set numbers are located in the last few bytes of each ROM. Table 4-1 lists the last address of each ROM and Figure 4-1 shows what is contained in the last eight bytes of each ROM.

The easiest way to examine these numbers is by using the memory-examine down utility. To access this utility, use test-select code 06. Enter the address of the last byte of the ROM to be examined. Next, push the ENTER switch to examine each byte location starting with the last byte in the ROM.

Table 4-1   Last Byte Address of Each ROM

ROM	Address of Last Byte
0	07FF
1	0FFF
2	17FF
3	1FFF
4	27FF
5	2FFF

REV HIGH BYTE	REV LOW BYTE	ROM SET HIGH BYTE	ROM SET LOW BYTE	ZEROS (UNUSED)	ONES COLUMN CHECK	ZEROS COLUMN CHECK	CHECK SUM

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Figure 4-1   Last Eight Bytes of a ROM

4.1.3   Spin-Up Delay After Power-On

When spinning up the disk drive after a power loss, a 40-second delay will occur before the drive will begin a spin-up cycle under either of the following conditions:

- When RUN/STOP switch is already depressed at power-on.
- When RUN/STOP switch is pushed in within three seconds after power-on.

This 40-second delay will occur regardless of whether the power loss is due to a power failure or to a normal circuit breaker power-down.

4.1.4   Spindle Motor Thermal Timeouts

The R80 Engineering Specification calls for a three-minute waiting period between successive start-up cycles of the spindle motor. This waiting period is required to prevent the spindle motor from overheating and opening an internal thermal switch in the motor.

A spindle motor thermal timeout may be caused by frequent spindle motor start-up or loss of cooling due to a fan failure.

If the spindle motor thermal switch opens, it will cause a spin-up fault on the operator control panel and an LED error code display of 01, 02, 03, 04, or 26.

To recover from a spindle motor thermal timeout, check the fans first. If the fans are operating, let the motor cool off for 10 to 15 minutes while power is applied to the drive.

4.1.5   HDA Fault Isolation

Voltage checks can be used in some cases to determine whether or not an HDA problem actually exists. If it appears the the HDA is defective, check the voltages applied to the HDA before replacing the unit. If all power supply voltages are present and within the specified tolerances, -4 volts should be present on pins 7 and 8 of J601 on the HDA. Also, $+6$ volts should be present on pins 9 and 10 of J601. If either of these voltages are missing or incorrect, the problem will likely be found in the associated voltage regulators located on the read/write module and not in the HDA itself.

Also check for -8.2 volts on pin 2 of J602 on the HDA. If this voltage is missing or incorrect, the problem will usually be found on the servo module between the -12 volt regulator and J401.

APPENDIX A
BINARY TO HEXADECIMAL
CONVERSION

The LED display on the microprocessor module consists of eight LEDs in a row which are read as two hexadecimal digits. Use Table A-1 to convert the binary LED code into hexadecimal.

Table A-1   Binary to Hexadecimal Conversion

Binary	Hexa-decimal
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

D

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