

# **RA7x/SA7x Pocket Reference Guide**

Order Number EK-RSA7X-PG-002

This guide contains quick-reference information for RA7x disk drives (RA70, RA71, RA72, and RA73) and SA7x enclosures.

**Digital Equipment Corporation**

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## Introduction and Related Documentation

This guide contains quick-reference information for RA7x disk drives (RA70, RA71, RA72, and RA73) and SA7x enclosures.

For more complete information about RA7x disk drives and SA7x enclosures, see the related documentation listed in Table 1.

**Table 1 Related Documentation**

<b>Document Title</b>	<b>Order number</b>
<i>RA70 Disk Drive Technical Description Manual</i>	EK-ORA70-TD
<i>DSA Troubleshooting Flowchart</i>	EK-DSATF-TM
<i>BA27 Field Maintenance Print Set</i>	MP-01429
<i>SA7x Support Print Set</i>	EM-01435
<i>SA7x Field Maintenance Print Set</i>	MP-01435
<i>SAXxx Storage Array Configuration Guide</i>	EK-SAXXX-CG
<i>SA7x Enclosure User Guide</i>	EK-OSA7X-UG
<i>SA7x Enclosure Service Manual</i>	EK-OSA7X-SM
<i>RA7x Disk Drive Service Manual</i>	EK-ORA7X-SM
<i>RA70 Field Maintenance Print Set</i>	MP-01428
<i>RA71/RA72 Support Print Set</i>	EM-01434
<i>RA71/RA72 Field Maintenance Print Set</i>	MP-01434
<i>RA73 Field Maintenance Print Set</i>	MP-01439
<i>RA73 Support Print Set</i>	EM-01439

## 2 RA7x/SA7x Pocket Reference Guide

### RA7x Characteristics

Table 2 lists the characteristics of RA70 and RA71-RA73 disk drives.

**Table 2 RA7x Characteristics**

Characteristics	RA70	RA71	RA72	RA73
<b>Total Number of Heads</b>	12	15	21	22
<b>Number of Data Heads</b>	11	14	20	21
<b>Number of Dedicated Servo Heads</b>	1	1	1	1
<b>Surfaces Containing Data and Embedded Servo Information</b>	11	14	20	21
<b>Formatted Data Storage Capacity</b>	280 MB	700 MB	1.0 GB	2.0 GB

Although RA70 and RA71-RA73 disk drives are very similar in appearance, they differ structurally and electronically. The RA70 shoe plate is not interchangeable with those for the RA71-RA73 disk drives. None of the RA7x HDAs or ECMs are interchangeable.



### Thermal Stabilization Specifications

**When condensation is visible** on the enclosure or the disk drive, stabilize the unit in the operating environment for six hours, or until the condensation is no longer visible.

**When condensation is not visible** on the enclosure or disk drive or enclosure, see Table 3 for correct thermal stabilization times.

**Table 3 Thermal Stabilization Times**

Temperature Range Degrees C	Temperature Range Degrees F	Minimum Stabilization Time
60 to 66	140 to 151	3 hours
50 to 59	122 to 139	2 hours
40 to 49	104 to 121	1 hour
30 to 39	86 to 103	30 minutes
<b>18 to 29</b>	<b>65 to 85</b>	<b>No stabilization required</b>
10 to 17	50 to 64	30 minutes
0 to 9	32 to 49	1 hour
-10 to -1	14 to 31	2 hours
-20 to -11	-4 to 13	3 hours
-30 to -21	-22 to -5	4 hours
-40 to -31	-40 to -21	5 hours

### Setting Capacity Indicator Switch

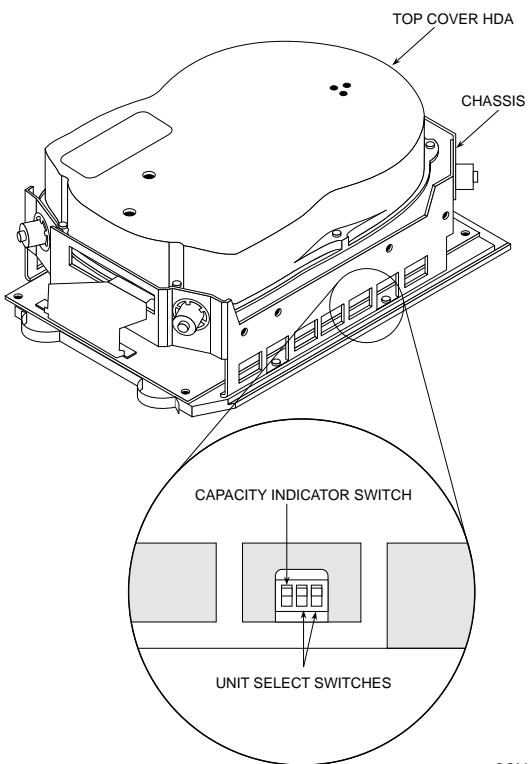
Set the Capacity Indicator switch on the RA71 and RA72 disk drives, shown in Figure 1, as follows:

#### NOTE

The capacity indicator switch has *no function* on an RA73.

- **RA71 (700 MB)**  
Capacity Indicator switch should be up (on).
- **RA72 (1 GB)**  
Capacity Indicator switch should be down (off).

Figure 1 RA71/RA72 Capacity Indicator Switch



COM-R002

## **Troubleshooting**

This section includes troubleshooting tips, an example of a drive internal error log (Figure 2), and a troubleshooting flowchart (Figure 3).

### **Tips for DSA Troubleshooting**

Observe the following tips when troubleshooting DSA products:

- Avoid formatting new HDA units.
- Note that EDC errors are not drive problems.
- Note that forced errors are not necessarily HDA problems.
- Avoid running standalone diagnostics unless drive or system error logs are unavailable and all other troubleshooting techniques have failed.
- Ensure that equipment is thermally stabilized before attempting to power up.
- Use proper ESD grounding methods. Equipment is highly susceptible to static damage.
- Adhere to the service delivery strategy as outlined in specific component service manuals.

Figure 2 Drive Internal Error Log

```

-----
Error Log Entries for Drive 0
-----
(D) = decimal, (A) = ASCII, (H) = hex
Select starting entry location [(7), 1-191] ? 8
Enter how many error log entries to display [(191), 0-191] ? 30
Pause and prompt after every 10 error log entries [(Y), N] ? Y
Drive Max#Entries Seeks/Power-on Cum. Seeks Cum. Power-on Minutes
Type (D) (D) (D) (D) (H)
RA70 191 580 125000 7200 00001C20
-----
Entry Entry Err Err Seek MFG Drive-Specific Hex Data Drive Err
Locn Count Typ Code Count Code Byte 0-9, right to left Message
(D) (D) (A) (H) (D) (H) (H) (A)
8 2 00 0 00 00 00 00 00 00 00 00 00 00 passed.test
7 3 DE 39 453122 32 00 00 09 0A 00 00 00 04 32 58 wrgkoff.trk
6 3 DE E7 452446 33 00 00 09 04 FF FB 0B 05 42 75 inc.lhd.seek
5 3 DE E9 452446 34 00 00 09 03 FF FB 0B 05 12 9D exp.seek.tmr
4 3 00 451699 00 00 00 09 02 02 F6 05 04 79 A0 drv.sys.ini
3 3 00 451699 00 00 00 09 01 02 F6 05 04 7A BB exp.onl.atn
2 3 00 451616 00 00 00 09 00 00 00 00 00 42 A0 drv.sys.ini
1 3 00 451616 00 00 00 09 00 00 00 00 00 40 C0 drv.pwr.rst
191 2 00 0 00 00 00 00 00 00 00 00 00 00 passed.test
-----
1 2 3 4 5 6 7 8 9

```

1. Drive error code—see "Drive error codes and fault numbers" in this guide for an explanation of these codes
2. Manufacturing code (OCP code)—see the OCP error codes table in this guide for an explanation of these codes
3. Logic Processor Number of Minutes (bytes 9, 8, 7, and 6)
4. Servo Processor Destination Cylinder (bytes 5 and 4)
5. Servo Processor Destination Logical Head Number (byte 3)
6. Servo Processor Physical State Number (byte 2)—see the following page for a list of physical state numbers
7. Logic Processor Logical State Bit Flags (byte 1)—see the following page for a list of logical state bit numbers
8. Logic Processor Fault Number (byte 0)
9. Drive error message—see "Drive error codes and fault numbers" in this guide for a translation of these error messages

