RM80 160 MEG

CHAPTER 3
ADJUSTMENTS

3.1 INTRODUCTION

This chapter describes the adjustment procedures for the RM80 Disk Drive. Only two adjustments can be made, the belt tension adjustment and the servo adjustment.

3.2 BELT TENSION ADJUSTMENT

The belt tension should be checked whenever the motor, pulley, belt or HDA is replaced. Since the belt may stretch slightly with use, belt tension should also be examined anytime a drive corrective action call is made. To check or adjust belt tension, perform the following steps with the HDA in place.

Belt Tension Check-Out Procedure

1. Spin-down the HDA by releasing the RUN switch on the operator control panel.
2. Raise the drive logic chassis (Paragraph 2.10).
3. Examine the position of the brass-colored slider relative to the opening in the metal reference marker on the motor actuator assembly. When belt tension is adjusted properly, the end of the brass-colored slider should extend through the opening and be flush with the outside edge of the metal reference marker. Refer to Figure 3-1 to locate the belt tension adjustment mechanism. Refer to Figure 3-2 to see a close-up of the brass-colored slider and the metal reference marker.

Belt Tension Adjustment Procedure

If an examination of the belt tension mechanism reveals that the adjustment must be made, then switch off ac power to the drive at circuit breaker CB1 on the rear. Then perform the following steps.

1. Locate the belt tension adjustment screw at the base of the motor. Refer to Figure 3-1.
2. Loosen the locking nut on the adjustment screw.
3. Turn the adjustment screw clockwise to move the brass-colored slider toward the front of the drive. When adjusted properly, the end of the brass-colored slider should extend through the opening and be flush with the outside edge of the metal reference marker. Refer to Figure 3-2.
4. After the adjustment is made, tighten the locking nut on the adjustment screw.
5. Restore the ac power to the drive and spin-up the HDA.

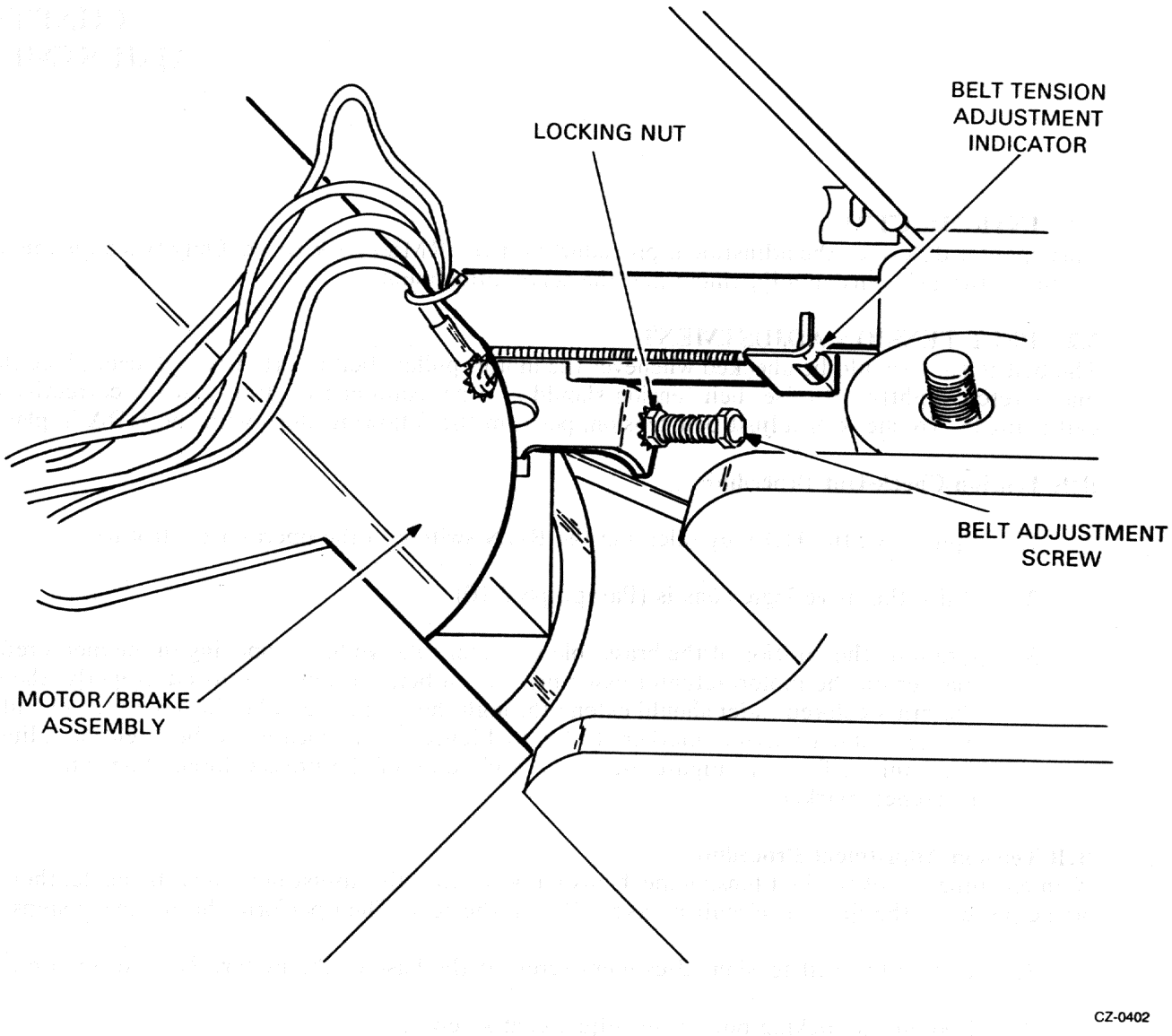


Figure 3-1 Location of Belt Tension Adjustment Mechanism

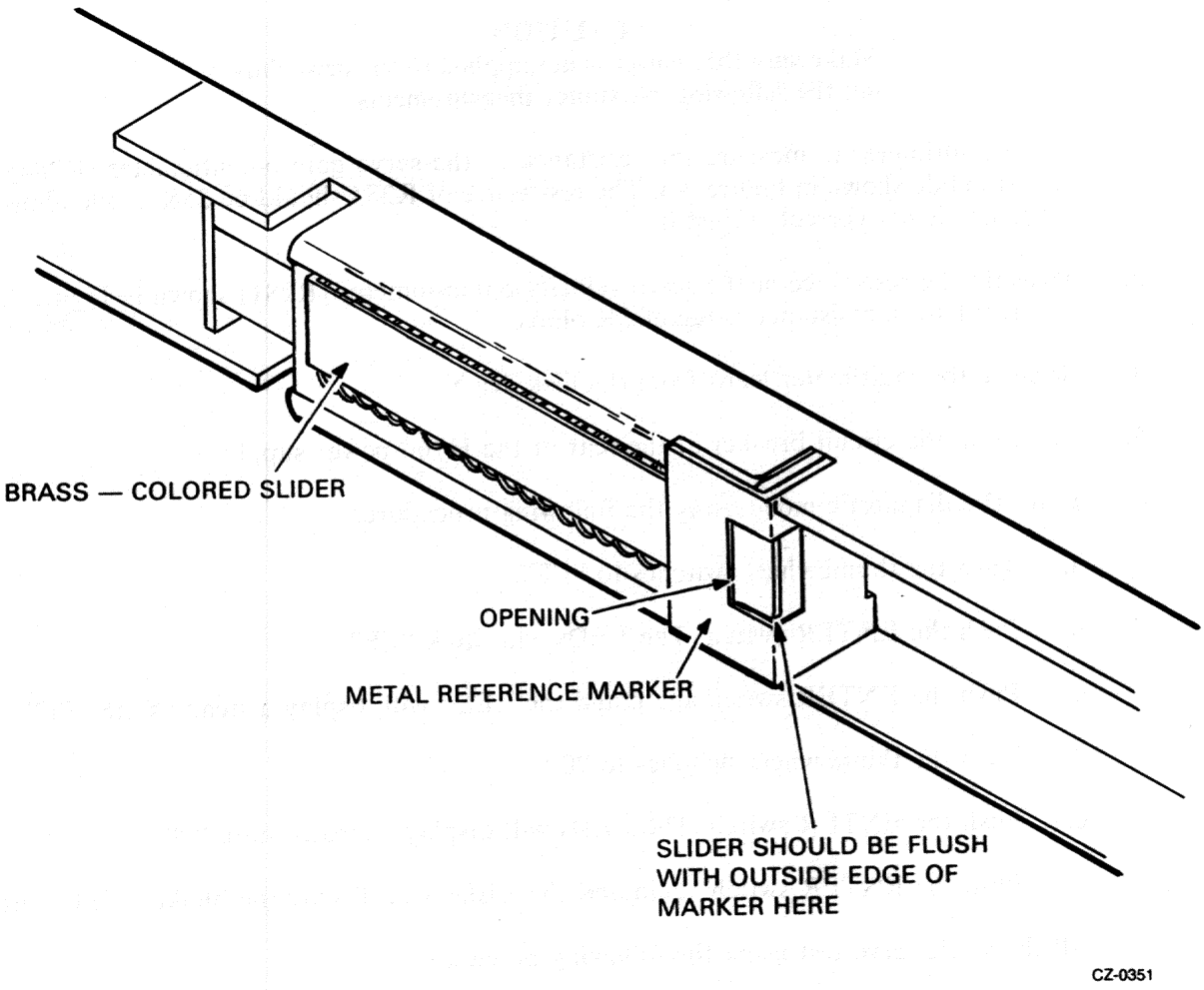


Figure 3-2 Close-Up of Belt Tension Adjustment Indicator

3.3 SERVO ADJUSTMENT

The servo adjustment must be performed after replacing a servo module or HDA. Use the following procedures to make this adjustment.

1. Remove power to the R80 drive using the circuit breaker at the rear of the H766 power supply.

CAUTION

Make sure that power is not applied to the drive during the following resistance measurements.

2. Use a multimeter to measure the resistance of the servo gain potentiometer (R284) on the servo module shown in Figure 3-3. The resistance of R284 should be 25K ±500 ohms. If the resistance is not correct, adjust it.

3. Measure the resistance of the servo velocity potentiometer (R281) shown in Figure 3-3. Adjust R281 for a resistance value of 5K ohms.

4. Remove the multimeter leads from the disk drive.

5. Switch on the circuit breaker at the rear of the H766 power supply.

6. Enter the diagnostic mode using the following procedure.

   a. Turn the thumbwheel switches to "FF".

   b. Push the ENTER switch. The LEDs will blink "FF".

   c. Push the ENTER switch again and the LEDs will display a steady state "FF".

   d. Turn the thumbwheel switches to "00".

   e. Push the ENTER switch. The LEDs will display a steady state "00".

   f. Push the ENTER switch again and the LEDs will display the blinking "EC" prompt.

7. Call the static servo test using the following procedure.

   a. Turn the thumbwheel switches to "27".

   b. Push the ENTER switch. The LEDs will momentarily display "27" and then "AA" when the test completes successfully. If an error code occurs, remove power from the drive, replace the servo module, and repeat Steps 2 through 7b. If the test ended with an "AA", then proceed to Step 7c.

   c. Push the ENTER switch again and the LEDs will display the blinking "EC" prompt.

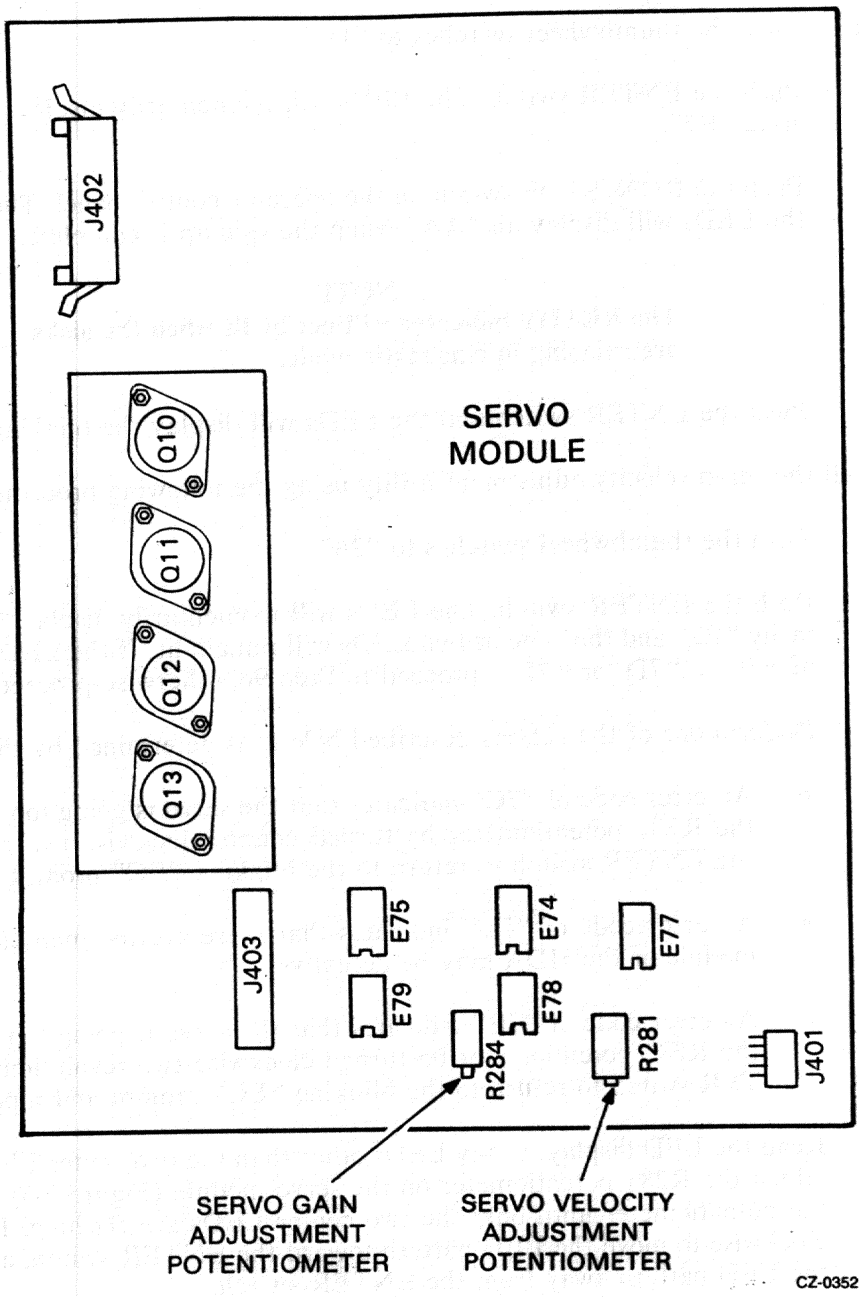


Figure 3-3 Location of Servo Adjustment Potentiometers

8. Spin-up the disk using the following procedure.

   a. Turn the thumbwheel switches to "1E".

   b. Push the ENTER switch. The LEDs will momentarily display "1E" and then a steady state "E7".

   c. Push the RUN/STOP switch on the operator control panel. The drive will spin-up and the LEDs will display an "AA" when the spin-up is complete.

NOTE
The READY indicator will not be lit when the disks are spinning in diagnostic mode.

   d. Push the ENTER switch and the LEDs will display the blinking "EC" prompt.

9. Call the servo velocity adjustment utility using the following procedure.

   a. Turn the thumbwheel switches to "26".

   b. Push the ENTER switch. The LEDs will momentarily display "26" and then momentarily "E7" and then one or two LEDs will remain lit. If the LEDs display an error code of "7C", "7D"or "7E", proceed to Step 9c, otherwise proceed to Step 9d.

   c. Perform one of the actions described below, as determined by the LED error code.

   - An error code of "7C" indicates that the servo is going too slow and requires that the R281 potentiometer be turned counterclockwise two revolutions. Then push the ENTER switch to return to the blinking "EC" prompt and repeat Step 9.

   - An error code of "7D" indicates that there are too many seek errors. The servo module or the HDA may be defective.

   - An error code of "7E" indicates that the servo is going too fast and requires that the R281 potentiometer be turned clockwise two revolutions. Then push the ENTER switch to return to the blinking "EC" prompt and repeat Step 9.

   d. Read the LED display. If any LEDs other than the two center LEDs are on or flashing, adjust the R281 potentiometer on the servo module (Figure 3-3). The goal is to adjust the potentiometer until only the two center LEDs are flashing. Rotate R281 counterclockwise to move the LED pattern toward the ENTER switch, and clockwise to move the LED pattern away from the ENTER switch.

NOTE
Rotate the servo velocity adjustment potentiometer (R281) slowly, since there is a time delay before the LED patterns react to the adjustment.

   e. Let the servo velocity adjustment utility run for 20 minutes to thermally stabilize the positioner motor. After 20 minutes, proceed to Step f.

   f. Read the LED display. Readjust the R281 potentiometer until only the two center LEDs of the display are on or flashing.

g. Turn the thumbwheel switches to "DD".

h. Push the ENTER switch. The LEDs will display "AA" or blink "EC", depending on how long the ENTER switch is pushed.

i. Push the ENTER switch again if the LEDs display an "AA". The LEDs should then display the blinking "EC" prompt.

10. Call the entire unit test by using the following procedure.

a. Turn the thumbwheel switches to "25".

b. Push the ENTER switch. The LEDs will momentarily display "25" and then "E7". Wait until all the tests are run and the LEDs display "AA".

c. Push the ENTER switch and the LEDs will display the blinking "EC" prompt.

11. Return on-line using the following procedure.

a. Turn the thumbwheel switches to "1D".

b. Push the ENTER switch. The LEDs will momentarily display "1D" and then "E7".

c. Turn the thumbwheel switches to "00".

d. Push the ENTER switch. The LEDs will display "00" and the drive will be on-line. To determine if the drive is on-line, push the WRITE PROTECT switch. If the WRITE PROTECT indicator lights, then the drive is back on-line.

CHAPTER 4
DRIVE-RESIDENT DIAGNOSTICS

4.1 INTRODUCTION

This chapter describes the RM80 firmware diagnostic capabilities. It begins with a description of the functional firmware fault and error codes. It shows the location of the maintenance controls and how to use them. Next, a description of each utility routine and diagnostic test is presented. The error codes are tabulated and explained at the end of the chapter.