**Servo Processor Physical State Numbers (Byte 2)**

- 00–reset
- 01–retract (unload heads)
- 02–spin-up motor
- 03–spin-down motor
- 04–detent (track follow)
- 05–seek to cylinder
- 06–return to cylinder zero (load heads)
- 07–recalibrate
- 08–diagnostic

**The following State Numbers apply only to the RA73:**

- 09–fault
- 0A–PLL lock

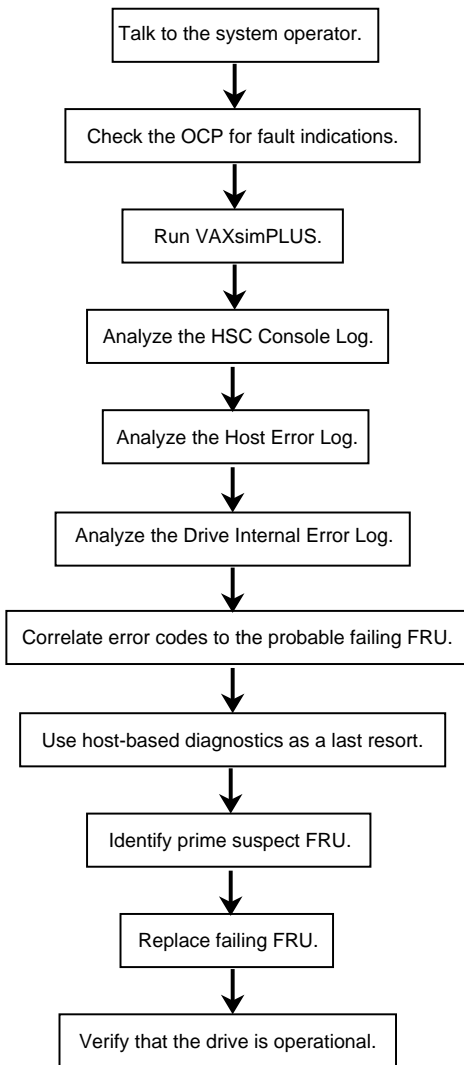
**Logic Processor Logical State Bit Flags (Byte 1)**

- Bit 07–hard error
- Bit 06–soft fault
- Bit 05–internal read/write ready
- Bit 04–drive timing enabled
- Bit 03–logical attention
- Bit 02–logical topology state
- Bit 01–logical available state
- Bit 00–logical available state

**NOTE**

**For more information about the physical state numbers and logical state bit flags, see the *RA7x Disk Drive Service Manual*.**

**Figure 3 Troubleshooting Flowchart**



### RA7x Parts

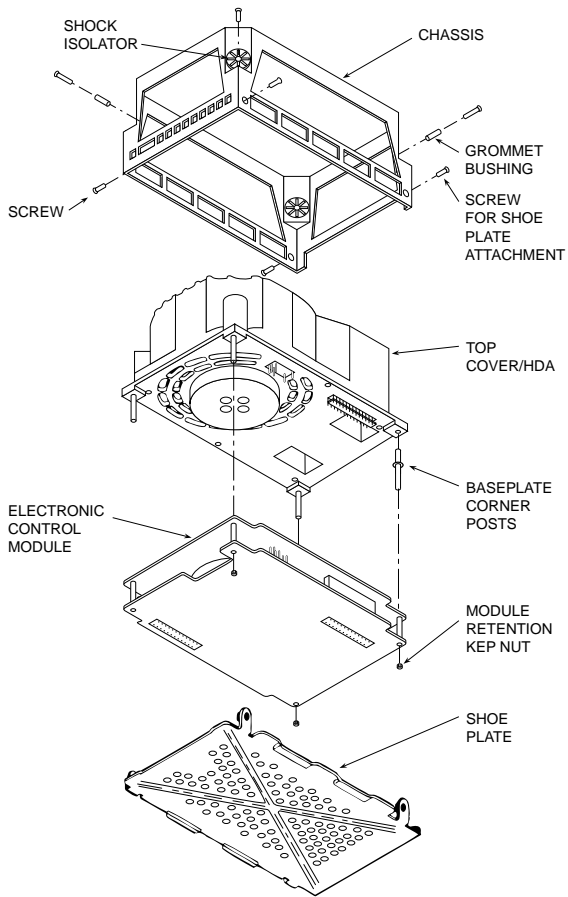
Table 4 lists RA7x part numbers. Figures 4 and 5 shows exploded views for RA70 and RA71-RA73 disk drives.

**Table 4 RA7x Part Numbers**

<b>Part</b>	<b>Part Number</b>
<b>RA70 Disk Drive</b>	
ECM	70-22494-01
HDA	70-21946-01
Shoe plate	70-22474-01
<b>RA71 Disk Drive</b>	
ECM	54-20826-01
HDA	70-28492-01
Shoe plate	70-29408-01
<b>RA72 Disk Drive</b>	
ECM	54-20826-01
HDA	70-28492-02
Shoe plate	70-29408-01
<b>RA73 Disk Drive</b>	
ECM	54-21396-01
HDA	70-28699-01
Shoe plate	70-29408-01
<b>RA7x Disk Drive</b>	
Electronically conductive field service grounding kit	29-11762

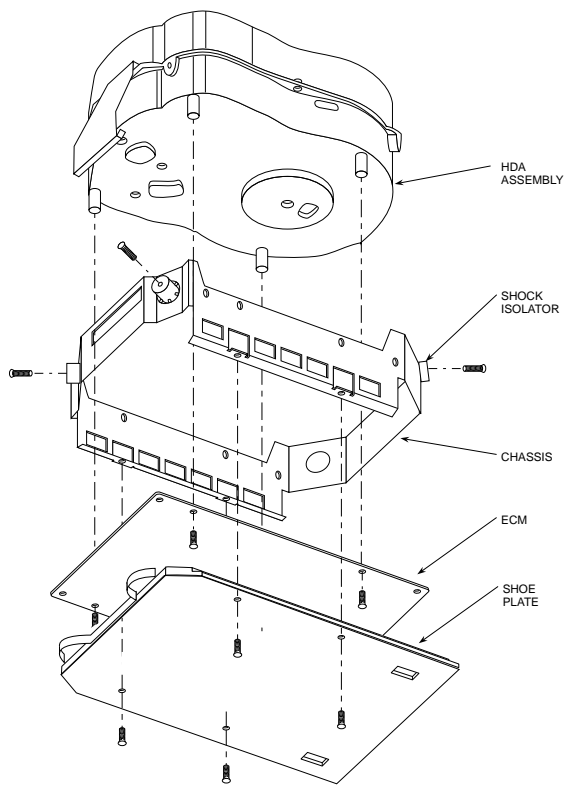


Figure 4 RA70 Exploded View



COM-R004

Figure 5 RA71-RA73 Exploded View



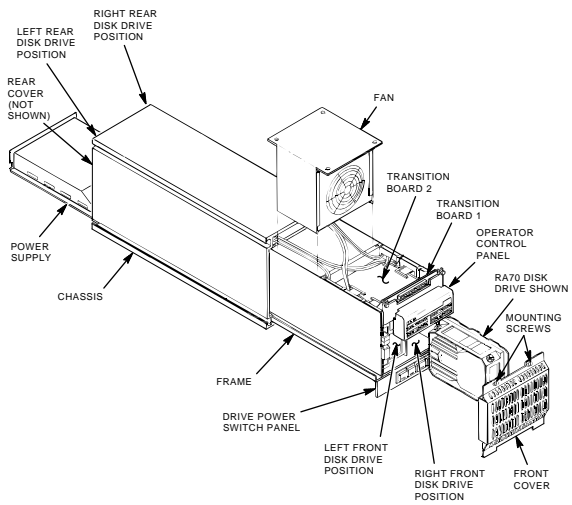
## SA7x Parts

Table 5 contains a list of part numbers. Figure 6 shows an exploded view of an SA7x enclosure.