4.2 FUNCTIONAL AND DIAGNOSTIC FIRMWARE

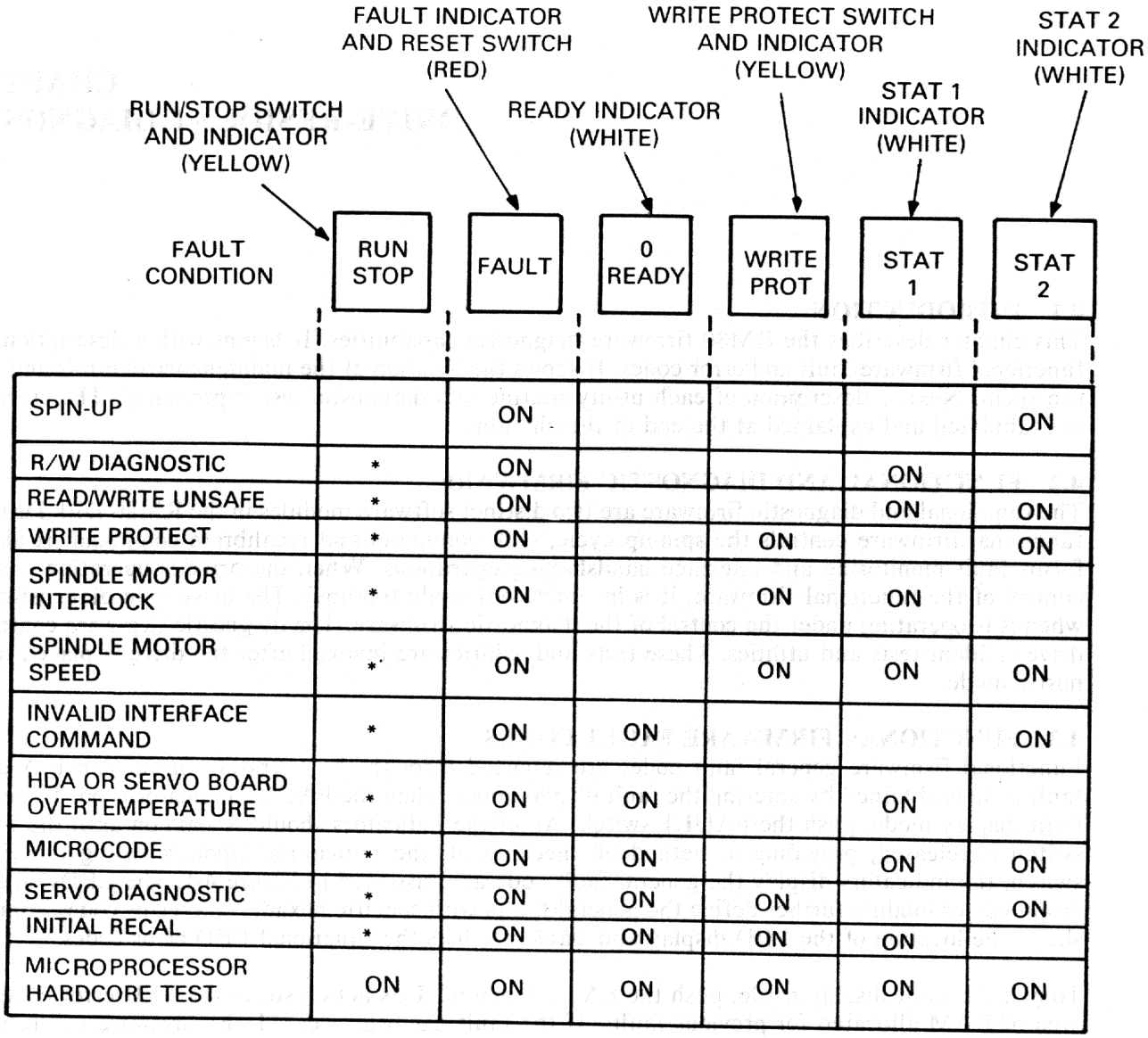
The functional and diagnostic firmware are two distinct software modules in the RM80 Disk Drive. The functional firmware controls the spin-up cycle, seek command and recalibrate command. It also performs fault monitoring and interface handshaking operations. When the drive is operating under the control of the functional firmware, it is in functional mode (on-line). The drive is in diagnostic mode when it is operating under the control of the diagnostic firmware. The diagnostic firmware controls the drive-resident tests and utilities. These tests and utilities are invoked after the drive is placed in diagnostic mode.

4.3 FUNCTIONAL FIRMWARE FAULT CODES

Functional firmware general fault codes are reported through the operator control panel. A general fault code is obtained by entering the fault display mode when the FAULT indicator is on. To enter the fault display mode, push the FAULT switch. All of the indicators should remain on until the FAULT switch is released, providing a method of checking all the indicators. Upon releasing the FAULT switch, the indicators display the general fault code as illustrated in Figure 4-1. The LEDs on the microprocessor module further define the general faults with specific hexadecimal error codes. Figure 4-2 shows the location of the LED display and Table 4-1 lists the functional LED error codes.

To exit the fault display mode, push the FAULT switch. This action stores the LED error code in the area of RAM allocated for previous faults. If the fault has been cleared, the firmware will return the operator control panel to its previous state. If the fault still exists, the FAULT indicator will light again.

The read/write unsafe and invalid interface command fault conditions can be corrected by the CPU, in which case the FAULT indicator goes off without operator intervention. If the fault cannot be corrected by the CPU, the FAULT indicator remains on and the fault must then be cleared through manual intervention.



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

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

CZ-8035

Figure 4-1 Operator Control Panel General Fault Indicators

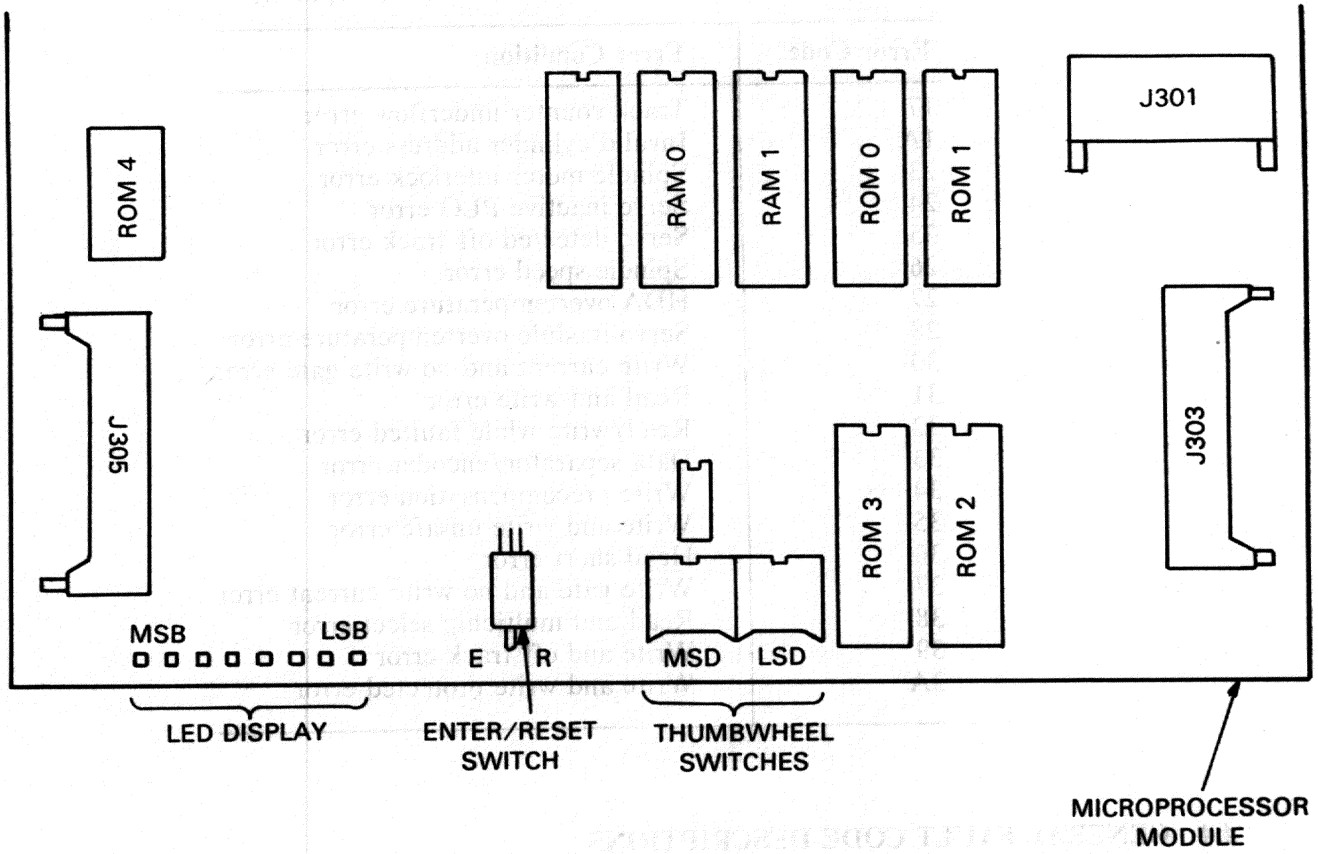


Figure 4-2 Internal Maintenance Controls and Indicators

Table 4-1 Functional LED Error Codes

Error Code	Error Condition
01	Spindle motor timeout error
02	Spin-up too slow error
03	Spindle not accelerating error
04	Spin-up too long error
05	Sequence hold/sequence pick error
06	Microcode error
0A	Invalid interface command error
11	Wrong peak entering detent error
12	Servo active PLO error
13	No fine track error
14	Servo speed or direction error
15	Seek/recal timeout error
16	Guard band error

Table 4-1 Functional LED Error Codes (Cont)

Error Code	Error Condition
17	Track counter underflow error
1A	Invalid cylinder address error
23	Spindle motor interlock error
24	Servo inactive PLO error
25	Servo detected off track error
26	Spindle speed error
27	HDA overtemperature error
28	Servo module overtemperature error
30	Write current and no write gate error
31	Read and write error
32	Read/write while faulted error
33	Data separator/encoder error
34	Write precompensation error
35	Write and write unsafe error
36	Head short error
37	Write gate and no write current error
38	Read and multichip select error
39	Write and off track error
3A	Write and write protected error

4.4 GENERAL FAULT CODE DESCRIPTIONS

Nine general fault codes are reported through the operator control panel indicators. These nine general fault codes are described in the paragraphs below.

4.4.1 Microprocessor Hardcore Test Fault

The microprocessor hardcore test is run when power is applied through CB1 on the back of the drive. POWER UP RESET starts the firmware at memory location "0000". The firmware then performs tests on the hardware listed below.

- Microprocessor
- ROMs
- RAMs
- Microprocessor bus
- Servo bus
- Personality bus
- Sector/byte counter
- Personality microsequencer

If the hardcore test fails, all the indicators on the operator control panel will be on. More detailed information on the hardcore failure can be obtained by examining the internal LED display. Refer to Table 4-2 for the LED error codes.

Table 4-2 LED Error Codes for Hardcore Tests

Error Code	Error Condition
00	Microprocessor self-test error
53	Personality module microsequencer error
80	ROM set error
85	RAM 0 error
86	RAM 1 error
87	ROM 0 checksum error
8A	Module interlock error
8B	Discrete port enable error
8F	ROM 1 checksum error
97	ROM 2 checksum error
9F	ROM 3 checksum error
A7	ROM 4 checksum error
B0	Three module microprocessor bus error
B1	Three module personality bus error
B2	Three module servo bus error

4.4.2 Spindle Spin-Up Fault

The spindle begins rotating when the RUN switch is pushed. During the spin-up cycle, the firmware monitors spindle acceleration and speed. If the spindle takes too long to attain its final speed, is rotating too slowly, or is not accelerating, the firmware stops the spindle and turns on the FAULT indicator. If the fault display mode is then entered, a spin-up fault will be indicated. The internal LED display indicates the specific error code. Refer to Table 4-3.

Table 4-3 LED Error Codes for Spin-Up Faults

Error Code	Error Condition
01	Spindle motor timeout error
02	Spin-up too slow error
03	Spindle not accelerating error
04	Spin-up too long error

4.4.3 Read/Write Unsafe Fault

A read/write unsafe fault is detected any time the microprocessor interrupt is enabled. Upon recognizing a read/write unsafe condition, the firmware sets drive fault in the status register on the personality module. The RM adapter recognizes the fault and terminates the read or write command. The internal LED display indicates the specific error code. Refer to Table 4-4.

Table 4-4 LED Error Codes For Read/Write Unsafe Faults

Error Code	Error Condition
30	Write current and not write gate error
31	Read and no write gate error
32	Read/write while faulted error
33	Data separator/encoder error
34	Write precompensation error
35	Write and write unsafe error
36	Head short error
37	Write gate and no write current error
38	Read and multichip select error
39	Write and off track error
3A	Write and write protected error

4.4.4 Write Protect Fault

The write protect fault occurs if a write operation is attempted when the WRITE PROT switch is latched. A code of "3A" is also displayed on the internal LEDs.

4.4.5 Spindle Motor Interlock Fault

Before the firmware enters the spin-up routine, the belt tension microswitch is checked. If the belt tension lever is in the released position, the firmware will sense this and not spin-up the disk, lighting the FAULT indicator. If the disks are already spinning and a failure occurs in the belt tension interlock circuit, the disks will spin-down and the FAULT indicator will light. The internal LED error code is "23".

4.4.6 Spindle Motor Speed Fault

If the spindle slows to below 3420 r/min, the firmware turns on the FAULT indicator and stops the spindle motor. The internal LED error code is "26".

4.4.7 Invalid Interface Command Fault

An invalid interface command fault is generated by one of the two conditions listed below.

- The firmware receives a command other than a seek, recalibrate, or offset from the personality module.
- The firmware receives a command when the drive is not ready.

The internal LED error code for an invalid interface command fault is "0A".

4.4.8 HDA or Servo Overtemperature

There are two temperature sensors in the R80 Disk Drive, one on the bottom of the HDA and the other on the servo module heat sink. If the firmware detects an overtemperature condition, the FAULT indicator is lit. The LED error codes for these overtemperature conditions are listed in Table 4-5.

Table 4-5 LED Error Codes for HDA or Servo Module Overtemperature

Error Code	Error Condition
27	HDA overtemperature error
28	Servo module overtemperature error

4.4.9 Microcode Fault

Near the end of each ROM is an instruction to jump to a microcode fault routine. This instruction is only executed if the firmware malfunctions. When this instruction is executed, it calls the microcode fault routine. This routine turns off the spindle motor, displays an "06" in the LEDs, and lights the FAULT indicator on the operator control panel.

4.4.10 Servo Diagnostic Fault

After the spindle is up to speed, the firmware performs static servo diagnostics before doing the initial recalibration of the heads. The tests listed below are run during the static servo diagnostics.

- Track counter test
- Servo position loop test
- Servo velocity loop test

If the servo diagnostics fail, the FAULT indicator will light and the spin-up cyle can not be completed. (Refer to Figure 4-3.) Table 4-6 shows the LED error codes that appear on the microprocessor module with a servo diagnostic fault. Pushing the FAULT switch will light all the operator control panel indicators, then display the fault. If the FAULT switch is pushed again, the firmware will run the servo diagnostics again.

Table 4-6 LED Error Codes for Servo Diagnostics

Error Code	Error Condition
C2	Fine track status error
C3	Fine track over range error
C4	Fine track under range error
C5	Off track status error
C6	Off track over range error
C7	Off track under range error
CB	Acceleration status error
CD	Track counter error

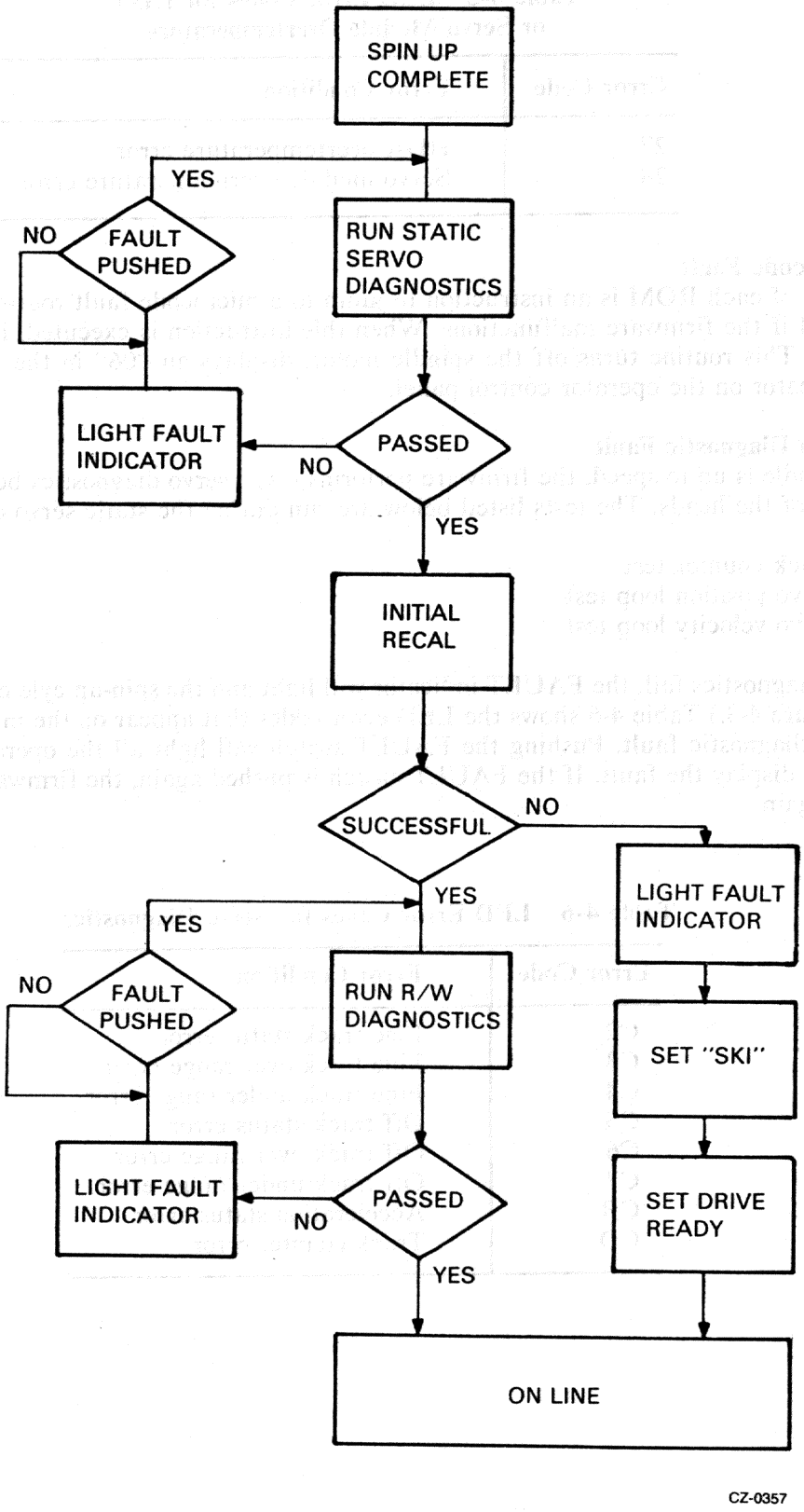


Figure 4-3 Spin-Up Diagnostic Flowchart

4.4.11 Initial Recalibration Fault

During the spin-up cycle, the firmware does the inital recal after running the static servo diagnostics (refer to Figure 4-3). If the initial recal is successful, the firmware then runs the read/write diagnostics. If the initial recal is unsuccessful, the firmware lights the FAULT indicator, sets seek incomplete in the RM adapter and then lights the drive READY indicator. The CPU will then come back with a recalibration command which will clear the FAULT indicator and retry a recal. The CPU will retry the recalibration until successful or until the number of retries for the CPU are executed. Refer to Table 4-7 for the LED error codes.