**Table 5 SA7x Part Numbers**

<b>Part</b>	<b>Part Number</b>
Chassis (enclosure assembly)	70-23901-01
Drive position filler	70-23970-01
Fan assembly	70-24440-01
Frame assembly	70-23913-01
OCP	
assembly	70-25696-01
cable, long 80 cm (31.5 in)	70-26254-02
cable, short 35.6 cm (14 in)	70-26254-01
Power cord	17-00442-19
Power harness	70-26255-01
Power supply	H7869-AK
Pushbutton switch	
with green LED	12-12717-13
Pushbutton switch cap	
left front	12-14027-14
left rear	12-14027-15
right front	12-14027-13
right rear	12-14027-12
SDI Cables	
External cable assembly	70-26257-01
Internal cable assembly	70-26256-01
Internal SDI cable harness	17-01699-01
Transition board	
Board 1	54-19171-01
Board 2	54-19015-01
Transition interface cables	17-02147-01

Figure 6 SA7x Enclosure Exploded View

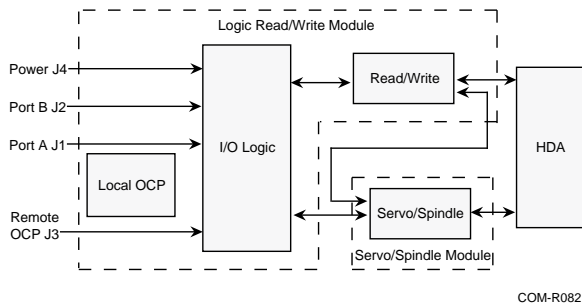


CXO-1845D\_S\_R

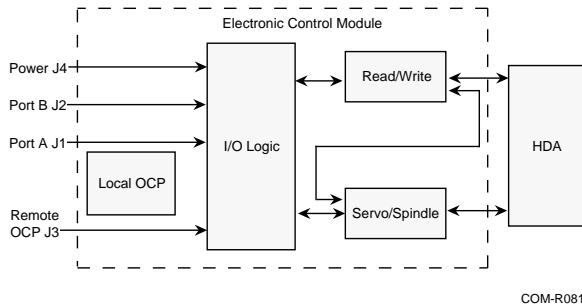
### RA7x Electronics Block Diagrams

Figures 7 and 8 are electronics block diagrams for RA70 and RA71-RA73 disk drives.

**Figure 7 RA70 Electronics—Simplified Block Diagram**



**Figure 8 RA71-RA73 Electronics—Simplified Block Diagram**



### RA71-RA73 Support

Tables 6, 7, and 8 list the *minimum* versions of operating systems, diagnostics, and SDI controllers that support RA71-RA73 disk drives in Release 43.

The diagnostics and VAX supervisor programs in Table 6 all recognize RA71-RA73 disk drives. The retired VAX Supervisor programs in Table 9 do not recognize RA71-RA73 disks drives. However, they will properly test and operate the RA71-RA73 disk drives with the above disk drive diagnostics when the disk drives are "attached as RA70 disk drives" during program setup.

**Table 6 VAX Diagnostics for RA71-RA73**

<b>Diagnostic Supervisor</b>	<b>Description</b>	<b>Version</b>
EVRAE	Generic MSCP Exerciser	4.3
EVRLB	UDA/KDB50 Basic Disk Formatter	8.3
EVRLF	UDA/KDB50 Basic Subsystem Diagnostic	10.4
EVRLG	UDA/KDB50 Disk Drive Exerciser	10.3
EVRLJ	VAX UDA/KDB50/KDM70 Exerciser	4.3
EVRLK	VAX Bad Block Replace Utility	4.3
EVRLM	VAX Disk Resident Error Log Utility	3.3
EVRLN	KDM70 EEPROM Update Utility	1.6
EBSAA	DUP Control Program	1.6
EBSAA	Supervisor, 8200, 8250, 8300, 8550 (Bereta)	14.4-PAT1
ELSAA	Supervisor, 5800, 6000-2xx, 6000-3xx	14.4-PAT1
EMSAA	Supervisor, 6000-5xx	14.4-PT1
ERSAA	Supervisor, 6000-4xx	14.4-PAT1
EVSBA	VAX Diagnostic Autosizer	7.5
EVSBB	VAX Online Autosizer	4.0

**Table 7 Operating Systems for RA71-RA73**

<b>Operating Systems Software</b>	<b>RA71/RA72 Minimum Version</b>	<b>RA73 Minimum Version</b>
VMS	5.4-2 <sup>1</sup>	5.5-2
VAXsimPLUS	1.6	2.0
ULTRIX-32	4.2	4.3
VAXELN	4.3	4.3-x
VAX System V	3.2.1	Not planned

<sup>1</sup>The Error Log Formatter (ERF) Version 5.4-2 must be upgraded to Version 5.4-2 (0001) to support RA71-RA72. Version 5.5-2 is required to support the RA73 disk drive.

**Table 8 SDI Controllers for RA71-RA73**

<b>SDI Controller</b>	<b>Minimum Version</b>
HSC40 (CRONIC)	V600
HSC50 (CRONIC)	V410
HSC60 (CRONIC)	V600
HSC70 (CRONIC)	V600
HSC90 (CRONIC)	V600 K.SI Interface SW Version 12 K.SDI Interface SW Version 39/40
KDM70	SW Version 30 (3.0) HW Version 17
KDA50	SW Version 8 HW Version 4
KDB50	SW Version 20 HW Version 28
UDA50A	SW Version 6 HW Version 0

**Table 9 Retired VAX Supervisor Programs**

<b>Supervisor Program</b>	<b>Description</b>
ECSAA	Supervisor, 750
EDSAA	Supervisor, 8600, 8650
EJSAA	Supervisor, 8820/30/40
ENSAA	Supervisor, 725, 730
ESSAA	Supervisor, 780, 785
EWSAA	Supervisor, 9000
EBSAA	Supervisor, 8530, 8550, 8700, 8800, 8820N



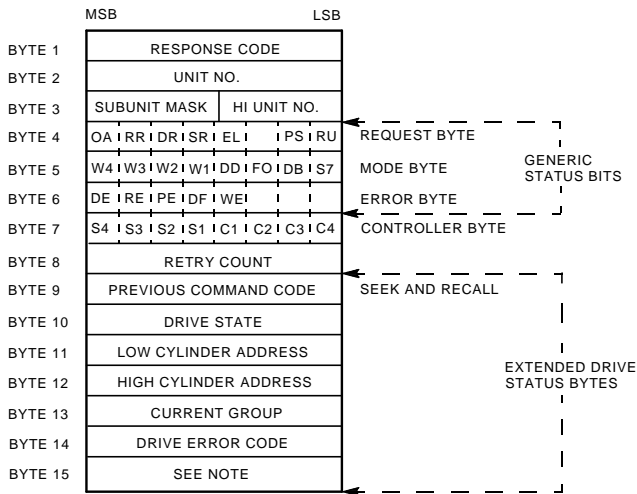
### **RA7x Drive Status Information**

Figures 9 through 22 disk drive status information diagrams for the RA7x disk drives. These drives format the drive status bytes as shown in Figure 9. Note that Byte 15 contains different data for RA70 and RA71-RA73 disk drives. Byte 15 contains the OCP code for an RA70 disk drive; for RA71-RA73 drives, byte 15 contains the fault number.

#### **NOTE**

**Unless specifically stated otherwise, the status information diagrams apply to the *same bytes* for all RA7x drives.**

Figure 9 RA7x Drive Status



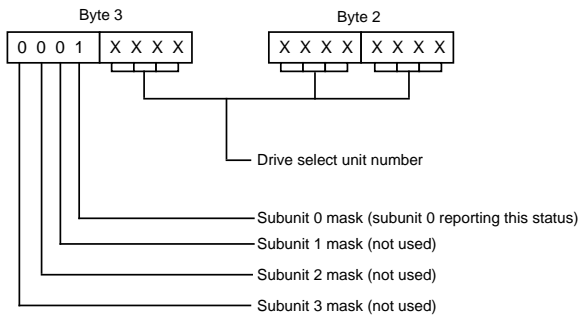
NOTE: IF DRIVE IS RA70, BYTE 15 CONTAINS OCP CODE. IF DRIVE IS RA71/RA72/RA73, BYTE 15 CONTAINS FAULT NUMBER.