Table 4-7 LED Error Codes For Seek Incomplete Faults

Error Code	Error Condition
11	Wrong peak entering detent error
12	Servo active PLO error
13	No fine track error
14	Servo speed and direction error
15	Seek/recal timeout error
16	Guard band error
17	Track counter underflow error
1A	Invalid cylinder address error

4.4.12 Read/Write Diagnostic Fault

After the firmware has performed the initial recalibration, it then executes the read/write diagnostics before lighting the drive READY indicator. The tests listed below are performed during the read/write diagnostics.

- Read only test
- Write/read test

If the read/write diagnostics fail, the FAULT indicator will light and the spin-up cyle can not be completed. (Refer to Figure 4-3.) Table 4-8 shows the LED error codes that appear on the microprocessor module with a read/write diagnostic fault. Pushing the fault switch will light all the operator panel indicators, then display the fault. If the FAULT switch is pushed again, the firmware will run the read/write diagnostics again. If the read/write diagnotics pass, the firmware then lights the drive READY indicator.

Table 4-8 LED Error Codes for Read/Write Diagnostics

Error Code	Error Condition
60	Read/write head select error
61	Data port preset error
62	Read-only test overall read error
63	Read-only test partial read error
64	Read/write test guard band error
65	Sector timeout error
66	Read-only test read and no enable error
67	Write test not executable error
6A	Write/read test overall read error
6B	Write/read test partial read error
6E	Write/read test read and no enable error
	Any functional errors

4.5 SEEK INCOMPLETE ERRORS

A seek incomplete does not light the FAULT indicator, but displays an error code on the internal LEDs. The drive flags the CPU with a seek incomplete and waits for a recalibrate command. Upon recognizing the recalibrate command, the firmware stores the LED code in memory, clears the internal LED display, and then calls the recalibrate routine. Table 4-7 shows the internal LED error codes that are generated by a seek incomplete.

4.6 SEQUENCE HOLD/SEQUENCE PICK ERROR

The loss of SEQUENCE HOLD or SEQUENCE PICK causes the following indications. If SEQUENCE HOLD and SEQUENCE PICK are not asserted after the RUN switch is pushed, the spindle will not spin-up and the RUN indicator will not light. If SEQUENCE HOLD or SEQUENCE PICK is lost while the spindle is spinning, the firmware will stop the spindle and turn off the RUN indicator. The internal LED error code is "05".

4.7 DIAGNOSTIC FIRMWARE CONTROLS AND INDICATORS

The RM80 internal maintenance controls and LEDs are located in the front left hand corner of the microprocessor module. Refer to Figure 4-2. These maintenance controls and LEDs are divided into three functional areas, thumbwheel switches, an ENTER/RESET switch, and an eight bit LED display.

4.7.1 Thumbwheel Switches

There are two hexadecimal thumbwheel switches (S2 and S3) next to each other. The switch on the right is the least significant hexadecimal digit. The switch on the left is the most significant hexadecimal digit. The rotary position of each thumbwheel switch is shown by a hexadecimal digit on the top surface of the switch. The test select codes and input parameters to run the utility routines and diagnostics are entered through the thumbwheel switches.

WARNING

Your fingers may hit the fans when using the thumbwheel switches.

4.7.2 ENTER/RESET Switch

The ENTER/RESET switch (S1) is a momentary-contact, dual-throw, center-off-position switch. The switch rests in its center-off-position. When the toggle switch is pushed to the right, it is in the RESET position, which is marked by an "R" on the circuit module. When the toggle switch is pushed to the left, it is in the ENTER position, which is marked by an "E" on the circuit module.

4.7.2.1 The ENTER Position – The ENTER position is periodically polled by the firmware to determine if a new action is required. The ENTER switch provides the Field Service engineer with a means of communicating with the firmware. For example, to initiate a diagnostic test, a test select code is placed in the thumbwheel switches and then the ENTER switch is pushed to start the test.

4.7.2.2 The RESET Position – The RESET position is connected to interrupt line RST 5.5 on the microprocessor chip. RST 5.5 is a maskable interrupt that is disabled by the firmware during seek operations. Pushing the RESET switch while the drive is in functional mode forces the firmware to reinitialize the drive logic. If the drive halts on a hardcore fault during power up, pushing the RESET switch places the drive in functional mode. While in diagnostic mode, pushing the RESET switch terminates the test.

4.7.3 LED Display

The LED display consists of a row of eight LEDs. The least significant LED is to the right. The codes displayed in the LEDs are read as two hexadecimal digits (four LEDs to each digit). Refer to Appendix A and B for hexadecimal conversion charts. Several kinds of codes appear in the LEDs. They display error codes, prompt codes, test complete codes and test select codes for entry verification.

4.8 TEST SELECT CODES

Each utility routine and diagnostic test has a unique test select code. The test select codes are listed in Table 4-9. To call a routine or test, enter the test select code into the thumbwheel switches and push the ENTER/RESET switch to the ENTER position. When the firmware detects that the switch has been pushed to the ENTER position, it reads the contents of the thumbwheel switches. The LEDs momentarily display the test select code to verify that the firmware has received it.

Table 4-9 Test Select Codes

Test Select Codes	Tests
01	Examine diagnostic extended status area utility
02	Examine previous error utility
03	Examine drive state utility
04	Examine operational counters utility
05	Memory examine up utility
06	Memory examine down utility
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 microsequencer 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
18	Seek – seek test with fixed parameters
19	Incremental seek test with input 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
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	Loop mode set utility
FF	Enter diagnostic mode

A test termination code of "DD" provides the user with a way of halting diagnostic drive tests. Most tests complete so quickly that they cannot be terminated in this way. However, seek-seek and incremental seek tests are of sufficient duration that they may be terminated prematurely in this manner. Also, tests with the loop mode set can be run for long periods of time. To stop all tests safely, use the "DD" test termination code.

To use the "DD" test termination code, follow the steps listed below.

1. Turn the thumbwheel switches to "DD".

2. Hold the ENTER switch in until an "AA" appears in the LEDs. If the switch is held too long, the "AA" will change to a blinking "EC". Each of these codes is a sign that the test has halted.

If the drive is in loop mode, it will still be in loop mode when the tests are halted with a "DD" code.

4.9 PROMPT CODES

The firmware uses several prompt codes to notify the user when it is waiting for information. These prompt codes are displayed as blinking codes in the LEDs. Table 4-10 lists the prompt codes and their meaning.

Table 4-10 Prompt Codes

Blinking "EC" (1110 1100)	Indicates that the firmware is waiting for a test select code.
Blinking "01, 02, 03, 04".	Indicates the number of the current input parameter required by the diagnostic utility or test.
Blinking "EE" (1110 1110)	Indicates an invalid test select code was entered. To recover from this state, enter a valid test select code into the thumbwheel switches and push the ENTER switch.

4.10 STEADY STATE LED CODES

Each diagnostic test or utility has three steady state LED codes, test active, test complete and error.

4.10.1 Test Active Code

A steady state "E7" in the LEDs indicates that the firmware is actively executing a test.

4.10.2 Test Complete Code

A steady state "AA" in the LEDs indicates that the firmware has completed a utility or test successfully. Before running another test, return to the "EC" prompt by pushing the ENTER switch.

4.10.3 Error Codes

A steady state error code in the LEDs indicates where a test or utility has failed. The error codes are listed at the end of this chapter. To recover from an error code, push the ENTER switch to return to the "EC" prompt.

4.11 ENTER DIAGNOSTIC MODE

The RM80 Disk Drive normally operates in an on-line functional mode; that is, under the control of the functional firmware. To perform diagnostic tests, the drive must be placed into diagnostic mode under the control of the diagnostic firmware. The steps listed below will place the drive in diagnostic mode.

1. Turn the thumbwheel switches to "FF".
2. Push the ENTER switch. The LED will blink "FF".
3. Push the ENTER switch again and the LEDs will display a steady state "FF".
4. Turn the thumbwheel switches to "00".
5. Push the ENTER switch. The LEDs will display a steady state "00".
6. Push the ENTER switch again and the LEDs will display the "EC" prompt to indicate the firmware is waiting for a test select code.

If the above sequence is not followed exactly, the test will fail and the LEDs will display a blinking "FF". Return to Step 1.

If the drive fails its hardcore diagnostic tests during the power-on cycle, push the RESET switch and then follow the above steps.

4.12 RETURN ON-LINE

After performing diagnostic tests, the drive must be returned to the control of the functional firmware. The return to the on-line functional mode is accomplished by the steps listed below.

1. Turn the thumbwheel switches to "1D".
2. Push the ENTER switch. The LEDs will momentarily display a "1D" and then display "E7".
3. Turn the thumbwheel switches to "00".
4. Push the ENTER switch. The drive is in functional on-line mode.

If the switches are not working, an alternate way to return the drive to on-line functional mode is to turn the power off and then on by means of CB1 (located in the back).

4.13 DRIVE UTILITY ROUTINES

The RM80 Disk Drive has eleven utility routines available when the drive is in diagnostic mode. These utility routines let the Field Service engineer control the drive from diagnostic mode. They also supplement the diagnostic tests by providing a way for the field engineer to gain more information about the internal drive status. The general areas covered by these utility routines are listed below.

- Drive control from diagnostic mode
- Examination of drive memory contents
- Adjustments to the servo circuits
- Preparation for diagnostic loop mode tests
- Reformatting the FE read-only cylinder

4.13.1 Memory Examine Utilities

The memory examine utilities allow the Field Service engineer to examine the contents of the drive internal ROMs and RAMs. The five memory examine modes are listed below.

- Memory examine up/down
- Examine diagnostic extended status area
- Examine drive state
- Examine seek counters
- Examine previous errors

The disk drive may have up to six ROMs and two RAMs. Each ROM has 2048 address locations, and each RAM has 256 address locations. Table 4-11 lists the hexadecimal addresses for each memory chip.

Table 4-11 Internal Memory Address Locations

Memory Chip	First Address	Last Address
ROM #0 (E34)	0000	07FF
ROM #1 (E35)	0800	0FFF
ROM #2 (E4)	1000	17FF
ROM #3 (E3)	1800	1FFF
ROM #4 (E25)	2000	27FF
ROM #5 (NOT USED)	2800	2FFF
RAM #0 (E32)	4000	40FF
RAM #1 (E33)	4100	41FF

4.13.1.1 Memory Examine Up Utility – The memory examine up utility allows the Field Service engineer to display the contents of any memory location, by incrementing through the address locations. To use the memory examine up utility, follow the steps listed below.

1. Turn the thumbwheel switches to "05".
2. Push the ENTER switch. The LEDs will momentarily display "05" and then blink "01", calling for the first input parameter.
3. Turn the thumbwheel switches to the low byte of the memory address.
4. Push the ENTER switch. The LEDs will momentarily display the contents of the thumbwheel switches, and then blink an "02".
5. Turn the thumbwheel switches to the high byte of the memory address.
6. Push the ENTER switch. The LEDs will momentarily display the contents of the thumbwheel switches and then display the eight bits of data stored at that address location.
7. Push the ENTER switch to increment the memory address pointer. Each time the ENTER switch is pushed, the contents of the next memory address will be displayed.

To exit from this utility, turn the thumbwheel switches to "DD" and push the ENTER switch.

4.13.1.2 Memory Examine Down Utility – The memory examine down utility allows the Field Service engineer to display the contents of any memory location, by decrementing through the address locations. This utility operates similar to the memory examine up utility described above. The difference is that the memory pointer is decremented instead of incremented. Use test select code "06" to call this utility.

4.13.1.3 Examine Diagnostic Extended Status Area Utility – The diagnostic extended status area is a segment of RAM 0 reserved for the storage of status and failure information on the test just run. The extended status area occupies 16 address locations. This utility displays these 16 bytes of information. The program starts at the first address of the extended status area. The layout of the extended status area is provided in Table 4-12. To call this utility, use test select code "01". The address pointer is incremented each time the ENTER switch is pushed. All 16 bytes must be examined before the test complete code "AA" is displayed. Push the ENTER switch again to return to the "EC" prompt.

Table 4-12 Diagnostic Extended Status Area

Byte Number	Contents
Byte 1	Test select code
Byte 2	Input parameter number 1
Byte 3	Input parameter number 2
Byte 4	Input parameter number 3
Byte 5	Input parameter number 4
Byte 6	Input parameter number 5
Byte 7	Input parameter number 6
Byte 8	Test result (an "AA" or error code)
Byte 9 thru 16	Starting here, the information in the last eight bytes varies with each diagnostic test. In most cases, it will consist of one or two bytes of actual test data, followed by one or two bytes of expected test data. The description of each diagnostic test will define what is contained in these last eight bytes.

4.13.1.4 Examine Previous Error Utility – The RM80 Disk Drive stores the 16 latest LED functional error codes in RAM 0. The examine previous error utility allows the Field Service engineer to display these 16 previous errors in the LEDs. When a test select code of "02" is entered, the LEDs momentarily display the "02" code and then display the most recent functional error code. Each time the ENTER switch is pushed, the next most recent error code will be displayed in the LEDs. After examining all 16 locations, push the ENTER switch again and an "AA" will appear in the LEDs. Push the ENTER switch one more time to return to the "EC" prompt.

NOTE

The 16 stored error codes are lost when the drive power is turned off.

4.13.1.5 Examine Drive State Utility – The examine drive state utility allows the Field Service engineer to display the software state words maintained by the drive functional firmware. The four software state words are shown in Table 4-13. They are stored in RAM 0. To examine these four bytes of information, enter test select code "03". The LEDs will momentarily display "03" and then display the contents of the first byte. Each time the ENTER switch is pushed, the contents of the next address location will be displayed in the LEDs. After all four bytes have been examined, push the ENTER switch again and an "AA" will appear in the LEDs. Push the ENTER switch once again to return to the "EC" prompt.

Table 4-13 Drive State Bytes

Bit	Definition
	Byte 1 Drive-State Byte
0	Off-line
1	Not used
2	Not used
3	Diagnostic non-manual request
4	Diagnostic quick verify flag
5	Servo diagnostics need to be run
6	Servo/read/write diagnostics failed
7	Initial recal complete
	Byte 2 Command-Status Byte
0	Fault display in progress
1	Sector size 0 = 30 sectors 1 = 32 sectors
2	Seek performed
3	Recalibration performed
4	Hard fault
5	Not used
6	Diagnostic mode
7	Velocity check mode
	Byte 3 Interface-Status Byte
0	Fault
1	Seek error
2	On cylinder
3	Unit ready
4	Hard fault
5	Start enable
6	Not used
7	Not used
	Byte 4 Drive-status Byte
0	Spindle stopped
1-7	Not used

NOTE
When the drive-state bytes are examined, a true bit condition is indicated when the LED is on.

4.13.1.6 Examine Operational Counters Utility – The RM80 functional firmware maintains three counters in RAM to monitor the items listed below.

- Seek/recalibration errors
- Number of seeks
- Number of read and no enable errors

The contents of these counters may be displayed in diagnostic mode with the examine seek counter utility. These counters are reset during drive power up or whenever the RESET switch is pushed while the drive is in the functional mode of operation.

The byte order in which the counter information is retrieved is shown in Table 4-14. Note that each counter has an overflow indicator byte that is retrieved first. Whenever a counter overflows, its indicator byte will contain an "FF" code.

Table 4-14 Recovery Sequence of Seek Counter Bytes

Byte	Definition	
1	Overflow Indicator	Seek/Recal Error Counter
2	Low Byte	
3	High Byte	
4	Overflow Indicator	Seek Counter
5	Low Byte	
6	Middle Byte	
7	High Byte	
8	Overflow Indicator	Read and No Enable Counter
9	Low Byte	
10	High Byte	

To call the examine seek counters utility, enter a test select code of "04". The LEDs will momentarily display "04" and then display the first byte of seek counter information. Each time the ENTER switch is pushed, the next byte in the sequence will be displayed in the LEDs. After the 10th byte has been examined, and the ENTER switch is pushed again, the LEDs will display an "AA". Push the ENTER switch one more time to return to the "EC" prompt.

4.13.2 Spindle Control Utility

The spindle control utility allows the Field Service engineer to cycle the spindle either up or down from the drive diagnostic mode. While the drive is under the control of this utility, the firmware ignores whether SEQUENCE PICK and SEQUENCE HOLD signals are present. When the drive returns to functional mode, the spindle will spin-down if these two signals are not present, and results in a LED error code of "05".

To call the spindle control utility, enter a test select code of "1E". The LEDs will momentarily display "1E" and then a steady state "E7". The drive will spin-up when the RUN switch is pushed. The LEDs will display an "AA" when the spin-up is complete.

To spin-down in the diagnostic mode, enter test select code "1E" to call up the spindle control utility. The LEDs will momentarily display "1E" and then a steady state "E7". Then push the RUN switch, releasing it from the latched position. After the spindle stops, an "AA" will appear in the LEDs and the RUN indicator will go out.

NOTE

The READY light will not be lit when the disks are spinning in the diagnostic mode.

4.13.3 Head Select and Seek Utility

The head select and seek utility allows the field engineer to seek to a specific head and cylinder address (0 to 566). The firmware forces the drive into a read-only state before head selection, to prevent possible data damage. Use the information listed below to run and interpret the results of this utility.

- Test select code is "1F"
- Parameter #1 – Head number
- Parameter #2 – Cylinder low byte
- Parameter #3 – Cylinder high byte

After the third parameter is entered, the drive will seek to the desired cylinder and display an "E7" in the LEDs. Enter a "DD" to terminate this test. If a malfunction occurs, one of the error codes listed below appears in the LEDs.

- 70 – Read/write control select error
- 71 – Utility head select error
- 7F – Spindle not spinning error
- E1 – Seek check error
- EA – Can't run test, drive faulted error
- EF – FE entered invalid cylinder address error
- Any functional error (refer to Table 4-1)

If this utility fails with a "70", "71" or "E1" error code in the LEDs, an examination of the diagnostic extended status area will reveal the information given below.

- Extended status area for error code "70"
  - Byte 1 through 8 contain the same type of information for all tests. (Refer to Table 4-12.)
  - Byte 9 – Actual contents of bit 4 and 5 of RAM input port "EB". Bit 4 is read gate and bit 5 is write gate. A one indicates a nonasserted state.

- Byte 10 – Expected contents of bit 4 and 5 of RAM input port "EB". The hexadecimal code of "20" in byte 10 indicates read gate and no write gate.

- Extended status area for error code "71"
  - Bytes 1 through 8 contain the same type of information for all tests. (Refer to Table 4-12.)
  - Byte 9 – Actual head address
  - Byte 10 – Expected head address
- Extended status area for error code "E1"
  - Bytes 1 through 8 contain the same type of information for all tests. (Refer to Table 4-12.)
  - Byte 9 – Functional error code

4.13.4 Set Loop Mode Utility

The set loop mode utility allows the Field Service engineer to set up the diagnostic firmware to either loop on a test or not loop on a test. Once the diagnostic firmware has been set to run in a particular loop mode, it will remain in this state until the utility is recalled and an alternate mode is selected. To run the set loop mode utility, use the following information.

- Test select code is "CF"
- Input parameter #1
  - 0F – Loop forever on the test
  - 4F – Loop forever on the test but halt on error
  - FF – Halt on error or at the end of the test

NOTE

After drive power-up, the loop mode is always set to halt on error or at the end of the test.

After entering the input parameter, the LEDs will display "AA". Push the ENTER switch once to restore the "EC" prompt. The drive is now prepared to run the next test selected in the manner chosen in the set loop mode utility. For example, if the random seek test is called, and the loop forever on test parameter was chosen, the random seek test will be performed until the "DD" test termination code is entered. Hold the ENTER switch long enough (about one second) for the diagnostic firmware to complete its current test and examine the contents of the switches. Remember that the next test entered will also loop forever, unless the set loop mode utility is recalled and a different parameter is chosen.

4.13.5 Read-Only Cylinder Formatter Utility

The read-only cylinder formatter utility allows the Field Service engineer to reformat the prerecorded read-only cylinder in the guard band. As a safety precaution against the indiscriminate use of this utility, pin 13 of E11 on the microprocessor module must first be grounded. Figure 4-4 shows the location of E11. Use the information given below to run this utility.

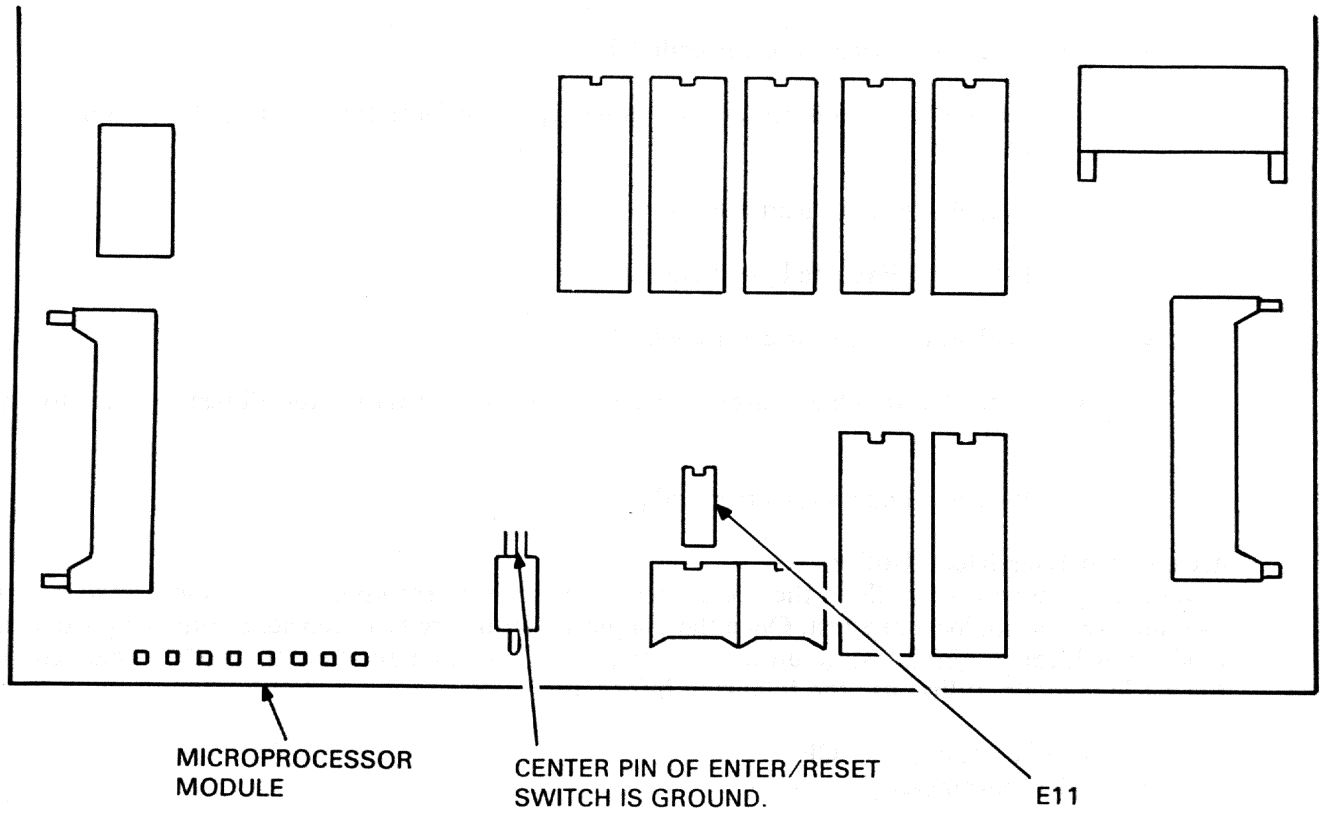


Figure 4-4 Ground Jumper for Read-Only Cylinder Formatter

- Install jumper from pin 13 of E11 to ground (center pin of ENTER/RESET switch)
- Test select code is "21"
- Error Codes
  - 60 – Read/write test head select error
  - 61 – Data port preset error
  - 62 – Read-only test overall read error
  - 63 – Read-only test partial read error
  - 64 – Read/write test guard band error
  - 65 – Sector timeout error
  - 66 – Read-only test read and no enable error
  - 6A – Write/read test overall read error
  - 6B – Write/read test partial read error
  - 6E – Write/read test read and no enable error
  - 7F – Spindle not spinning error
  - EE – Entry error
  - Any functional error code (refer to Table 4-1)

- Extended status area for error codes "62", "63", "66", "6A", "6B" and "6E"
    - Byte 9 – Number of bad heads
    - Byte 10 – Low byte of read and no enable counter
    - Byte 11 – High byte of read and no enable counter

4.13.6 Servo Velocity Adjustment Utility

This utility allows the Field Service engineer to adjust the servo velocity potentiometer on the servo module. The velocity adjustment should be performed after replacing the servo module or the HDA. Before doing this adjustment, the random seek test must be run for 20 minutes to stabilize the temperature of the HDA and servo system. The servo seek velocity adjustment utility uses the LED display to indicate the direction to adjust the velocity potentiometer. When the adjustment is correct, the two LEDs in the middle will alternate between steady state and flashing. Use the following information to run and interpret the results of this utility.

- Test select code is "26"
- Error codes
    - 7D – Bad seek count overflow error
    - 7E – Too fast seek error
    - 7F – Spindle not spinning error
    - E1 – Seek check error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "E1"
    - Bytes 1 through 8 contain the same type of information for all tests. (Refer to Table 4-12.)
    - Byte 9 – Functional error code

Refer to the adjustment chapter to perform the servo velocity adjustment.

4.14 DRIVE DIAGNOSTIC TESTS

The R80 Disk Drive diagnostics allow the Field Service engineer to test the drive in the diagnostic mode. The tests are run by entering a test select code when the LED display is blinking "EC". The test select code is then momentarily displayed. When the test is running, an "E7" is displayed in the LEDs. If an error is detected, the test will halt with an error code displayed in the LEDs. If the test is successful, an "AA" will be displayed in the LEDs. To return to the "EC" prompt from an "AA" or error code display, push the ENTER switch.

The tests listed below require input parameters or operator action.

- Operator control panel test
- Seek – seek test
- Incremental seek test
- Maintenance controls and indicators test

The paragraphs below describe each test, with their test select codes, parameters, error codes and the extended status area.

NOTE
The first eight bytes of the extended status area is the same for all diagnostic tests. The contents of these eight bytes is shown in Table 4-12, and is not repeated in the description of each diagnostic test.

4.14.1 Three Module Bus Test

This test checks the internal data bus on the microprocessor module, the servo bus (TSB SERVO), and personality bus (TSB NATIVE). The sector counter write I/O port is used to check the microprocessor internal data bus. The track counter on the servo module is used to test the servo bus. The diagnostic write data register and the diagnostic read buffer are used to test the personality bus. All cables must be connected to run this test since the module interlock signal is checked. Use the information given below to run and interpret the results of this test.

- Test select code is "07"
- Error codes
    - B0 – Three module microprocessor bus error
    - B1 – Three module personality bus error
    - B2 – Three module servo bus error
    - 8A – Module interlock error
    - 8B – Discrete port enable error
- Extended status area for error code "B0", "B1" and "B2"
    - Byte 9 – Acutal bus contents
    - Byte 10 – Expected bus contents

4.14.2 Microprocessor Module Bus Test

This test uses the sector counter write I/O port to check the microprocessor internal data bus in the same way as the three module bus test. The test is run with the servo and personality modules disconnected. The module interlock signal is not checked. If the three module bus test indicated a microprocessor bus error, this test is run to determine whether the servo module or personality module caused the failure. Use the information listed below to run and interpret the results of this test.

- Test select code is "08"
- B3 – Microprocessor module bus error
- Extended status area
    - Byte 9 – Actual contents of bus
    - Byte 10 – Expected contents of bus

4.14.3 Microprocessor and Personality Module Bus Test

This test checks the data bus between the personality and microprocessor modules. The diagnostic firmware writes into the diagnostic write data register and then reads the data through the diagnostic read buffer. The test is run with the servo module disconnected. The module interlock signal is not checked. This test checks the personality bus in the same way as the three module bus test. The microprocessor module bus test should be successfully completed before running this test. Use the information given below to run and interpret the results of this test.

- Test select code is "09"
- B4 – Personality module bus error
- Extended status area

- Byte 9 – Actual contents of bus
- Byte 10 – Expected contents of bus

4.14.4 Microprocessor and Servo Module Bus Test

This test checks the data bus between the servo and the microprocessor modules. The diagnostic firmware writes into the track counter and then reads the data. This test is run with the personality module disconnected. The module interlock signal is not checked. This test checks the servo bus in the same way as the three module bus test. The microprocessor module bus test should be successfully run before this test. Use the information given below to run and interpret the results of this test.

- Test select code is "0A"
- B5 – Servo module bus error
- Extended status area
  - Byte 9 – Actual contents of bus
  - Byte 10 – Expected contents of bus

4.14.5 Personality Module Microsequencer Test

This test checks the microsequencer logic on the personality module using the ECHO BIT signal. The diagnostic firmware sets the ECHO BIT in the drive status register. When the microsequencer receives the ECHO BIT signal, it returns the signal to the control buffer. When the diagnostic firmware recognizes that the bit is set, it clears the ECHO BIT using the same path.

After successfully running the microsequencer test, the diagnostic firmware checks the personality bus by calling the microprocessor and personality module bus test. Use the information given below to run and interpret the results of this test.

- Test select code is "0B"
- Error codes
  - 53 – Personality module microsequencer error
  - B4 – Personality module bus error
- Extended status area for error code "53"
  - Byte 9 – Actual ECHO BIT (bit 2). A zero indicates that the ECHO BIT did not set. A one indicates that the ECHO BIT did not clear.
- Extended status code for error code "B4"
  - Byte 9 – Actual contents of bus
  - Byte 10 – Expected contents of bus

4.14.6 Sector/Byte Counter Test

This test checks the sector/byte counters by using diagnostic controls that perform the functions listed below.

- Reset the sector/byte counters
- Load the sector/byte counters
- Clock the sector/byte counters

Use the information given below to run and interpret the results of this test.

- Test select code is "0C"
- 51 – Sector/byte counter error
- Extended status area
    - Byte 9 – Expected low byte of byte counter
    - Byte 10 – Expected high byte of byte counter
    - Byte 11 – Actual contents of sector counter
    - Byte 12 – Expected contents of sector counter

4.14.7 Operator Control Panel Test

This test checks the operator control panel switches and indicators for proper operation. As each switch is pushed, the operator control panel indicator and an internal LED will light. The one exception is the FAULT switch which only lights the FAULT indicator. The internal LEDs also display the presence of the plug valid signal and the plug address lines. The internal LEDs display the operator control panel switches as shown in Table 4-15.

Table 4-15 LED Display for Operator Control Panel Test

LEDs	Operator Control Panel Function
MSB 7	PLUG VALID
6	PLUG ADDRESS 4
5	PLUG ADDRESS 2
4	PLUG ADDRESS 1
3	STAT 2
2	STAT 1
1	WRITE PROTECT
LSB 0	RUN

Use test select code "0D" to start the operator control panel test. As each switch is pushed, the corresponding indicator and LED will light. There are no error codes, only visual indications. To exit this test, enter "DD" in the thumbwheel switches and push the ENTER switch. The LEDs then display "AA". Push the ENTER switch to return to the "EC" prompt.

4.14.8 Head-Select Multiplexer Test

This test checks the head-select multiplexer on the microprocessor module. The diagnostic firmware sets up the head-select multiplexer for diagnostic use. Then the diagnostic firmware loads the multiplexer and reads it back. Use the information given below to run and interpret the results of this test.

- Test select code is "0E"
- 54 – Multiplexer head select error
- Extended status area
    - Byte 9 – Actual contents of head-select multiplexer
    - Byte 10 – Expected contents of head-select multiplexer

4.14.9 General Purpose Counter Test

This test checks the ability of the two RAM chip general purpose counters to count, overflow, and interrupt the microprocessor correctly. Use the information given below to run and interpret the results of this test.

- Test select code is "0F"
- Error codes
  - 57 – RAM 1 general purpose counter error
  - 58 – RAM 0 general purpose counter error

4.14.10 Track Counter Test

This test checks the ability of the track difference counter to count. The diagnostic firmware connects the off/fine track compare logic to the output of the DAC. The DAC is then set to values which cause the off/fine track compare logic to generate DIFF CNTR CLK. If this test is run with the spindle spinning, the servo motor is disabled. Use the information given below to run and interpret the results of this test.

- Test select code is "11"
- CD – Track counter error
- Extended status area
  - Byte 9 – Actual contents of the track counter
  - Byte 10 – Expected contents of the track counter

4.14.11 Read/Write Fault Force Test

This test checks the read/write safety sense circuits. A combination of diagnostic firmware and fault force hardware checks the read/write faults listed below.

- Read and write error
- Write current and no write gate error
- Write gate and no write current error
- Separator/encoder error

This test checks logic on the microprocessor and read/write modules. Since the test is done while detented in the outer guard band, the spindle must be spinning. Use the information given below to run and interpret the results of this test.

- Test select code is "12"
- Error codes
  - A0 – Read and write safety error
  - A3 – Forced read and write error
  - A4 – Forced write current and no write gate error
  - A5 – Forced write gate and no write current error
  - A6 – Forced separator/encoder error
  - AB – Outer guard band seek error
  - 7F – Spindle not spinning error
  - EA – Can't run test, drive faulted error
  - Any functional error code (refer to Table 4-1)

- Extended status area for a forced read/write error
  - Byte 9 – Read/write error word 1

MSB	7	Head short error
	6	Read and multichip select error
	5	Write gate and no write current error
	4	Write current and no write gate error
	3	Write and write unsafe error
	2	Read and write error
	1	Write and write protected error
LSB		Write and off track error

  - Byte 10 – Read/write error word 2

MSB	7	Not used
	6	Not used
	5	Not used
	4	Not used
	3	Read/write while faulted error
	2	Servo check error
	1	Write precompensation error
LSB	0	Data separator/encoder error

4.14.12 Servo Position Loop Test

This test checks the servo position loop circuitry in a static mode. The diagnostic firmware uses the DAC to generate analog ramp voltages to the OFF/FINE track compare logic. The FINE TRK, POS PEAK and NEG PEAK signals are monitored by firmware to measure circuit tolerances. Use the information given below to run and interpret the results of this test.

- Test select code is "13"
- Error codes
  - C2 – Fine track status error
  - C3 – Fine track over range error
  - C4 – Fine track under range error
  - C5 – Off track status error
  - C6 – Off track over range error
  - C7 – Off track under range error
- Extended status area for error code "C2"
  - Byte 9 – Actual servo status
  - Byte 10 – DAC value
- Extended status area for error code "C5"
  - Byte 9 – Actual servo status
  - Byte 10 – Expected servo status

4.14.13 Velocity Loop Test

This test checks the servo velocity loop with a sawtooth waveform that forces the acceleration thresholds. The test performs the actions listed below.