**Figure 10 RA7x Response Opcode (Byte 1)**



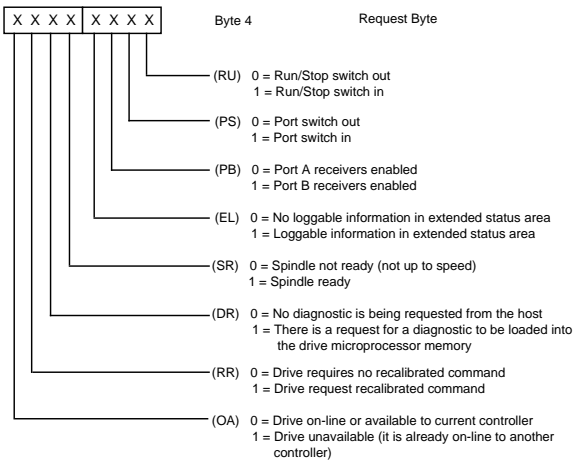
COM-R055

**Figure 11 RA7x Lower Unit (Byte 2) and High Unit and Subunit Mask (Byte 3)**



COM-R056

Figure 12 RA7x Request Byte (Byte 4)



**Figure 13 RA7x Mode Byte (Byte 5)**

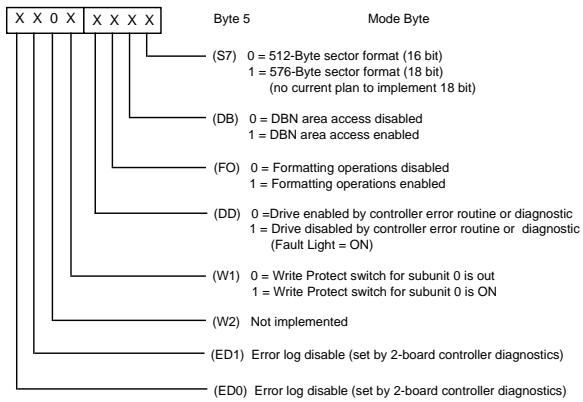
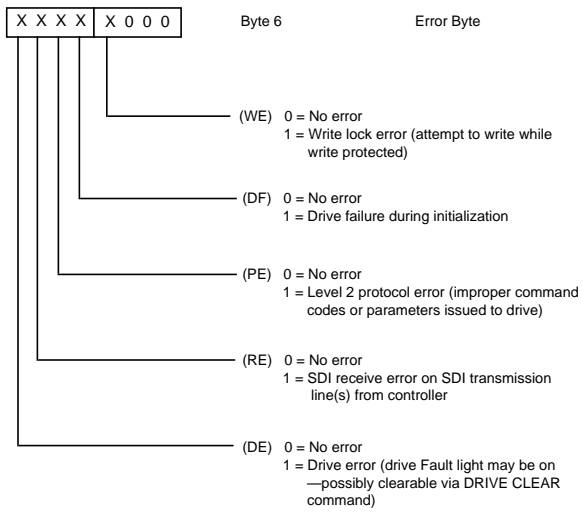
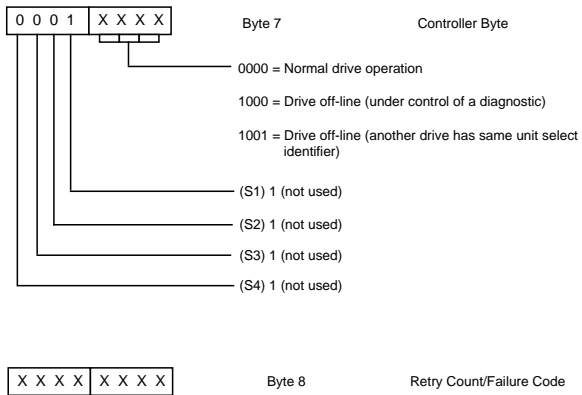


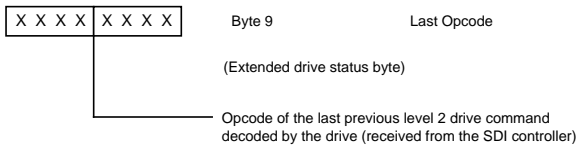
Figure 14 RA7x Error Byte (Byte 6)



**Figure 15 RA7x Controller Byte (Byte 7) and Retry Count (Byte 8)**



**Figure 16 RA7x Previous Command Opcode (Byte 9)**



COM-R061

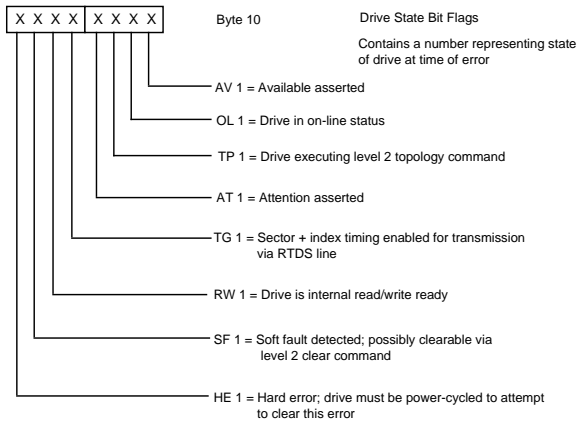
### Last Level 2 Drive Commands

The following is a list of the last level 2 drive commands decoded by the drive (received from the SDI controller).

- 81—change mode
- 82—change controller flags
- 03—diagnose
- 84—disconnect (drive)
- 05—drive clear
- 06—error recovery
- 87—get common characteristics
- 88—get subunit characteristics
- 0A—initiate seek
- 8B—on line
- 0C—run
- 8D—read memory
- 8E—recalibrate
- 90—topology
- 0F—write memory
- FF—select group (level 1 command, processed by firmware seek head select subroutines)

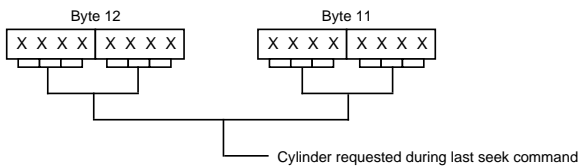


**Figure 17 RA7x Drive State Byte (Byte 10)**



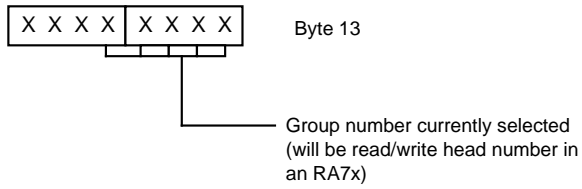
COM-R062

**Figure 18 RA7x Current Cylinder Address (Bytes 11 and 12)**



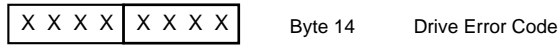
COM-R063

**Figure 19 RA7x Current Group (Byte 13)**



COM-R064

**Figure 20 RA7x Drive Error Code (Byte 14)**



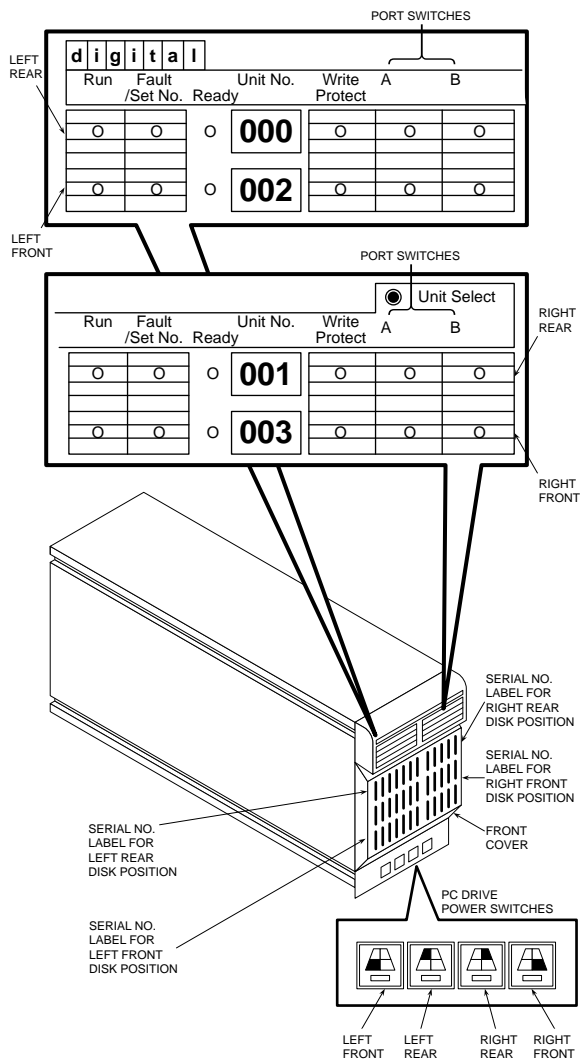
COM-R065

**Figure 21 RA70 OCP Code Byte; RA71-RA73 Fault Number Byte (Byte 15)**



COM-R066

Figure 22 SA7x OCP



## OCP Error Codes

Table 10 lists the error codes displayed by the OCP lights. The next section, "Drive Error Codes and Fault Numbers," describes each error code and the most probable cause of the error.