- Sets DIAG 1 mode
- Generates a sawtooth excitation for the servo by stepping the DAC up and down
- Determines the range when forward and reverse acceleration are true

Use the information given below to run and interpret the results of this test.

- Test select code is "14"
- CB – Acceleration status error
- Extended status area
  - Byte 9 – Actual servo status
  - Byte 10 – Expected servo status
  - Byte 11 – Direction flag
    - Forward = "00"
    - Reverse = "FF"
  - Byte 12 – Frequency flag
    - High frequency = "00"
    - Low frequency = "08"
  - Byte 13 – Iteration count

4.14.14 Servo Functional Test

The servo functional test checks the functional operation of the servo system by performing the actions listed below.

- Does a recalibration and then checks that the heads are not in the guard bands
- Seeks to the outer guard band and checks that the heads arrive there
- Does a recalibration from the outer guard band
- Seeks to cylinder 560 in 2 cylinder increments
- Seeks to the inner guard band and then checks that the heads are there
- Does a recalibration from the inner guard band

Use the information given below to run and interpret the results of this test.

- Test select code is "15"
- Error codes
  - 7F – Spindle not spinning error
  - D0 – Recalibration error
  - D1 – Outer guard band status error
  - D2 – Inner guard band status error
  - D3 – Seek into outer guard band error
  - D4 – Outer guard band status not true error

- D5 – Recal from outer guard band error
- D6 – Two track seek to track 560 error
- D7 – Seek into inner guard band error
- D8 – Inner guard band status not true error
- D9 – Recal from inner guard band error
- EA – Can't run test, drive faulted error

- Extended status area for error codes "D0", "D5", "D7" and "D9"

  - Byte 9 – Functional error code (refer to Table 4-1)

- Extended status area for error code "D6"

  - Byte 9 – Functional error code
  - Byte 10 – Destination cylinder

4.14.15 Random Seek Test

This test does 32 repetitions of a random sequence of 32 seeks. The last seek of each random sequence should encounter the inner guard band. The heads entering the inner guard band on the last seek indicates the sequence has completed correctly. Use the information given below to run and interpret the results of this test.

- Test select code is "16"
- Error codes

  - 7F – Spindle not spinning error
  - E0 – Random seek error
  - E1 – Seek check error
  - EA – Can't run test, drive faulted error
  - Any functional error code (refer to Table 4-1)

- Extended status area for error code "E1"

  - Byte 9 – Functional error code

- Extended status area for functional error codes

  - Byte 9 – Low byte of the destination cylinder
  - Byte 10 – High byte of the destination cylinder
  - Byte 11 – Low byte of old cylinder
  - Byte 12 – High byte of old cylinder

4.14.16 Seek – Seek Test With Input Parameters

This test does 32 repetitive seeks between cylinders that are entered at the beginning of the test. After calling the seek – seek test with a test select code of "17", the LEDs will momentarily display a "17". Then the LEDs will blink "01" indicating the first parameter must be inserted. Place the low byte of the starting cylinder address in the thumbwheel switches, then push the ENTER switch. The LEDs will then momentarily display what was in the thumbwheel switches and then blink "02" for the second parameter, etc. A blinking "EE" prompt code in the LEDs indicates the starting and ending address are the same. The test starts after the last parameter is entered. Use the information given below to run and interpret the results of this test.

- Test select code is "17"
- Parameter 1 – Low byte of the starting cylinder
- Parameter 2 – High byte of the starting cylinder
- Parameter 3 – Low byte of ending cylinder
- Parameter 4 – High byte of ending cylinder
- Error codes
    - 7F – Spindle not spinning error
    - EF – FE entered invalid cylinder address error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "EF"
    - Byte 9 – Low byte of starting cylinder
    - Byte 10 – High byte of starting cylinder
    - Byte 11 – Low byte of ending cylinder
    - Byte 12 – High byte of ending cylinder
    - Byte 13 – Low byte of maximum cylinder (30)
    - Byte 14 – High byte of maximum cylinder (02)
- Extended status area for error code "E1"
    - Byte 9 – Functional error code
- Extended status area for functional error codes
    - Byte 9 – Low byte of destination cylinder
    - Byte 10 – High byte of destination cylinder
    - Byte 11 – Low byte of starting cylinder
    - Byte 12 – High byte of starting cylinder
    - Byte 13 – Low byte of ending cylinder
    - Byte 14 – High byte of ending cylinder

4.14.17 Seek – Seek Test With Fixed Parameters

This test does 32 repetitive seeks between cylinders 0 and 560. Use the information given below to run and interpret the results of this test.

- Test select code is "18"
- Error codes
    - 7F – Spindle not spinning error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for functional error codes
    - Byte 9 – Low byte of destination cylinder
    - Byte 10 – High byte of destination cylinder
    - Byte 11 – Low byte of starting cylinder
    - Byte 12 – High byte of starting cylinder
    - Byte 13 – Low byte of ending cylinder
    - Byte 14 – High byte of ending cylinder

- Extended status area for error code "E1"
    - Byte 9 – Functional error code

4.14.18 Incremental Seek Test With Input Parameters

This test does an incrementing seek between cylinders entered at the beginning of the test. After each incremental seek step, the heads return to the starting cylinder. Call the incremental seek test with a test select code of "19". The LEDs momentarily display "19", and then blink "01", indicating the first parameter must be input through the thumbwheel switches. Place the low byte of the starting cylinder address in the thumbwheel switches and push the ENTER switch. The LEDs will momentarily display what was in the thumbwheel switches and then blink "02" for the second parameter, etc. A blinking "EE" prompt code in the LEDs indicates that the starting and ending address are the same. The test starts after the last parameter is entered. Use the information given below to run and interpret the results of this test.

- Test select code is "19"
- Parameter 1 – Low byte of starting cylinder
- Parameter 2 – High byte of starting cylinder
- Parameter 3 – Low byte of ending cylinder
- Parameter 4 – High byte of ending cylinder
- Error codes
    - 7F – Spindle not spinning error
    - EF – FE entered invalid cylinder address error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "EF"
    - Byte 9 – Low byte of starting cylinder
    - Byte 10 – High byte of starting cylinder
    - Byte 11 – Low byte of ending cylinder
    - Byte 12 – High byte of ending cylinder
    - Byte 13 – Low byte of maximum cylinder (30)
    - Byte 14 – High byte of maximum cylinder (02)
- Extended status area for error code "E1"
    - Byte 9 – Functional error code
- Extended status area for functional error codes
    - Byte 9 – Low byte of current cylinder
    - Byte 10 – High byte of current cylinder

4.14.19 Incremental Seek Test With Fixed Parameters

This test does an incrementing seek between cylinder 0 and 560. After each incremental seek step, the heads return to the starting cylinder. Use the information given below to run and interpret the results of this test.

- Test select code is "1A"
- Error codes
  - 7F – Spindle not spinning error
  - E1 – Seek check error
  - EA – Can't run test, drive faulted error
  - Any functional error code (refer to Table 4-1)
- Extended status area for functional error codes
  - Byte 9 – Low byte of current cylinder
  - Byte 10 – High byte of current cylinder
- Extended status area for error code "E1"
  - Byte 9 – Functional error code

4.14.20 Read-Only Test

This test reads with each read/write head using the prerecorded read-only cylinder. The diagnostic read/write hardware on the personality module monitors the data and does a data compare. The head selection is accomplished through the head select multiplexer. Use the information given below to run and interpret the results of this test.

- Test select code is "1B"
- Error codes
  - 60 – Read/write head select error
  - 61 – Data port preset error
  - 62 – Read-only test overall read error
  - 63 – Read-only test partial read error
  - 64 – Read/write test guard band error
  - 65 – Sector timeout error
  - 66 – Read-only test read and no enable error
  - 7F – Spindle not spinning error
  - EA – Can't run test, drive faulted error
  - Any functional error code (refer to Table 4-1)
- Extended status area for error code "62", "63" and "66"
  - Byte 9 – Number of bad heads
  - Byte 10 – Low byte of read and no enable counter
  - Byte 11 – High byte of read and no enable counter

4.14.21 Write/Read Test

This test does a write followed by a read with each read/write head on the two write/read cylinders in the guard band. The firmware uses the diagnostic read/write hardware on the personality module to write and verify the data. The head selection is accomplished through the head select multiplexer.

A prerequisite of this test is that the read-only test has run successfully. Use the information given below to run and interpret the results of this test.

- Test select code is "1C"
- Error codes

- 60 – Read/write head select error
- 61 – Data port preset error
- 62 – Read-only test overall read error
- 63 – Read-only test partial read error
- 64 – Read/write test guard band error
- 65 – Sector timeout error
- 66 – Read-only test and no enable error
- 67 – Write test not executable error
- 6A – Write/read test overall read error
- 6B – Write/read test partial read error
- 6E – Write/read test read and no enable error
- 7F – Spindle not spinning error
- EA – Can't run test, drive faulted error
- Any functional error code (refer to Table 4-1)

- Extended status area for error code "62", "63", "66", "6A", "6B" and "6E"

  - Byte 9 – Number of bad heads
  - Byte 10 – Low byte of read and no enable counter
  - Byte 11 – High byte of read and no enable counter

4.14.22 Maintenance Controls and Indicators Test

This test checks the ability of the firmware to read the thumbwheel switches and control the internal LEDs. The operator must interact with the test to place values in the thumbwheel switches and read the LEDs for proper operation. If the LEDs do not display the proper value, the microprocessor module should be replaced before attempting to run any internal diagnostics. Perform the steps listed below to run this test.

1. Turn the thumbwheel switches to "20"
2. Push the ENTER switch
3. Check that the LED display blinks "FF"
4. Turn the thumbwheel switch to "FF"
5. Push the ENTER switch
6. Check that the LEDs display a steady state "FF"
7. Turn the thumbwheel switches to "00"
8. Push the ENTER switch
9. Check that the LEDs display a steady state "00"
10. Push the enter switch
11. Check that the LEDs display a steady state "AA"
12. Push the ENTER to return to the "EC" prompt

If the diagnostic firmware does not read "FF" or "00" when it expects to, an error code of "FE" is displayed.

4.14.23 Logic Tests

This test runs the logic tests listed below.

- Three module bus test
- Personality module microsequencer test
- Sector/byte counter test
- Head select multiplexer test
- General purpose counter test

The test select code is "22". The error codes obtained from this logic test are the same as the error codes for each individual test.

4.14.24 Servo Tests

This test runs the servo tests listed below.

- Servo position loop test
- Servo velocity loop test
- Track counter test
- Servo functional test
- Random seek test

The test select code is "23". The error codes obtained from this servo test are the same as the error codes for each individual test.

4.14.25 Read/Write Tests

This test runs the read/write tests listed below.

- Read-only test
- Write/read test

The test select code is "24". The error codes obtained from this read/write test are the same as the error codes for each individual test.

4.14.26 Entire Unit Test

This test runs the tests listed below.

- Three module bus test
- Personality module microsequencer test
- Sector/byte counter test
- Head select multiplexer test
- General purpose counter test
- Servo position loop test
- Servo velocity loop test
- Track counter test
- Servo functional test
- Random seek test
- Read-only test
- Write/read test
- Read/write force fault test

The test select code is "25". The error codes obtained from this test are the same as the error codes from each individual test.

4.14.27 Static Servo Test

This test runs the static servo tests listed below.

- Servo position loop test
- Servo velocity loop test
- Track counter test

The test select code is "27". The LED error codes obtained from this servo test are the same as the error codes for each individual test.

4.15 ERROR CODE DEFINITIONS

A list of all the error codes and their definitions is presented in Table 4-16 in numerical order. This is a complete listing of all functional and diagnostic error codes that are encountered in the internal LED display.

Table 4-16 Error Code Definitions

Error Code	Definition
00	**Microprocessor Self-Test Error** – The microprocessor failed to complete its self-diagnostic test.
01	**Spindle Motor Timeout Error** – The spindle was not spinning after the RUN switch was pushed. The firmware did not detect a change of state of the spindle speed transducer during spin-up.
02	**Spin-Up Too Slow Error** – The spindle did not reach 1000 r/min in 6 seconds.
03	**Spindle Not Accelerating Error** – The motor was not accelerating during the spin-up cycle.
04	**Spin-Up Too Long Error** – The spindle did not reach 3420 r/min in 40 seconds.
05	**SEQUENCE HOLD/SEQUENCE PICK Error** – The signals, SEQUENCE PICK or SEQUENCE HOLD, were not present on the interface between the RM adapter and the R80 Disk Drive.
06	**Microcode Error** – Near the end of each ROM is an instruction to jump to a microcode fault routine. This instruction is only executed if the firmware malfunctions. When this instruction is executed, the microcode fault routine is called. This routine turns off the spindle motor, displays "06" in the LEDs, and lights the FAULT indicator on the operator control panel.
0A	**Invalid Interface Command Error** – This error was caused by one of the two conditions listed below. • The firmware received a byte command from the personality module that was not a seek, recalibration, or offset command. • The firmware received a command when the drive was not ready.
11	**Wrong Peak Entering Detent Error** – The wrong peak polarity of the TRACK POSITION signal was detected by the firmware before detenting. The servo TRACK POSITION signal generates negative and positive peaks as the servo head crosses odd and even cylinders. The firmware monitors the polarity of the peaks at 3/4 track away from detent. The polarity of the peak, at this time, depends on the direction of head travel and whether the destination cylinder is odd or even. The firmware looks for the servo patterns shown in Figure 4-5 as the head approaches the destination cylinder.