**Table 10 OCP Error Codes**

Description and FRUs	Run Stop	Fault	Ready	Write Protect A	Port A	Port B
<b>00—No error</b>	—	—	—	—	—	—
<b>01—Logic input/output module</b>						
Note <sup>1</sup>	—	—	—	—	—	On
<b>02—SDI PSID interface</b>						
ECM	—	—	—	—	On	—
SDI	—	—	—	—	On	—
con- troller						
SDI	—	—	—	—	On	—
cable						
<b>03—SDI gate array</b>						
ECM	—	—	—	—	On	On
<b>04—MC 6803 microcomputer</b>						
ECM	—	—	—	On	—	—
<b>05—27264 UVPR0M</b>						
ECM	—	—	—	On	—	On
<b>06—2716 static RAM</b>						
ECM	—	—	—	On	On	—
<b>07—X2816A EEPROM</b>						
ECM	—	—	—	On	On	On
<b>08—Bus decoders and drivers</b>						
Note <sup>1</sup>	—	—	On	—	—	—
<b>09—ZXENDEC</b>						
ECM	—	—	On	—	—	On

<sup>1</sup>Obtain the drive error code from the host error log, the internal drive error log, or the HSC console. Refer to the next section "Drive Error Codes and Fault Numbers."

**Table 10 (Continued) OCP Error Codes**

<b>Description and FRUs</b>	<b>Run Stop</b>	<b>Fault</b>	<b>Ready</b>	<b>Write Protect A</b>	<b>Port A</b>	<b>Port B</b>
SDI con- troller	–	–	On	–	–	On
<b>0A–Analog signal processor</b>						
ECM	–	–	On	–	On	–
HDA	–	–	On	–	On	–
<b>0B–Detector qualifier</b>						
Note <sup>1</sup>	–	–	On	–	On	On
<b>11–Servo module digital circuits</b>						
ECM	–	On	–	–	–	On
HDA	–	On	–	–	–	On
<b>12–Servo gate array</b>						
ECM	–	On	–	–	On	–
<b>13–TMS 32020 processor</b>						
ECM	–	On	–	–	On	On
<b>14–Static RAM</b>						
ECM	–	On	–	On	–	–
<b>15–Servo analog</b>						
ECM	–	On	–	On	–	On
HDA	–	On	–	On	–	On
<b>16–Voltage controlled oscillator (VCOO)</b>						
ECM	–	On	–	On	On	–
HDA	–	On	–	On	On	–
<b>17–Spindle motor control chip</b>						
ECM	–	On	–	On	On	On
HDA	–	On	–	On	On	On
<b>18–Spindle power amp</b>						
ECM	–	On	On	–	–	–
HDA	–	On	On	–	–	–
<b>19–Actuator power amp</b>						

<sup>1</sup>Obtain the drive error code from the host error log, the internal drive error log, or the HSC console. Refer to the next section "Drive Error Codes and Fault Numbers."

**Table 10 (Continued) OCP Error Codes**

<b>Description and FRUs</b>	<b>Run Stop</b>	<b>Fault</b>	<b>Ready</b>	<b>Write Protect</b>	<b>Port A</b>	<b>Port B</b>
ECM	–	On	On	–	–	On
HDA	–	On	On	–	–	On
<b>1A–Actuator analog</b>						
ECM	–	On	On	–	On	–
HDA	–	On	On	–	On	–
<b>1B–A-D and D-A converters</b>						
ECM	–	On	On	–	On	On
HDA	–	On	On	–	On	On
<b>1C–Analog MUXs</b>						
ECM	–	On	On	On	–	–
HDA	–	On	On	On	–	–
<b>1E–HDA Capacity Indicator switch setting</b>						
ECM	–	On	On	On	On	–
HDA	–	On	On	On	On	–
Note <sup>2</sup>	–	On	On	On	On	–
<b>1F–Head/disk assembly</b>						
HDA	–	On	On	On	On	On
ECM	–	On	On	On	On	On
<b>30–Microprocessor module</b>						
ECM	On	On	–	–	–	–
<b>31–OCP module</b>						
ECM	On	On	–	–	–	On
Note <sup>1</sup>	On	On	–	–	–	On
<b>32–Fault module</b>						
Note <sup>1</sup>	On	On	–	–	On	–
<b>33–Spindle motor control module</b>						
Note <sup>1</sup>	On	On	–	–	On	On

<sup>1</sup>Obtain the drive error code from the host error log, the internal drive error log, or the HSC console. Refer to the next section "Drive Error Codes and Fault Numbers."

<sup>2</sup>Verify that the HDA Capacity Switch setting is as described in "Setting the Capacitor Indicator Switch" section.

**Table 10 (Continued) OCP Error Codes**

<b>Description and FRUs</b>	<b>Run Stop</b>	<b>Fault</b>	<b>Ready</b>	<b>Write Protect A</b>	<b>Port A</b>	<b>Port B</b>
<b>34–Digital signal processor module</b>						
ECM	On	On	–	On	–	–
HDA	On	On	–	On	–	–
<b>35–SDI module</b>						
ECM	On	On	–	On	–	On
SDI cable	On	On	–	On	–	On
SDI con- troller	On	On	–	On	–	On
<b>36–Microprocessor unit module</b>						
Note <sup>1</sup>	On	On	–	On	On	–
<b>37–Diagnostic module</b>						
ECM	On	On	–	On	On	On
HDA	On	On	–	On	On	On
<b>3E–Debug error trap</b>						
Note <sup>1</sup>	On	On	On	On	On	–
<b>3F–Power supply</b>						
ECM	On	On	On	On	On	On
Power supply	On	On	On	On	On	On
Note <sup>1</sup>	On	On	On	On	On	On

<sup>1</sup>Obtain the drive error code from the host error log, the internal drive error log, or the HSC console. Refer to the next section "Drive Error Codes and Fault Numbers."

## Drive Error Codes and Fault Numbers

### 00—Internal Error Log Events

**Error Description:** The following fault numbers (FNs) may appear in the drive internal error log with a drive error code of "00" (not a drive error):

**FN:** 00—passed.test.—no drive detected fault

**FN:** 20—drv.sys.rst.—valid drive system reset

**FN:** 3E—rdg.off.trk.—read gate and off track

The drive will not post a recoverable read-and-off-track error to prevent interruption to the controller. This allows the controller to execute all of its available retry/error recovery sequences to the drive and if necessary, retrieve user data during a recoverable error.

**FN:** A0—drv.sys.ini.—valid drive system initialize.

The drive received an INIT pulse from the controller via the SDI RTCS line.

**FN:** BB—exp.onl.atn.—expired on-line timer with attention.

While in the on-line state, the drive timed out the controller and raised attention. A second timeout occurred and the drive performed a disconnect to the SDI and went to the available state. This is usually the result of a host failure, a controller failure, or SDI cable disconnection.

**FN:** BC—inv.sys.ini.—invalid or spurious SDI INIT.

The drive received a SDI initialize pulse (via RTCS line) and discontinued the drive clock (per SDI specification), but the controller did not clear SDI INIT after the drive responded with discontinued clocks.

**FN:** C0—drv.pwr.rst.—drive power reset

**FN:** 28—int.brt.ers.—initiate burst write erase

**FN:** 29—ini.brt.wrt.—initiate burst write

**FN:** 2A—passed.brwt.—burst write complete

**Most Probable Cause:** Refer to specific Fault Number (FN) above.

### 03—Spin-Up Timeout

**Error Description:** The I/O processor has instructed the spindle subsystem to spin up, but the spindle subsystem has not indicated up to speed within 15 seconds.

**FN:** 70—exp.sup.tmr.—expired spinup timer



**FN:** 72—exp.pur.tmr.—expired purge cycle timer)

**Most Probable Cause:** ECM, HDA

#### 04—Spin-Up Actuator Fault

**Error Description:** Prior to a spinup operation, the drive firmware performs some actuator tests. A failure during this test will result in this error and the drive will abort any further attempts to spin up the disks.

**FN:** 6F—sup.svo.dgn.—spinup servo diagnostic fault)

**Most Probable Cause:** HDA, ECM

#### 05—Power Supply

**Error Description:** The drive has detected changes in PWR OK resulting from the detection of ACOK or changes detected by the on board +12v and +5v dc sensor circuits. This may cause all of the operator control panel (OCP) indicators to stay on.

**FN:** 3F—inv.driv.pwr.—invalid or spurious drive power

**Most Probable Cause:** SA7x Power Supply, Internal SA7x cables, ECM, site power problems

#### 06—Microcode Fault

**Error Description:** The I/O processor tried to access an unused ROM location due to a hardware problem or a software error internal to the drive.