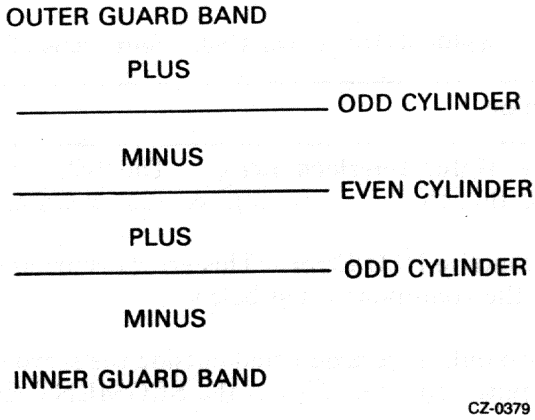


Figure 4-5 Servo Patterns

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
12	**Servo Active PLO Error** – This error occurred during seek mode, indicating one of the conditions listed below. • Two pulses were detected outside the servo sync window that had the same timing characteristics as the SEGMENT CODE and SYNC pulses. • Four successive servo segments passed without the PLO fault circuit detecting the SEGMENT CODE and SYNC pulse combination.
13	**No Fine Track Error** – The firmware did not detect "FINE TRACK" at the end of a seek operation.
14	**Servo Speed or Direction Error** – This error occurred during seek mode, indicating one of the conditions listed below. • Positioner going too fast • Positioner going in the wrong direction
15	**Seek/Recal Timeout Error** – The seek or recalibration operation took too long.
16	**Guard Band Error** – The heads entered the guard band during a seek.
17	**Track Counter Underflow Error** – The track counter decremented past zero before the firmware expected it.
1A	**Invalid Cylinder Address Error** – The firmware received an invalid cylinder address. Valid cylinder addresses are between 0 and 560 decimal.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
23	**Spindle Motor Interlock Error** – The belt tension interlock microswitch indicated that the belt tension lever was released.
24	**Servo Inactive PLO Error** – This error occurred during detent mode, indicating one of the conditions listed below. • Two pulses were detected outside the servo sync window that had the same timing characteristics as the SEGMENT CODE and SYNC pulses. • Four successive servo segments passed without the PLO fault circuit detecting the SEGMENT CODE and SYNC pulse combination.
25	**Servo Detected Off Track Error** – The servo was detected off track during detent mode.
26	**Spindle Speed Error** – The spindle slowed down to less than 3420 r/min (3600 - 5%).
27	**HDA Overtemperature Error** – The temperature of the HDA was too high.
28	**Servo Module Overtemperature Error** – The temperature of the heat sink on the servo module was too high.
30	**Write Current and No Write Gate Error** – Write current was detected without WRITE GATE asserted.
31	**Read and Write Error** – READ GATE and WRITE GATE were asserted at the same time.
32	**Read/Write While Faulted Error** – WRITE GATE or READ GATE was asserted while the drive is in a fault condition.
33	**Data Separator/Encoder Error** – During a write operation, the write precompensation data did not match the data out of the read decoder.
34	**Write Precompensation Error** – During a write operation, the early and late data strobes in the write precompensation logic occurred at the same time.
35	**Write and Write Unsafe Error** – A write unsafe from the preamplifier IC was asserted during a write operation.
36	**Head Short Error** – A shorted head winding was detected during a write operation.
37	**Write Gate and No Write Current Error** – No write current was sensed when WRITE GATE was asserted.
38	**Read and Multichip Select Error** – More than one preamplifier IC was selected during a read operation.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
39	**Write and Off Track Error** – The head was off track during a write operation.
3A	**Write and Write Protected Error** – A write command was attempted while the drive was write protected.
46	**False Drive Fault Error** – The RST 7.5 interrupt on the microprocessor was asserted without a drive fault condition present.
51	**Sector/Byte Counter Error** – The sector or byte counter failed to count correctly.
53	**Personality Module Microsequencer Error** – The echo bit test of the microsequencer failed on the personality module.
54	**Multiplexer Head Select Error** – The head select multiplexer did not select the correct head during the head select multiplexer test.
57	**RAM 1 General Purpose Counter Error** – The general purpose counter in RAM 1 failed.
58	**RAM 0 General Purpose Counter Error** – The general purpose counter in RAM 0 failed.
60	**Read/Write Head Select Error** – The wrong head was selected through the head select multiplexer during the read/write tests.
61	**Data Port Preset Error** – The data byte written into the diagnostic write register could not be read back correctly through the diagnostic read register on the personality module.
62	**Read-Only Test Overall Read Error** – The data read from three or more heads was bad during the read-only test.
63	**Read-Only Test Partial Read Error** – The data read from one or two heads was bad during the read-only test.
64	**Read/Write Test Guard Band Error** – The head was not in the inner guard band after seeking to cylinder 563.
65	**Sector Timeout Error** – The diagnostic could not find the proper sector to read or write on.
66	**Read-Only Test Read and No Enable Error** – The firmware detected that a head went off track more than 15 times during the read-only test.
67	**Write Test Not Executable Error** – The write test cannot be executed because the prerequisite read-only test failed.
6A	**Write/Read Test Overall Read Error** – The data read from three or more heads was bad during the write/read test.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
6B	**Write/Read Test Partial Read Error** – The data read from one or two heads was bad during the write/read test.
6E	**Write/Read Test Read and No Enable Error** – The firmware detected that a head went off track more than 15 times during the write/read test.
70	**R/W Control Select Error** – WRITE GATE was present during the head select and seek utility.
71	**Utility Head Select Error** – The wrong head was selected through the head select multiplexer during the head select and seek utility.
7C	**Too Slow Seek Error** – The heads were moving too fast during the servo velocity adjustment utility. Turn the velocity potentiometer counterclockwise a turn or two and then restart the utility.
7D	**Bad Seek Count Overflow Error** – There were too many seek errors during the servo velocity adjustment utility.
7E	**Too Fast Seek Error** – The heads were moving too fast during the servo velocity adjustment utility. Turn the velocity potentiometer clockwise a turn or two and then restart the utility.
7F	**Spindle Not Spinning Error** – The spindle was not spinning at the beginning of the read/write or servo tests.
80	**ROM Set Error** – The ROMs were not of the same set. **NOTE** **Each ROM in the set should have an identical ROM set word, indicating that the firmware in the ROMs in compatible. The ROM set word consists of two bytes. The contents of these bytes can be displayed in the LEDs using the examine memory up utility with the addresses listed below.** **ROM Number** / **High Byte** / **Low Byte** ROM #0 / 07FA / 07FB ROM #1 / 0FFA / 0FFB ROM #2 / 17FA / 17FB ROM #3 / 1FFA / 1FFB ROM #4 / 27FA / 27FB
85	**RAM 0 Error** – RAM 0 did not pass the RAM test.
86	**RAM 1 Error** – RAM 1 did not pass the RAM test.
87	**ROM 0 Checksum Error** – The checksum of ROM 0 did not agree with the calculated checksum.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
8A	**Module Interlock Error** – Not all of the module interconnecting cables were connected.
8B	**Discrete Port Enable Error** – The discrete port enable latch failed to set, therefore, the microprocessor could not communicate with the servo module or personality module.
8F	**ROM 1 Checksum Error** – The checksum of ROM 1 did not agree with the calculated checksum.
97	**ROM 2 Checksum Error** – The checksum of ROM 2 did not agree with the calculated checksum.
9F	**ROM 3 Checksum Error** – The checksum of ROM 3 did not agree with the calculated checksum.
A0	**Read and Write Safety Error** – A R/W fault could not be cleared.
A3	**Forced Read and Write Error** – The diagnostic firmware could not force READ GATE and WRITE GATE at the same time.
A4	**Forced Write Current and No Write Gate Error** – The diagnostic firmware could not force write current without WRITE GATE.
A5	**Forced Write Gate and No Write Current Error** – The diagnostic firmware could not force WRITE GATE without write current.
A6	**Forced Separator/Encoder Error** – The diagnostic firmware could not force a miscompare of the data from the write precompensation logic and the read decoder logic during a write operation.
A7	**ROM 4 Checksum Error** – The checksum of ROM 4 did not agree with the calcualted checksum.
AB	**Outer Guard Band Seek Error** – The diagnostic firmware could not seek into the outer guard band during the R/W force fault test.
B0	**Three Module Microprocessor Bus Error** – The microprocessor module internal data bus failed during the three module bus test.
B1	**Three Module Personality Bus Error** – The bus between the microprocessor module and the personality module failed during the three module bus test.
B2	**Three Module Servo Bus Error** – The bus between the microprocessor module and the servo module failed during the three module bus test.
B3	**Microprocessor Module Bus Error** – The microprocessor module internal data bus test failed during the microprocessor module bus test.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
B4	**Personality Module Bus Error** – The bus between the microprocessor and the personality module failed during the microprocessor module and personality module bus test.
B5	**Servo Module Bus Error** – The bus between the microprocessor and the servo modules failed during the microprocessor module and servo module bus test.
C2	**Fine Track Status Error** – Something other than the FINE TRACK bit was set in the servo status register when the firmware was expecting only FINE TRACK.
C3	**Fine Track Over Range Error** – The DAC value needed to make FINE TRACK go false was too high.
C4	**Fine Track Under Range Error** – The DAC value needed to make FINE TRACK go false was too low.
C5	**Off Track Status Error** – Something other than POS PEAK and NEG PEAK bits was set in the servo status register when the firmware was expecting only these two.
C6	**Off Track Over Range Error** – The DAC value needed to make off track (NEG PEAK or POS PEAK) go true was too high.
C7	**Off Track Under Range Error** – The DAC value needed to make off track (NEG PEAK or POS PEAK) go true was too low.
CB	**Acceleration Status Error** – The FWD ACC or REV ACC signals were either present when they should have been absent, or absent when they should have been present.
CD	**Track Counter Error** – The track difference counter did not count properly.
D0	**Recalibration Error** – The first recalibration in the servo functional test failed.
D1	**Outer Guard Band Status Error** – The servo status indicated the heads were in the outer guard band when they should have been over cylinder 0.
D2	**Inner Guard Band Status Error** – The servo status indicated that heads were in the inner guard band when they should have been over cylinder 0.
D3	**Seek Into Outer Guard Band Error** – The seek to the outer guard band from cylinder 0 failed.
D4	**Outer Guard Band Status Not True** – The servo status indicated that the heads were not in the outer guard band when the heads should have been.
D5	**Recal From Outer Guard Band Error** – The drive failed to perform a recalibration when the heads were in the outer guard band.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
D6	**Two Track Seek To Track 560 Error** – The drive failed to successfully complete a seek from cylinder 0 to cylinder 560 in increments of 2 cylinders.
D7	**Seek Into Inner Guard Band Error** – The drive failed to seek into the inner guard band from cylinder 560.
D8	**Inner Guard Band Status Not True Error** – The servo status indicated that the heads were not in the inner guard band when the heads should have been.
D9	**Recal From Inner Guard Band Error** – The drive failed to perform a recalibration when the heads were in the inner guard band.
E0	**Random Seek Error** – The heads did not enter the inner guard band on the last seek of the random seek test.
E1	**Seek Check Error** – The drive failed to meet one of the seek preconditions listed below. • Spindle not at proper speed • Drive unsafe condition occurred • Drive failed recalibration test
EA	**Can't Run Test, Drive Faulted Error** – This test cannot be run because the drive has a non-clearable fault.
EE	**Entry Error** – The same starting and ending addresses were entered during a diagnostic seek test.
EF	**FE Entered Invalid Cylinder Address Error** – An invalid cylinder address was entered during a diagnostic seek test.
FE	**Thumbwheel Switch Error** – The diagnostic firmware did not read the expected value from the thumbwheel switches during the maintenance controls and indicators test.

CHAPTER 5
DRIVE FAULT ISOLATION

5.1 INTRODUCTION

This chapter describes the fault isolation procedures for the R80 Disk Drive. Although these procedures are greatly dependent on the internal LED error codes, the drive has several other features that help in fault isolation. This chapter begins with a description of the fault isolation features that are available. Fault isolation tables are then presented, enabling the Field Service engineer to look up the most likely failing FRU for each LED error code. A section on power supply problems is presented next. The chapter ends with a series of troubleshooting tips.

5.2 FAULT ISOLATION FEATURES

The R80 Disk Drive has many features that are helpful in fault isolation. These features are listed below.

- Operator control panel fault codes
- LED error codes
- Storage of previous error codes

5.2.1 Operator Control Panel Fault Codes

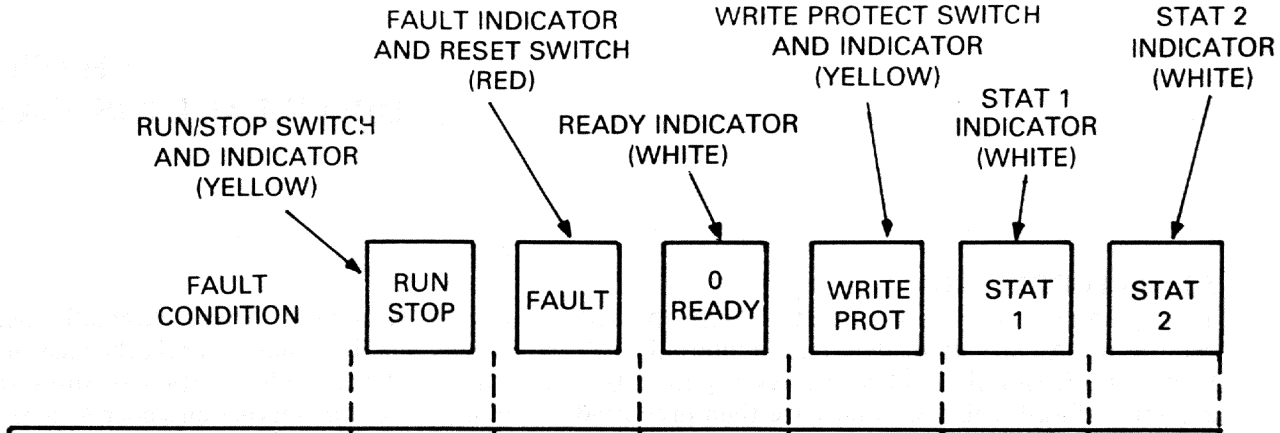
Functional firmware general fault codes are reported through the operator control panel. A general fault code is obtained by entering the fault display mode when the FAULT indicator is on. To enter the fault display mode, push the FAULT switch. All of the indicators should remain on until the FAULT switch is released, providing a method of checking all the indicators. Upon releasing the FAULT switch, the indicators display the general fault code as illustrated in Figure 5-1. The causes of these fault codes are described in Chapter 4.

To exit the fault display mode, push the FAULT switch. This action stores the LED error code in the area of RAM allocated for previous errors. If the fault has been cleared, the firmware will return the operator control panel to its previous state. If the fault still exists, the fault indicator will light again.

The seek incomplete, read/write unsafe, and invalid interface command fault conditions can be corrected by the CPU, in which case the FAULT indicator goes off without operator intervention. If the fault cannot be corrected by the CPU, the FAULT indicator remains on and the fault must then be cleared through manual intervention.

5.2.2 Internal LED Error Codes

The R80 Disk Drive indicates error codes through an internal LED display on the microprocessor module. The location of the LED display is shown in Figure 5-2. The LED display has eight LEDs in a row. The least significant LED is to the right. The codes displayed in the LEDs are read as two hexadecimal digits (four LEDs to each digit). Table 5-1 lists all the LED error codes.



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

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

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Figure 5-1 Operator Control Panel General Fault Indicators

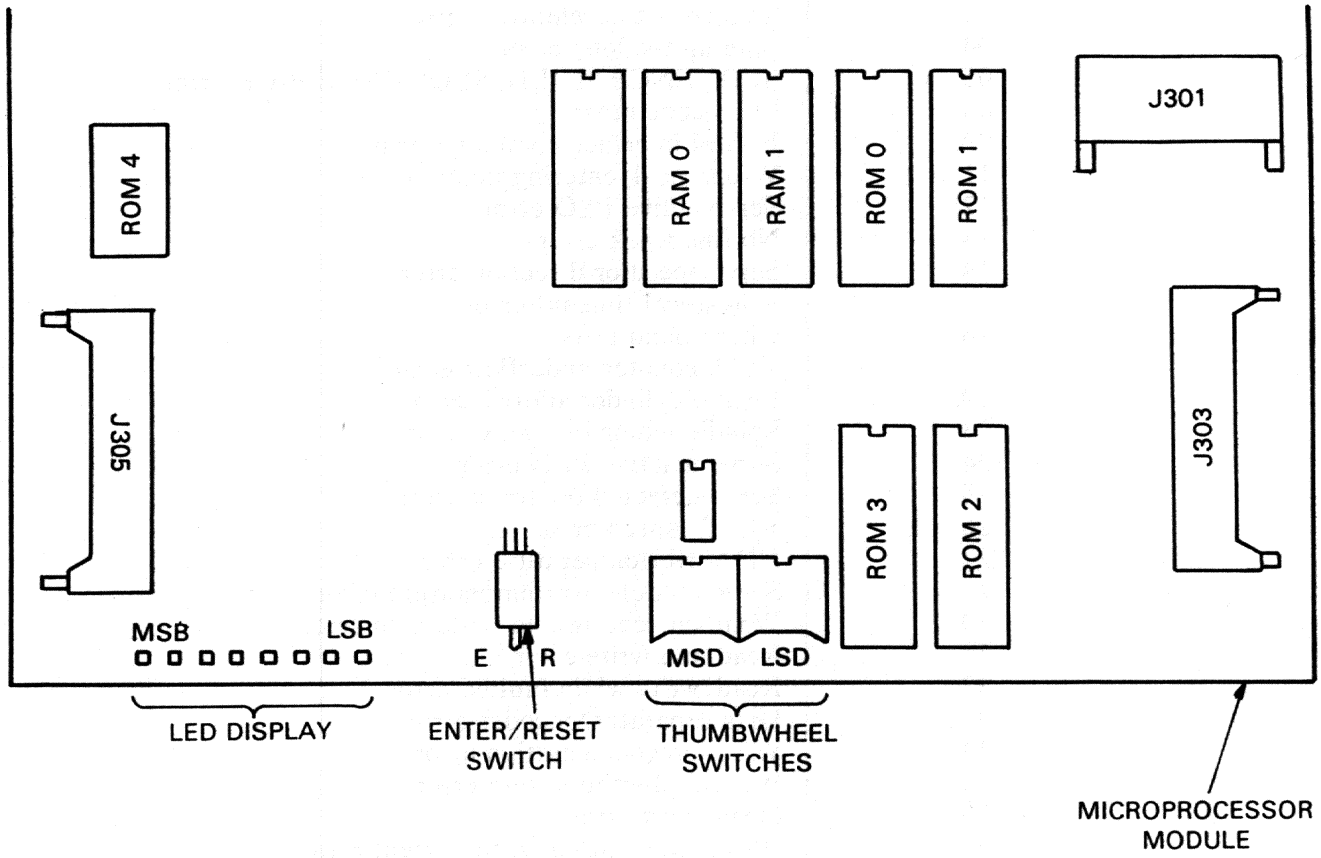

Figure 5-2 Internal LED Display

Table 5-1 Internal LED Error Codes

Error Code	Error
00	Microprocessor self-test error
01	Spindle motor timeout error
02	Spin-up too slow error
03	Spindle not accelerating error
04	Spin-up too long error
05	SEQUENCE HOLD/SEQUENCE PICK error
06	Microcode error
0A	Invalid interface command error
11	Wrong peak entering detent error
12	Servo active PLO error
13	No fine track error
14	Servo speed or direction error
15	Seek/recal timeout error
16	Guard band error
17	Track counter underflow error
1A	Invalid cylinder address error
23	Spindle motor interlock error
24	Servo inactive PLO error
25	Servo detected off track error
26	Spindle speed error
27	HDA overtemperature error
28	Servo module overtemperature error
30	Write current and no write gate error
31	Read and write error
32	Read/write while faulted error
33	Data separator/encoder error
34	Write precompensation error
35	Write and write unsafe error
36	Head short error
37	Write gate and no write current error
38	Read and multichip select error
39	Write and off track error
3A	Write and write protected error
46	False Drive Fault Condition
51	Sector/byte counter error
53	Personality module microsequencer error
54	Multiplexer head select error
57	RAM 1 general purpose counter error
58	RAM 0 general purpose counter error
60	Read/write head select error
61	Data port preset error
62	Read-only test overall read error
63	Read-only test partial read error
64	Read/write test guard band error
65	Sector timeout error
66	Read-only test read and no enable error
67	Write test not executable error
6A	Write/read test overall read error
6B	Write/read test partial read error

Table 5-1 Internal LED Error Codes (Cont)

Error Code	Error
6E	Write/read test read and no enable error
70	Read/write control select error
71	Utility head select error
7C	Too slow seek error
7D	Bad seek count overflow error
7E	Too fast seek error
7F	Spindle not spinning error
80	ROM set error
85	RAM 0 error
86	RAM 1 error
87	ROM 0 checksum error
8A	Module interlock error
8B	Discrete port enable error
8F	ROM 1 checksum error
97	ROM 2 checksum error
9F	ROM 3 checksum error
A0	Read and write safety error
A3	Forced read and write error
A4	Forced write current and no write gate error
A5	Forced write gate and no write current error
A6	Forced separator/encoder error
A7	ROM 4 checksum error
AB	Outer guard band seek error
B0	Three module microprocessor bus error
B1	Three module personality bus error
B2	Three module servo bus error
B3	Microprocessor module bus error
B4	Personality module bus error
B5	Servo module bus error
C2	Fine track status error
C3	Fine track overrange error
C4	Fine track underrange error
C5	Off track status error
C6	Off track overrange error
C7	Off track underrange error
CB	Acceleration status error
CD	Track counter error
D0	Recalibration error
D1	Outer guard band status error
D2	Inner guard band status error
D3	Seek into outer guard band error
D4	Outer guard band status not true error
D5	Recal from outer guard band error
D6	Two track seek to track 560 error
D7	Seek into inner guard band error
D8	Inner guard band status not true error
D9	Recal from inner guard band error

Table 5-1 Internal LED Error Codes

Error Code	Error
E0	Random seek error
E1	Seek check error
EA	Can't run test, drive faulted error
EE	Entry error
EF	F.E. entered invalid cylinder address error
FE	Thumbwheel switch error

5.2.3 Storage of Previous Error Codes

The R80 Disk Drive can store up to 16 previous error codes in RAM memory. Most error codes are stored when the operator control panel FAULT switch is pushed to clear a fault condition. Other error codes, like seek incompletes, are stored as they occur. These error codes may be retrieved through the internal LED error display on a last in, first out basis. The most recent error code will be displayed first. These errors may be examined by invoking the examine previous error utility with a test select code of 02. Refer to Chapter 4.

NOTE

Always examine the previous errors before switching off power. Once the power has been removed, all stored previous errors are lost.