**FN:** Not Appropriate

**Most Probable Cause:** ECM

### 07—Frame Sequence Error

**Error Description:** There are three transmission error types that are reported as sequence errors:

- A message continuation frame or message end frame was decoded before a message start frame.
- Two message start frames were decoded in a row.
- Less than two frames, a message start frame and a message end frame, or more than 63 frames have been decoded before a message end frame.

**FN:** A1—grp.frm.seq.—group select frame sequence error

**FN:** AB—str.frm.seq.—start frame sequence error

**FN:** AC—con.frm.seq.—continue frame sequence error

**FN:** AD—end.frm.seq.—end frame sequence error

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 08—Level 2 Message Checksum Error

**Error Description:** The last level 1 frame transmitted as a result of a level 2 command is the message end frame. The lower eight bits of the end frame contain a checksum for the entire level 2 message. This error occurs if the checksum calculated by the drive does not match the checksum transmitted as part of the message end frame.

**FN:** A5—inc.cmd.cksm—incorrect command packet checksum

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 09—SDI Message Framing Error

**Error Description:** The upper eight bits of the control frame did not match one of the nine possible framing codes as defined in the SDI specification.

**FN:** A4—inv.frm.code.—invalid frame code

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 0A—SDI Command Opcode Parity Error

**Error Description:** The opcode in a level 2 SDI command was received with incorrect parity. The opcode byte must be even parity.

**FN:** B3—inc.opc.prtty—incorrect command opcode parity

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 0B—Invalid Opcodes

**Error Description:** One of two conditions have been detected:

- The opcode received in the level 2 command was not one of the 16 possible opcodes.
- The opcode received in the level 2 command was one of the 16 possible opcodes, but the opcode parity was wrong.

**FN:** B2—inv.cmd.opcd.—invalid command packet opcode

**FN:** B7—inv.lv1.opcd.—invalid level 1 command opcode

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 0C—Command Length Error

**Error Description:** The byte count for any given level 2 command is incorrect.

**FN:** A3—inv.cmd.byct.—invalid command packet byte count

**FN:** B1—inv.cmd.byct.—invalid command packet byte count

**FN:** B6—inc.lv1.byct.—invalid level 1 command packet byte count

**Most Probable Cause:** ECM, SDI controller, SDI cable

**0E—Real-Time Command Contains Invalid Head Address**

**Error Description:** A real-time command is one of the SDI level 1 data transfer commands. If the low byte of any of these commands indicates an invalid head, this error occurs.

**FN:** A2—inv.grp.num.—invalid group select (head) number

**Most Probable Cause:** ECM, SDI controller, SDI cable

**13—Spindle Fault**

**Error Description:** The motor control circuit has detected a condition that could prevent the spindle from spinning at a safe speed.

**FN:** 63—ast.smc.ft.—asserted spindle motor control fault

**Most Probable Cause:** ECM, HDA

**14—Spindle Over Current**

**Error Description:** The current being used by the spindle motor is too high.

**FN:** 61—ast.smc.pwr.—asserted spindle motor control power

**FN:** 62—neg.smc.pwr.—negated spindle motor control power

**Most Probable Cause:** ECM, HDA, SA7x power supply

### 16—Guard Band Error

**Error Description:** During normal operation, the heads have moved into the inner or the outer guard band area. If the servo system is in the process of loading or unloading heads (for example: the positioner is moving from the landing zone or to the landing zone), the I/O processor will mask out the guard band signals internal to the GASP gate array and thus prevent a servo fault from occurring.

**FN:** 46—out.grd.bnd.—outer guard band fault

**FN:** 47—inn.grd.bnd.—inner guard band fault

**Most Probable Cause:** ECM, HDA

### 17—Invalid or Inconsistent Parameters

**Error Description:** One or more of the parameters sent by the controller as part of the level 2 command is invalid or inconsistent.

**FN: 18—inv.gbd.cyl.**—invalid guard band cylinder access

**FN: AE—inc.sct.fmt.**—incorrect drive sector format

**FN: B8—inv.lv1.grp.**—invalid level 1 group select (head) number

**FN: C2—inv.sct.fmt.**—invalid drive sector format

**FN: C3—inv.dmr.num.**—invalid diagnose memory region number

**FN: C4—inc.dmr.num.**—incorrect diagnose memory region number

**FN: C6—inv.top.disc.**—invalid topology disconnect

**FN: C7—err.flg.astd.**—generic error bit flag asserted

**FN: C9—inv.lv1.num.**—invalid error recovery level number

**FN: CB—inv.grp.num.**—invalid group select (head) number level 2

**FN: CC—inv.cyl.adr.**—invalid cylinder address number level 2

**FN: CD—inv.dgn.cyl.**—invalid diagnostic cylinder access

**FN: D0—inv.rmr.num.**—invalid read memory region number

**FN: D1—inv.rmr.ofst.**—invalid read memory region offset

**FN: D3—inv.wmr.byct.**—invalid write memory region byte count

**FN: D4—inv.wmr.num.**—invalid write memory region number

**FN: D5—inv.wmr.ofst.**—invalid write memory region offset

**FN: D6—inv.wmr.siz.**—invalid write memory region size

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 18—Opcode/Parameter Invalid/Inconsistent with Drive State

**Error Description:** The level 2 command received from the controller is valid, but the command itself or a parameter contained in the command is inconsistent with the drive's current state or physical status.

**FN:** 68—*asup.bkd.ctrl.*—spinup blocked by the controller

**FN:** 69—*sup.bkd.dgn.*—spinup blocked by diagnostic

**FN:** B4—*inc.cmd.ftt.*—incorrect command drive fault state

**FN:** B5—*inc.cmd.lsn.*—incorrect command drive logical state number

**FN:** B9—*inv.svo.hsw.*—invalid level 1 servo head switch

**FN:** C1—*drv.wrt.prt.*—drive write protected

**FN:** C5—*inc.drst.top.*—incorrect drive state—NOT topology

**FN:** C8—*flt.not.negd.*—fault or error not cleared

**FN:** CA—*inv.svo.rcv.*—invalid servo error recovery

**FN:** CE—*inv.svo.sek.*—invalid servo seek

**FN:** CF—*run.sw.stop.*—run switch in 'STOP' position

**FN:** D2—*inv.run.lsn.*—invalid run logical state number

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 1D—Actuator Over Speed Error

**Error Description:** During course positioning mode the positioner velocity was greater than design specifications.

**FN:** 4B—*act.ovr.spd.*—actuator over speed

**Most Probable Cause:** ECM, HDA

### 1E—Actuator Over Current Error

**Error Description:** The current being used by the read/write head actuator is too high.

**FN:** 4C—*act.ovr.cur.*—actuator over current

**Most Probable Cause:** ECM, HDA

### 1F—Sector Overrun Error

**Error Description:** The internal read gate or write gate was asserted and a sector pulse or an index pulse occurred.

**FN:** 51—sct.ovr.run.—sector over run

**Most Probable Cause:** ECM, SDI controller, SDI cable, HDA

### 25—Off Track Error

**Error Description:** During track following mode, the DSP processor determined that the read/write heads are not within track center line tolerances.

**FN:** 4D—svo.off.trk.—servo off track error

**Most Probable Cause:** HDA, ECM

### 26—Spindle Speed Error

**Error Description:** The spindle speed is not operating within design specifications. The nominal spindle speed is 4000 r/min for the RA70 and 3600 r/min for the RA71/RA73 disk drives.

**FN:** 6E—inc.sup.svo.—incorrect spinup servo state number

**FN:** 71—inc.sup.psn.—incorrect spinup physical state number

**FN:** 73—inc.pur.psn.—incorrect purge cycle physical state number

**FN:** 77—inc.run.psn.—incorrect run physical state number

**Most Probable Cause:** ECM, HDA

### 27—HDA Over Temperature

**Error Description:** The temperature inside the HDA has exceeded the maximum allowed for safe operation.

**FN:** 4F—hda.ovr.tmp.—head disk assembly over temperature

**Most Probable Cause:** SA7x fan, HDA, ECM.

Be sure the disk is operating within the environmental specifications.



### 28—Module Over Temperature Error

**Error Description:** Sensing circuits on the ECM have detected temperatures that exceed the maximum allowed for safe and reliable operation.

**FN:** 4E—snk.ovr.tmp.—heat sink assembly over temperature

**FN:** 3C—xep.ovr.tmp.—module exception over temperature error

**FN:** 3D—com.ovr.tmp.—module common over temperature error

**Most Probable Cause:** SA7x fan, ECM, HDA. Be sure that the disk is operating within the environmental specifications.

### 31—Read Gate and Write Gate Error

**Error Description:** The SDI gate array detected both internal read gate and write gate at the same time.

**FN:** 5A—rdg&wrs.ast.—read state and write state both asserted

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 32—Read/Write While Faulted

**Error Description:** Even though the drive is in a faulted condition, the drive detected either RTCS read gate or RTCS write gate.

**FN:** 52—flt&rdg.wrg.—fault and read gate or write gate both asserted

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 33—Attempt to Write Through Bursts

**Error Description:** The read/write heads were over the embedded burst area of the sector, and the internal write gate was asserted.

**FN:** 53—wrg&brt.prt.—write gate and burst protection both asserted

**Most Probable Cause:** SDI controller, ECM, SDI cable

#### NOTE

See Table 9 and verify the minimum controller revision.

### 34—Data Encoder/Decoder Error

**Error Description:** A failure of the data encoder/decoder custom chip or some of its associated circuitry.

**FN:** 5C—enc.pls.ft.—encoder pulse fault (RWENDEC)

**Most Probable Cause:** ECM

### 35—Write Unsafe

**Error Description:** A condition exists with the write data path (for example: read/write heads, preamp chips, flex circuit, etc.) which would prevent the drive from correctly writing data to the disk surface.

**FN:** 5B—wrg&wrt.uns.—write gate and write unsafe both asserted

**Most Probable Cause:** ECM, HDA

### 39—Write and Off Track

**Error Description:** While write gate was asserted, the read/write heads moved off track.

**FN:** 58—wrg&off.trk.—write gate and off track both asserted

**Most Probable Cause:** ECM, HDA

### 3A—Write and Write Protected

**Error Description:** The drive was write protected and detected the assertion of the internal write gate.

**FN:** 59—wrg&wrt.prt.—write gate and write protection both asserted

**Most Probable Cause:** ECM, SDI controller, SDI cable

### 3B—AGC Fault

**Error Description:** Either the automatic gain control (AGC) circuit has failed or read signal amplitude variations have far exceeded the capability of the AGC circuit to maintain a proper signal lock. The latter of these may be caused by a severe signal degradation ratio (SDR, erasure) from a defective HDA.

**FN:** 5D—agc.lck.flt.—automatic gain control lock fault

**Most Probable Cause:** ECM, HDA

### 3C—Servo Faults

**Error Description:** There are hardware-detected inconsistencies with the servo system. These are divided into two categories: actuator faults and servo faults.

**FN:** 57—hrd.svo.flt.—hard servo fault

**Most Probable Cause:** ECM, HDA

### 41—SDI Command/Response Timeout

**Error Description:** The drive detected the start of an incoming SDI command or the transmission of an SDI response, but the operation did not complete within a specified time period.

**FN:** A8—exp.rsp.tmr.—expired response packet timer

**FN:** A9—exp.cmd.tmr.—expired command packet timer

**Most Probable Cause:** ECM, SDI controller, SDI cable

#### 43—TCR and R/W Ready Out L

**Error Description:** Transfer command received (TCR) and read/write ready out L indicates the drive received a data transfer command and read/write ready was not asserted.

**FN:** 50—tcr&r/w.rdy.—TCR and NOT read/write ready both asserted

**Most Probable Cause:** ECM, SDI controller, SDI cable

#### 44—Format Command and Format Not Enabled

**Error Description:** An SDI level 1 select track and format on index or format on sector or index command was decoded by the SDI gate array, but the enable format bit was not set.

**FN:** 55—fmt.w/o.ena.—format command without format enabled error

**Most Probable Cause:** ECM, SDI controller, SDI cable

#### 4B—Index Error

**Error Description:** Index was detected when it should not have been or was not detected when it should have been.

**FN:** 56—idx.pls.flt.—index pulse fault

**Most Probable Cause:** HDA, ECM

#### 4C—External Hardware Fault

**Error Description:** The gate array or the ground connection on the ECM is broken.

**FN:** 5E—ext.hrd.flt.—external hardware fault

**Most Probable Cause:** ECM

#### 4D—Write and Bad Embedded

**Error Description:** The drive internal write gate is asserted and embedded bursts are not valid.

**FN:** 54—wrg&emb.bad.—write gate and embedded NOT OK both asserted

**Most Probable Cause:** ECM, HDA

#### 4F—SDI Transmit Error—Pulse Error

**Error Description:** Extra or missing pulses on the SDI write command line (data pulse error) or the RTCS line (control pulse error) were detected.

**FN:** 5F—tcr&pls.err.—TCR and pulse error both asserted (PSID)

**Most Probable Cause:** ECM, SDI controller, SDI cable

#### 50—DSP Diagnostic Timeout

**Error Description:** There is not a specific error code for a failure during the initialization section of the DSP diagnostic. However, if the DSP fails to execute the basic initialization, it is most likely hung (or lost) and is not able to pass an error code to the I/O processor. It is possible that the initialization completed and the problem is with the analog loop test. Realize that the effect is the same: the I/O processor detects diagnostic timeout due to the fact the DSP does not respond with diagnostic complete or error detected.

**FN:** 84—exp.exc.tmr.—expired servo (DSP) execute timer

**Most Probable Cause:** ECM

#### 51—Byte/Sector Counter Failure

**Error Description:** Reported any time the counter is checked and is incorrect.

**FN:** E5—inv.sct.ctr.—invalid sector counter

**Most Probable Cause:** ECM

### 60—Read/Write Head Select Failure

**Error Description:** One of two conditions occurred. While trying to select a specific head to read or write, the DSP detected a soft servo fault and as such could not complete the head switch operation, or the I/O processor timed out waiting for the DSP to complete the head switch operation. Realize that if the drive detects any other faults, these faults are reported with the real-time error code associated with the error.

**FN:** F2—inv.dgn.cnt.—invalid diagnostic (head) bit error count

**FN:** F3—inc.dgn.cnt.—incorrect diagnostic (track) bit error count

**FN:** F5—exp.dgn.sct.—expired diagnostic sector timer

**FN:** FA—exp.dgn.rws.—expired diagnostic read/write sector timer

**FN:** FE—inc.dgn.rdy.—incorrect diagnostic ready

**Most Probable Cause:** ECM, HDA

## 61—Drive Capacity Configuration Error

**Error Description:** One of two conditions occurred. Either the HDA capacity indicator switch on the RA71/RA72 disk drive was set incorrectly, or the ECM logic cannot determine whether the HDA is an RA71 disk drive (700 MB storage capacity) or an RA72 disk drive (1 GB storage capacity).

If the HDA capacity indicator switch was set incorrectly, the drive will spin down and you will be unable to spin it up again until you set the switch correctly. You will receive fault number 19. Verify the switch setting. If the HDA is an RA71, the switch should be in the on position (up). If the HDA is an RA72, the switch should be in the off position (down). See the section on setting RA71/RA72 capacity indicator switch and refer to Figure 1.

If the capacity indicator switch is set correctly and you obtain fault number 1A, this indicates that the head table, which defines whether the drive is an RA71 or an RA72, cannot be read from the HDA. The problem may be related to the ECM or HDA.

**FN:** 19—inc.hda.swi.—incorrect HDA capacity switch setting

**FN:** 1A—inv.hda.type—invalid HDA type (can't determine HDA type)

**Most Probable Cause:** ECM, HDA

## 62—Read Failure

**Error Description:** One of six possible conditions occurred during the diagnostic read section of the test. The six conditions are:

- Invalid sector number
- Expired sector timer
- Expired read sector timer
- Incorrect read sector
- Read diagnostic failure
- Incorrect sector error count

**FN:** F4—inv.dgn.sct.—invalid diagnostic read sector number

**FN:** F6—inv.dgn.rsfc.—invalid diagnostic read sector fault

**FN:** F7—exp.dgn.rds.—expired diagnostic read sector timer

**FN:** F8—inc.dgn.rds.—incorrect diagnostic read sector number

**Most Probable Cause:** ECM, HDA



**67—Write Failure**

**Error Description:** One of five possible conditions occurred during the diagnostic write section of the test. The five conditions are:

- Invalid sector number
- Expired sector timer
- Expired write sector timer
- Incorrect write sector
- Write diagnostic failure

**FN:** F9—inv.dgn.wsn.—invalid diagnostic write sector number

**FN:** FB—inv.dgn.wsf.—invalid diagnostic write sector fault

**FN:** FC—exp.dgn.wrs.—expired diagnostic write sector timer

**FN:** FD—inc.dgn.wrs.—incorrect diagnostic write sector number

**Most Probable Cause:** ECM, HDA

**85—External RAM Failure**

**Error Description:** If, during any data verification process, the data stored in the processor external RAM location does not match the data that was written to that location, the test is terminated and this error is reported.