5.3 FAULT ISOLATION TABLES

The R80 fault isolation tables are based on the use of the internal LED error codes to perform trouble-shooting. This information is divided into two tables. The first table lists the LED error codes which directly indicate that one or several FRUs may be at fault. A priority of FRU replacement is assigned, based on the failure rate of each FRU, as well as other considerations. Table 5-2 provides the FRU replacement sequence for these direct FRU indications.

A	Microprocessor module
B	Servo module
C	Personality module
D	Read/write module
E	Operator control panel module
F	40 conductor data cable (personality module)
G	40 conductor data cable (servo module)
H	20 conductor data cable (personality module)
I	50 conductor read/write cable (read/write module)
J	20 conductor data cable (read/write module)
K	Operator control panel cable
L	Servo preamp cable
M	Power supply
N	HDA

Table 5-2 Direct FRU Indications

Error Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N
00	1		2			3								
01	Refer to Table 5-3													
02	Refer to Table 5-3													
03	Refer to Table 5-3													
04	Refer to Table 5-3													
05	Refer to Table 5-3													
06	1													
0A	2		1			3								
11*	2	1					3							4
12	2	1					3					4	6	5
13	2	1					3						5	4
14*	2	1					3						5	4
15*	Refer to Table 5-3													
16*	2	1					3						5	4
17*	2	1					3						5	4
1A	Refer to Table 5-3													
23	Refer to Table 5-3													
24	2	1					3					4	6	5
25*	2	1					3						5	4
26	Refer to Table 5-3													
27	Refer to Table 5-3													
28	Refer to Table 5-3													

Table 5-2 Direct FRU Indications (Cont)

Error Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N
30	2			1					3					4
31	Refer to Table 5-3													
32	1		2	3				4	5	6				7
33	1		3	2				5	4					
34	1		2			3								
35	5			1					2	3				4
36	5			1					2	3				4
37	5			1					2	3				4
38	5			1					2	3				4
39*	2	1					3					4		5
3A	1				2						3			
46	1	2												
51	1	2					3							
53	2		1			3								
54	1		2	3				4	5					
57	1													
58	1													
60	1		2	3				4	5					
61	2		1			3								
62	1		2	3				4	5	6				7
63	5		7	3				6	4	1				2
64	2	1					3							4
65	2	1					3							
66	Refer to Table 5-3													
67	Refer to Table 5-3													
6A	1		2	3				4	5	6				

Table 5-2 Direct FRU Indications (Cont)

Error Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N
6B	5		7	3				6	4	1				2
6E	Refer to Table 5-3													
70	1		2			3								
71	1													
7C	Refer to Table 5-3													
7D	2	1					3						5	4
7E	Refer to Table 5-3													
7F	Refer to Table 5-3													
80	1													
85	1													
86	1													
87	1													
8A	Refer to Table 5-3													
8B	1													
8F	1													
97	1													
9F	1													
A0	1		2	3		4		5	6	7				8
A3	1		2			3								
A4	1		2			3								
A5	1		2			3								
A6	1													
A7	1													
AB*	2	1					3						5	4
B0	1													

Table 5-2 Direct FRU Indications (Cont)

Error Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N
B1	2		1			3								
B2	2	1					3							
B3	1													
B4	2		1			3								
B5	2	1					3							
C2	2	1					3							
C3	2	1					3							
C4	2	1					3							
C5	2	1					3							
C6	2	1					3							
C7	2	1					3							
CB	2	1					3							
CD	2	1					3							
D0*	2	1					3						5	4
D1*	2	1					3						5	4
D2*	2	1					3						5	4
D3*	2	1					3						5	4
D4*	2	1					3						5	4
D5*	2	1					3						5	4
D6*	2	1					3						5	4
D7*	2	1					3						5	4
D8*	2	1					3						5	4
D9*	2	1					3						5	4
E0*	2	1					3						5	4

Table 5-2 Direct FRU Indications

Error Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N
E1	Refer to Table 5-3													
EA	Refer to Table 5-3													
EE	Refer to Table 5-3													
EF	Refer to Table 5-3													
FE	Refer to Table 5-3													

* Perform the servo adjustments before replacing the modules.

The second table concerns the LED error codes that indirectly indicate what the failing FRUs are. These error codes require further actions by the Field Service person to determine what FRUs may be responsible for the error. No attempt is made to prioritize FRU replacement here, since any of the FRUs in the error path could be at fault. A meter or oscilloscope may be required to isolate the actual failing FRU. Table 5-3 describes the fault isolation procedures for these indirect FRU indications.

The FRUs listed below are assigned a letter designation so they may be referred to in Table 5-2.

NOTE

Cables are not contained in the controlled distribution (CD) kit. Before replacing a cable, check for proper seating and continuity.

Table 5-3 Indirect FRU Failure

Error Code	Actions	Possible Causes
01	Attempt to spin-up the disk while watching the top of the spindle motor for rotation.	
	• If the spindle motor rotated, check that the belt is on properly.	Belt
	If the belt is on properly, isolate the fault to the failing unit.	HDA speed sensor Microprocessor module Read/write module 50 conductor read/write cable
	• If the spindle motor did not rotate, isolate the fault to the failing unit.	Motor/brake Motor too hot Motor start capacitor Power supply Logic dc power harness Logic ac power harness Microprocessor module
02 03 04	Isolate the fault to the failing unit.	Fan behind spindle motor Motor/brake Belt HDA speed sensor Microprocessor module HDA
05	Check CB2 on the RM adapter power supply.	Power not applied to RM adapter logic
	Check drive I/O cables.	Drive I/O cables are not connected properly
	Replace personality module.	Personality module
	If the problem still exists, trace START ENABLE, SEQUENCE PICK, and SEQUENCE HOLD from the personality module back through the RM adapter.	M7684 module in the RM adapter of this RM80 or in the RM adapter of other drives in the string. Power sequence cable or jumper.

Table 5-3 Indirect FRU Failure (Cont)

Error Code	Actions	Possible Causes
15	Check that the HDA positioner is in the UNLOCK position.	HDA positioner lock in LOCK position.
	If the HDA positioner lock was not locked, replace the following FRUs.	Servo module Microprocessor module 40 conductor data cable from servo module HDA positioner cable in the belt tension switch harness assembly HDA Power supply
1A	Replace the items in the list of possible causes.	Personality module Microprocessor module 40 conductor data cable from personality module
	If the problem still exists, check that the correct address is being received from the RM adapter desired cylinder register.	M7684 in RM adapter Drive I/O cables between the RM adapter and the RM80 personality module.
23	Check that belt tension lever is in the locked position.	Belt tension lever in the release position
	Check BELT TENSION signal on the microprocessor module.	
	• If the signal is asserted, replace the microprocessor module.	Microprocessor module
	• If the signal is not asserted, isolate the failing unit.	Belt tension microswitch Belt tension switch harness assembly
26	Check the fans.	Fan behind motor not working
	Attempt to spin-up the disk again.	
	• If the spin-up attempt fails, use corrective action for the new error code, or let the motor cool for 10 to 15 minutes.	Motor may be overheated
	• If the spin-up attempt succeeds, ignore this error and proceed on.	Motor over temperature may have occured previously
27	Check the items on the list of possible causes.	Fans not working Ambient temperature of the room too high Speed transducer cable not connected

Table 5-3 Indirect FRU Failure (Cont)

Error Code	Actions	Possible Causes
	If the problem still exists, trace the TEMP HDA signal through the following FRUs.	HDA thermal switch Read/write module 50 conductor read/write cable Microprocessor module
28	Check the items on the list of possible causes.	Fans not working Ambient temperature of the room too high
	If the problem still exists, trace the TEMP SERVO signal through the following FRUs.	Servo module 40 conductor data cable from the servo module Microprocessor module
31	Replace the items listed in possible causes.	Personality module Microprocessor module 20 conductor data cable from the personality module
	If the problem still exists, the cause may be in the RM adapter.	M7684 M7687 Drive I/O cables from RM adapter to RM80 personality module.
66	Perform the servo adjustments and then run the test again. If the error code of "66" occurs again, replace the servo module.	Servo adjustments Servo module HDA
67	Perform the read-only test, "1B"	Read-only test failed
6E	Perform the servo adjustments and then run the test again. If the error code of "6E" occurs again, replace the servo module.	Servo adjustments Servo module HDA
7C	Turn the servo velocity potentiometer (R281) two revolutions counterclockwise and restart the test.	The positioner motor was going too slow
7E	Turn the servo velocity potentiometer (R281) two revolutions clockwise and then restart the test.	The positioner motor going too fast
7F	Spin-up the spindle with the spindle control utility before running tests using the positioner motor.	Spindle not spinning

Table 5-3 Indirect FRU Failure (Cont)

Error Code	Actions	Possible Causes
8A	Check that all of the cables are properly connected. If all the cables are connected, check the I LOCK signal path.	Cables are not connected properly
E1	Examine byte 9 of the extended status area for the functional error code. Use corrective action for that functional error code.	Drive unsafe condition Recalibration failure
EA	Troubleshoot the previous LED error code.	The previous error code caused a drive faulted condition that inhibited this test.
EE	Enter the correct information for seek tests.	Starting and ending address were the same for the seek tests
	Install jumper for the read-only test.	The jumper for the read-only cylinder formatter utility is not present
EF	Enter a valid cylinder address.	The entered cylinder address was greater than 560 (0230 hexadecimal)
FE	Perform the test again following the correct procedure.	Either the wrong procedure was used or the wrong value was entered.
	If the problem still exists, replace the microprocessor module.	Microprocessor module

5.4 POWER SUPPLY PROBLEMS

Some power supply problems will exhibit themselves visually while others may not. Table 5-4 supplies a list of power supply failure symptoms to look for. For the power supply problems with no visual failure symptoms, refer to the power distribution diagram in Figure 5-3. If the dc voltages need to be measured, use Table 5-5 to find the voltage tolerances and Table 5-6 to find the locations of each voltage check point. Table 5-6 includes a list of reference figures showing the location of each voltage check point.

Table 5-4 Power Supply Failure Symptoms

Symptom Check	Action
Fans	Check that all four fans are spinning.
+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 heat sink are on. When lit, they indicate that both + and -12 volts are present.
FAULT indicator off. All other operator control panel indicators on.	Check if only the FAULT indicator on the operator control panel is not lit. This condition occurs only when the DC LOW signal is asserted. Possible causes could be the power supply, microprocessor module or servo module.

Table 5-5 DC Voltage Tolerances

DC Voltages	Acceptable Tolerances
+5 volts	±.2 volts
−5.2 volts	±.2 volts
+12 volts	±.6 volts
−12 volts	±.6 volts
+6 volts	±.3 volts
−4 volts	±.2 volts
−8.2 volts	±.65 volts
+24 volts	+3, −1 volts
−24 volts	+1, −3 volts

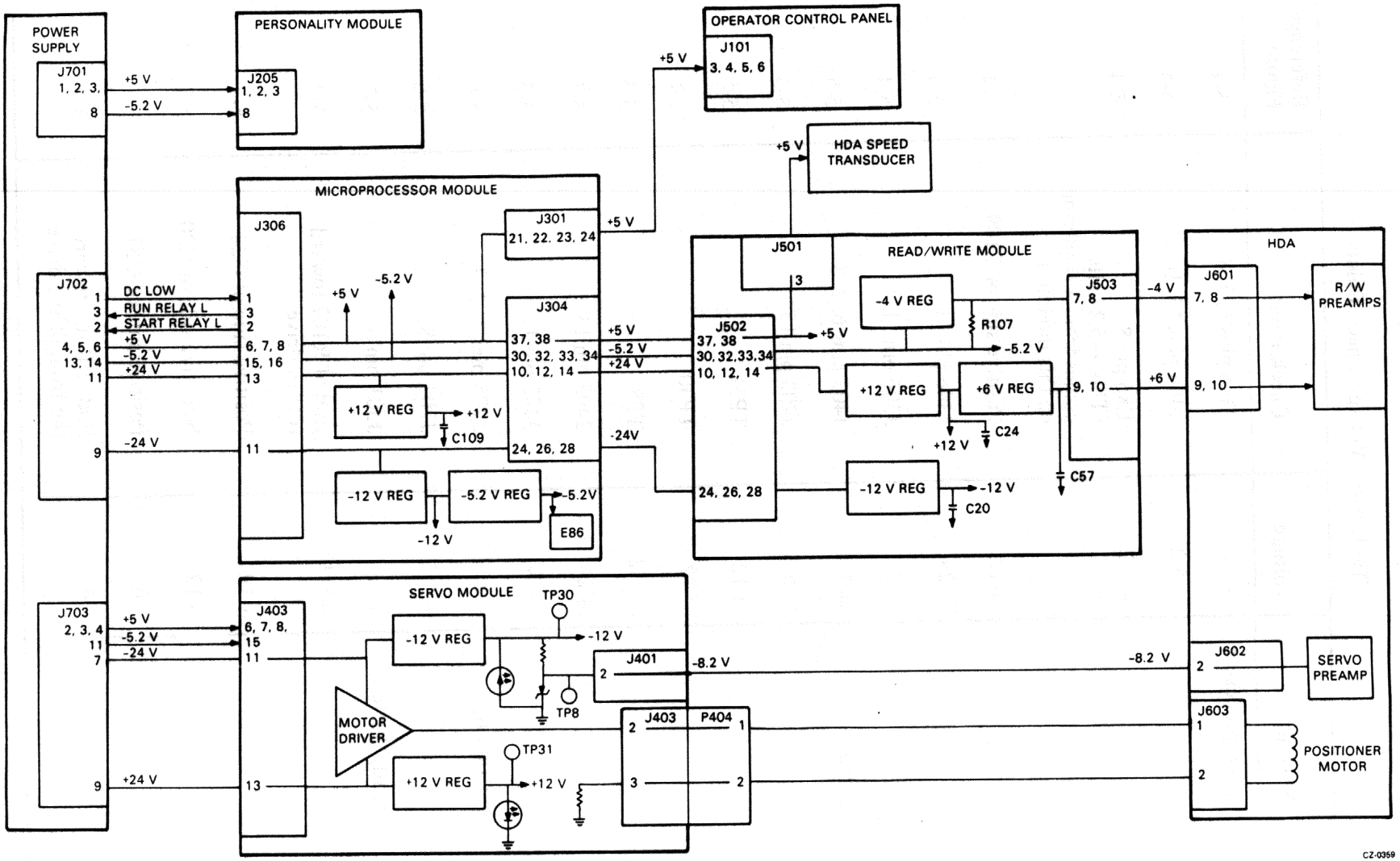

Figure 5-3 Power Distribution Diagram

Table 5-6 Voltage Check Points

Module	Voltage	Check Point	Reference Figure
Microprocessor	+5	J306 pins 6, 7, 8	5-4
	−5.2	J306 pins 15, 16	5-4
	−5.2	E86 pin 8 (This −5.2 volts comes from a regulator on this module.)	5-4
	+12	Positive side of C109	5-4
	+24	J306 pin 13	5-4
	−24	J306 pin 11	5-4
Servo	+5	J403 pins 6, 7, 8	5-5
	−5.2	J403 pin 15	5-5
	+12	TP31	5-5
	−12	TP30	5-5
	−8.2	TP8	5-5
	+24	J403 pin 13	5-5
	−24	J403 pin 11	5-5
Personality	+5	J205 pins 1, 2, 3	5-6
	−5.2	J205 pin 8	5-6
Read/Write	+5	J501 pin 3	5-7
	−5.2	End of R107 toward rear of drive	5-7
	+12	Positive side of C24	5-7
	−12	Negative side of C20	5-7
	+6	Positive side of C57	5-7
	−4	End of R107 toward the front of the drive	5-7

Table 5-6 Voltage Check Points (Cont)

Module	Voltage	Check Point	Reference Figure
HDA Preamplifier	+6	J601 pins 9, 10	5-8
	−4	J601 pins 7, 8	5-8
	−8.2	J608 pin 8	5-8

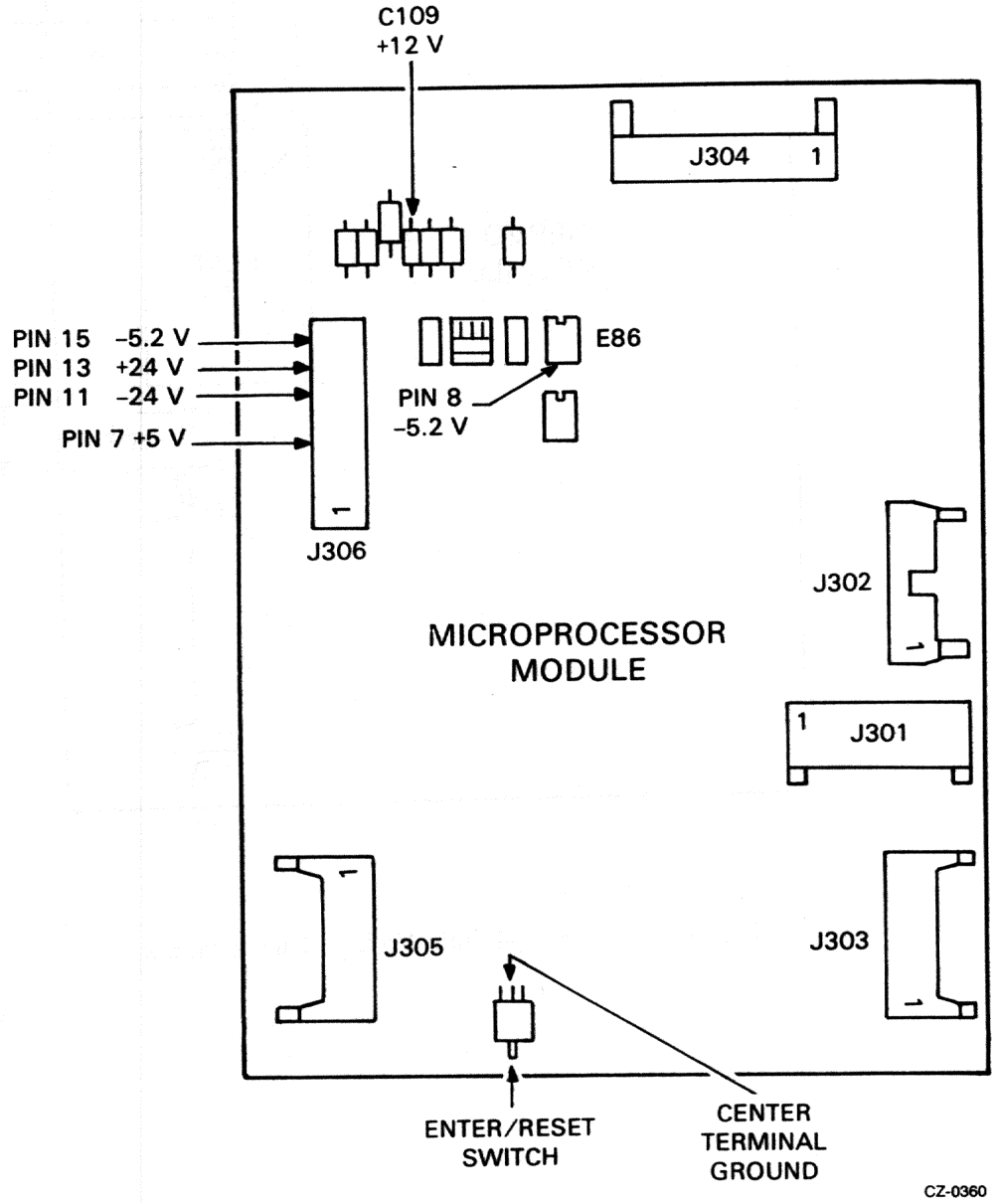

Figure 5-4 Microprocessor Module Voltage Check Points

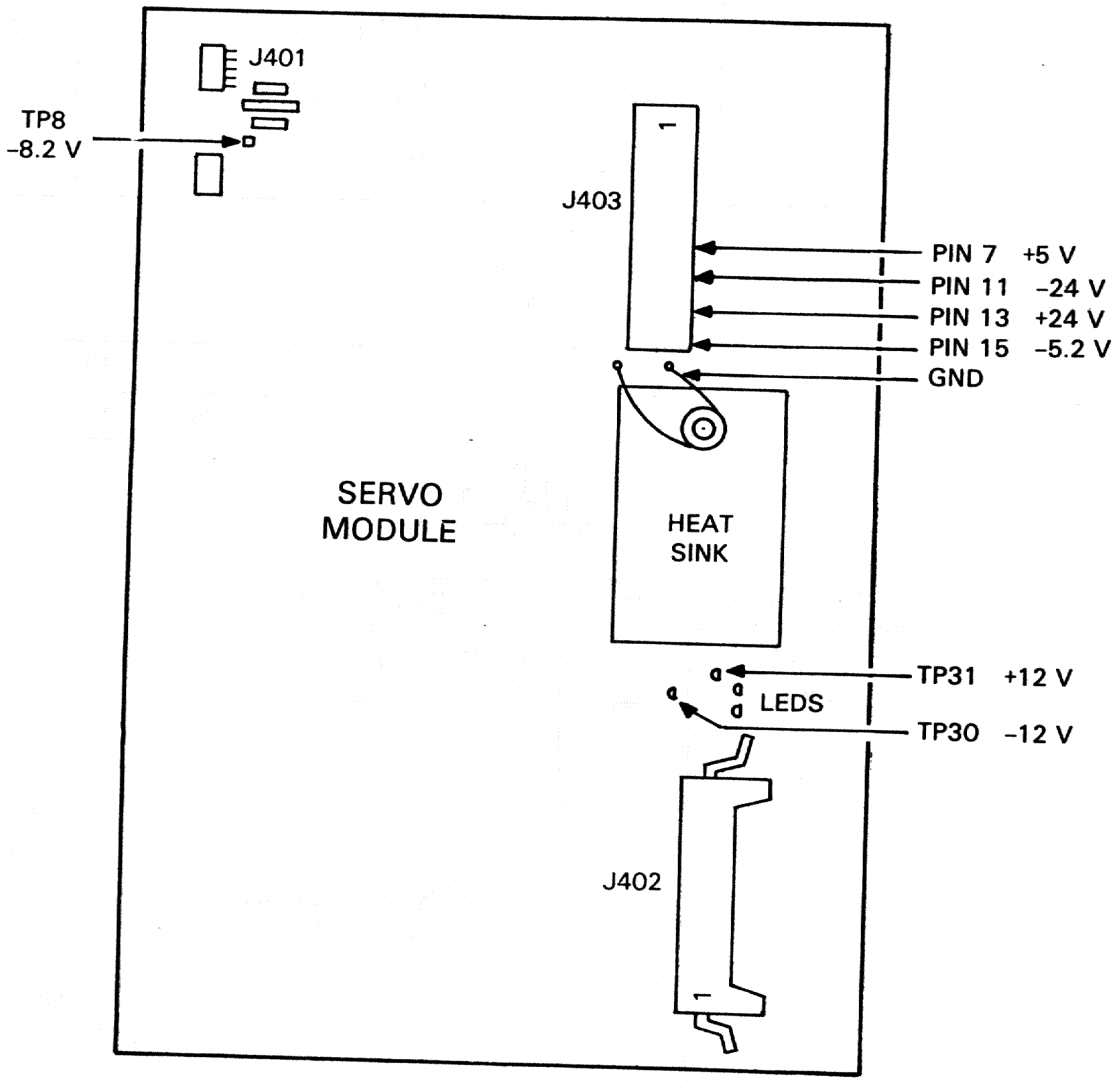

Figure 5-5 Servo Module Voltage Check Points

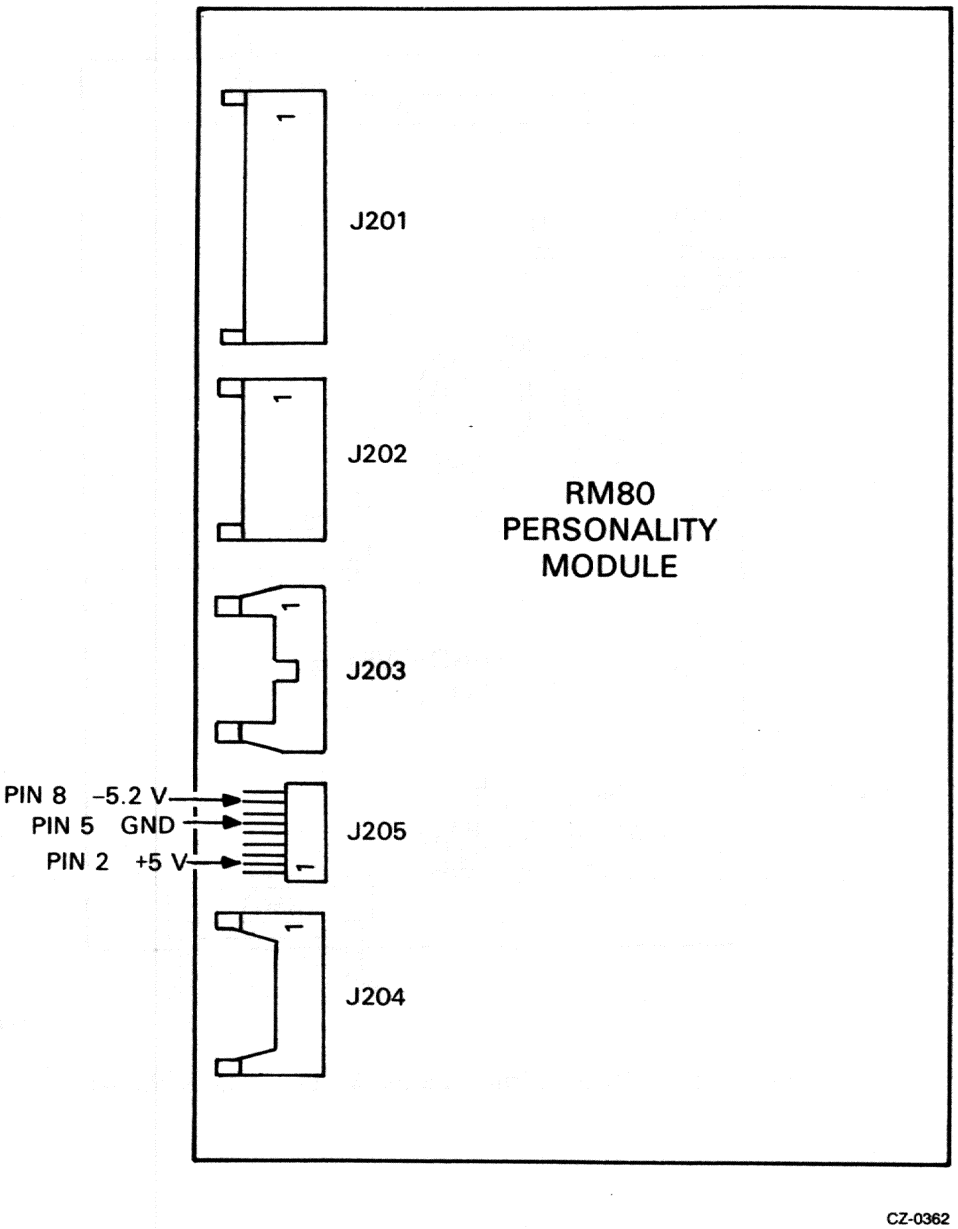

Figure 5-6 Personality Module Voltage Check Points

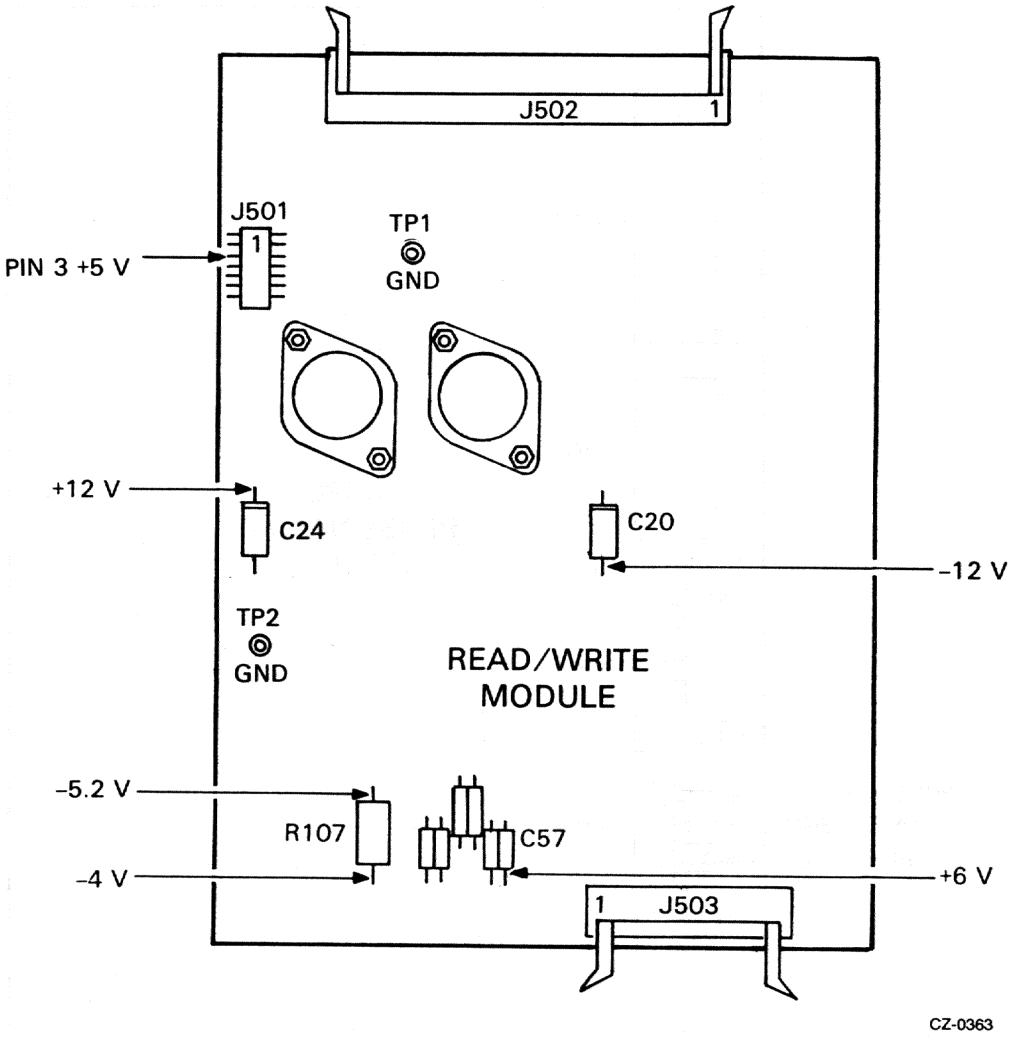

Figure 5-7 Read/Write Module Voltage Check Points

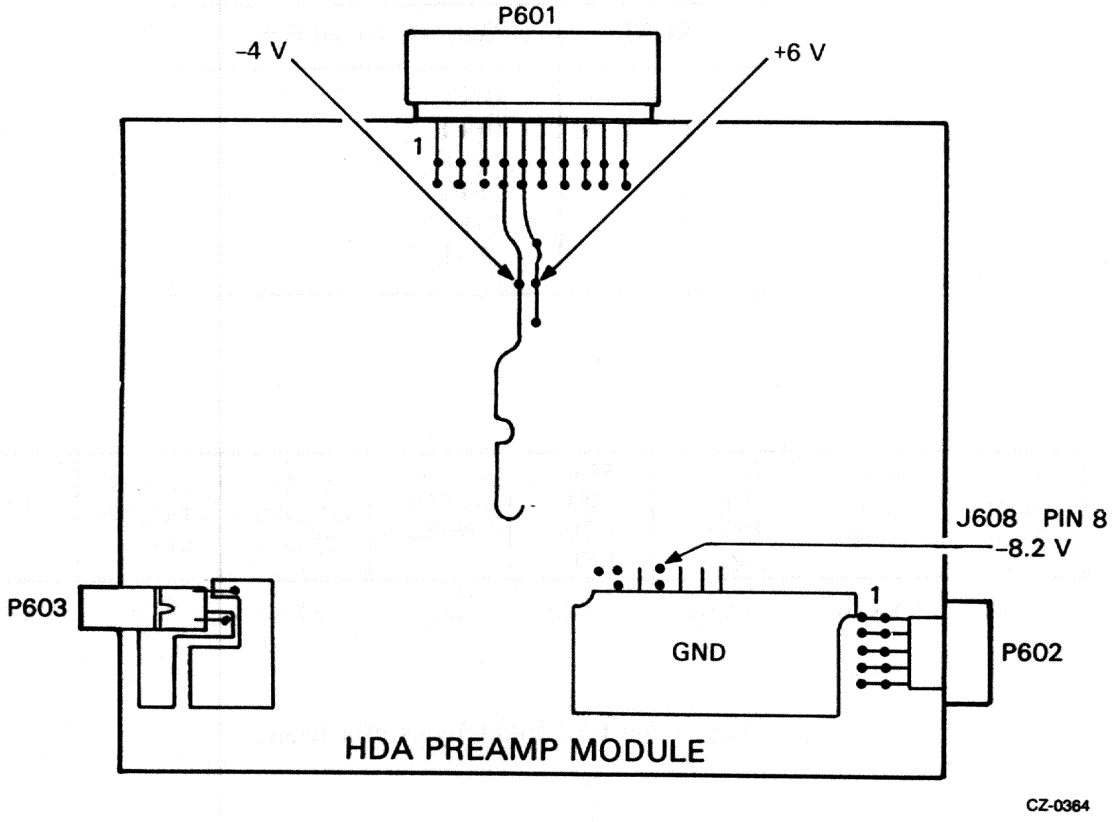

Figure 5-8 HDA Preamplifier Voltage Check Points

5.5 TROUBLESHOOTING TIPS

The following text describes some general troubleshooting tips that may be useful when performing R80 drive fault isolation.

5.5.1 Check Firmware Revision and ROM Set Numbers

The firmware revision and ROM set numbers are in the last few bytes of each ROM. The easiest way to examine these numbers is by using the memory examine down utility, test select code "06". Enter the address of the last byte of the ROM to be examined then push the ENTER switch to examine each byte location starting with the last byte in the ROM. Refer to Table 5-7 for the last address of each ROM. Figure 5-9 shows what is contained in the last eight bytes of each ROM.

Table 5-7 Last Byte Address of Each ROM

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

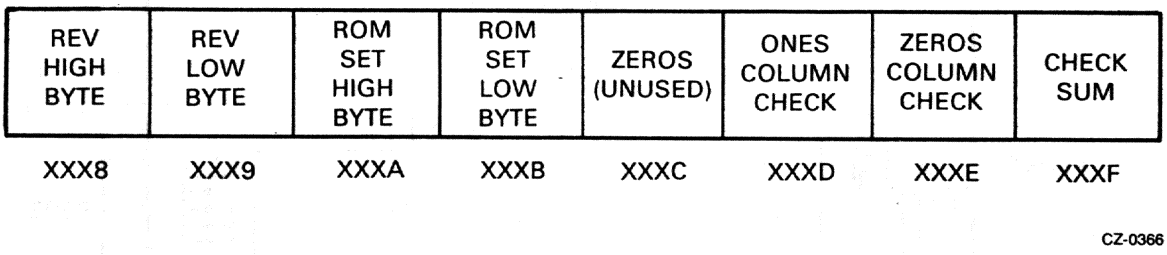

Figure 5-9 Last Eight Bytes of a ROM

5.5.2 Testing the Write Protect Function

The write protect function in the RM80 Disk Drive may be tested while the drive is in the functional mode with the following procedure.

1. Spin-down the disk by releasing the RUN/STOP switch.
2. Push in the WRITE PROTECT switch.
3. Spin-up the disk by pushing in the RUN/STOP switch. If the write protect function is working, the FAULT indicator will light. 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.

5.5.3 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 begins a spin-up cycle if one of the conditions listed below are met.

- The RUN/STOP switch is already depressed at power on.
- The 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 power failure or a normal circuit breaker power down.

5.5.4 Spindle Motor Thermal Timeouts

The RM80 engineering specification calls for a three minute wait period between successive start-up cycles of the spindle motor. This wait period is requried to prevent the spindle motor from overheating and setting an internal thermal switch in the motor. A spindle motor thermal timeout may be caused by one of the problems listed below.

- Frequent spindle motor start-up
- Loss of cooling due to a fan failure

If the spindle motor thermal switch was set, it would result in the symptoms listed below.

- LED error codes of 01, 02, 03, 04, or 26
- Spin-up fault on the operator control panel

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.