**FN:** E3—inv.dat.mem.—invalid external static RAM memory

**Most Probable Cause:** ECM

### 86—Internal RAM Failure

**Error Description:** If during any data verification process the data stored in the processor internal RAM location does not match the data that was written to that location, the test is terminated and this error is reported.

**FN:** E4—inv.ram.mem.—invalid internal static RAM memory

**Most Probable Cause:** ECM

### 87—UVPROM Checksum Failure

**Error Description:** This test calculates a checksum by adding, without carry, all the locations of the UVPROM. The sum is then compared to a stored value. If the computed sum and the stored sum do not match, this error will result.

**FN:** E2—inv.rom.sum.—invalid UVPROM checksum

**Most Probable Cause:** ECM

### 88—I/O Processor Sanity Failure

**Error Description:** This test verifies the I/O processor's ability to execute basic processor functions including branch instructions, verifying interrupts, and one of the general timers. Indications of this failure are:

- The basic processor functions fail.
- The interrupt/timer test fails.

**FN:** E0—ins.mcu.dgn.—insane microprocessor diagnostic

**FN:** E1—inv.ctr.int.—invalid counter over flow interrupt

**Most Probable Cause:** ECM

**89—EEPROM Failure**

**Error Description:** The I/O processor has detected a failure with the EEPROM memory used to store drive internal error log entries.

**FN:** 41—inv.log.fmt.—invalid EEPROM error log format

**FN:** 42—exp.pwc.tmr.—expired EEPROM page write cycle timer

**FN:** 43—inc.pwc.dat.—incorrect EEPROM write page cycle data

**FN:** 44—exp.bwc.tmr.—expired EEPROM byte write cycle timer

**Most Probable Cause:** ECM

**8A—GASP Mailbox Failure**

**Error Description:** The I/O processor address and data path lines to the GASP gate array are verified in both normal mode and register mode, and the hardware protocol (flags) and the data integrity of the mailboxes is verified in register mode.

**FN:** EC—inv.dsp.bus.—invalid DSP bus test

**FN:** ED—inv.dsp.mbx.—invalid DSP mailbox test

**Most Probable Cause:** ECM

**8B—DSP External RAM Failure**

**Error Description:** During the data verification process, the data stored in the DSP external RAM location does not match the data that was written to that location.

**FN:** EE—inv.dsp.mem.—invalid DSP memory test

**Most Probable Cause:** ECM

**8C—Sector Pulse Failure**

**Error Description:** A sector pulse error is reported if the signal sector pulse H should be asserted and it is not, or if the signal should not be asserted and it is.

**FN:** E6—inv.sct.pls.—invalid sector pulse

**Most Probable Cause:** ECM

#### **8D—External Loop Back Failure**

**Error Description:** External loop back failure occurs if the signal Init Req H should be asserted and it is not, or if it should not be asserted and it is.

**FN:** EA—ext.lop.tst.—invalid external loop back test  
**Most Probable Cause:** ECM

#### **94—Loop Back Frame Not Received**

**Error Description:** Non-transfer command received (NTPCR) did not become asserted after an SDI frame was sent.

**FN:** E7—int.lop.tst.—invalid internal SDI loop back test  
**Most Probable Cause:** ECM

#### **95—Loop Back Frame Code Incorrect**

**Error Description:** The frame was received, but it is not the same frame as was sent.

**FN:** E8—inv.frm.cod.—invalid response frame code  
**Most Probable Cause:** ECM

#### **96—Loop Back Frame Data Incorrect**

**Error Description:** The frame was received correctly and the frame code was correct, but the data that was received did not match the data that was sent.

**FN:** E9—inv.frm.byt.—invalid response frame byte  
**Most Probable Cause:** ECM

**9A—Read and Off Track**

**Error Description:** The heads were not fine-positioned or locked on track (relative to the embedded servo information) at the time a read operation was ready to start. The drive took the necessary actions to establish the on-track condition.

The drive will not post a recoverable read-and-off-track error to prevent interruption to the controller. This allows the controller to execute all of its available retry/error recovery sequences to the drive and if necessary, retrieve user data during a recoverable error.

**FN:** 09—rdg&off.trk.—read gate and off track both asserted

**Most Probable Cause:** HDA, ECM

**9B—Write and Off Track**

**Error Description:** While write gate was asserted, the read/write heads moved off track.

**FN:** 58—wrg&off.trk.—write gate and off track both asserted

**Most Probable Cause:** ECM, HDA

**A0 Illegal Diagnostic Sequence**

**Error Description:** The controller issued an SDI DIAGNOSE command to the drive. The drive determined that the requested diagnostics tests were not in correct sequence or out of context with the current state of the drive (for instance, seek test while drive spun down). It also indicates that one of the diagnose error commands was executed without the error log being in the correct state. This could be an **operator error** if special controller diagnostics were manually invoked and the user inadvertently entered incorrect parameters.

**FN:** D9—ill.dgn.seq—illegal diagnostic sequence

**Most Probable Cause:** Operator error, ECM, SDI controller

### C6—PLO Failure

**Error Description:** The VCO clock is not in sync or has fallen out of sync with the rotating disk.

**FN:** 48—plo.lck.ft.—PLO lock failure

**Most Probable Cause:** HDA, ECM

### C9—Analog Loop Failure

**Error Description:** There are three possible conditions that result in analog loop failure:

- The I/O processor could not complete a write to the GASP gate array mailbox.
- The I/O processor could not complete a read of the GASP gate array mailbox.
- The DSP could not complete the analog test or it completed the test but with incorrect results. This consists of three possible conditions:
  - The DSP timed out waiting for the A/D convert to complete.
  - The DSP received an unexpected interrupt.
  - The DSP found one or more of the conversions were out of tolerance.

**FN:** 85—inc.exc.rsp.—incorrect DSP execute response

**FN:** EF—inv.dsp.dgn.—invalid DSP diagnose response

**Most Probable Cause:** ECM

### CD—Track Count Error

**Error Description:** While in the course positioning mode, both gray codes (gray code X and gray code Y) changed during the same servo frame or one gray code changed on two consecutive frames.

**FN:** 49—trk.ctr.ft.—track counter—gray codes out of quad.

**Most Probable Cause:** ECM, HDA

**E0—Firmware Detected Fault - microprocessor Driver**

**Error Description:** The I/O processor firmware has detected an inconsistency in the microprocessor driver (MCUDRV). The MCUDRV provides the interface to the firmware timer functions and controls and monitors the I/O processor hardware timer.

**FN: 01—inc.opr.mode.—**incorrect operating mode

**FN: 02—inv.pwr.rst.—**invalid power on reset

**FN: 03—ctr/tmr.ft.—**counter/timer test failure

**FN: 04—int.ram.ft.—**internal RAM test failure

**FN: 05—inv.ctr.intr.—**invalid or spurious counter interrupt

**FN: 06—inv.tmr.intr.—**invalid or spurious timer interrupt

**FN: 07—inv.cap.intr.—**invalid or spurious input capture interrupt

**FN: 08—opn.tmr.num.—**invalid open timer number

**FN: 09—act.tmr.ft.—**can't open timer (already active)

**FN: 0A—cls.tmr.num.—**invalid close timer number

**FN: 0B—chk.tmr.num.—**invalid check timer number

**FN: 0C—get.tmr.num.—**invalid get timer number

**FN: 0D—mcu.und.ft.—**mcudrv module undefined fault

**FN: 0E—mcu.und.ft.—**mcudrv module undefined fault

**FN: 0F—mcu.und.ft.—**mcudrv module undefined fault

**Most Probable Cause:** ECM

### E1—Firmware Detected Fault - Test Handler

**Error Description:** The I/O processor firmware has detected an inconsistency in the test handler (TSTHDR). The TSTHDR controls the drive when and only when it is connected to the test device at the manufacturing plant or a repair center.

**FN: 10**—inv.tsts.adr.—invalid test memory address number

**FN: 11**—exp.tst.tmr.—expired test command received timer

**FN: 12**—inv.tst.byct.—invalid test command packet byte count

**FN: 13**—inv.tst.opcd.—invalid test command packet opcode

**FN: 14**—inv.rdm.ofst.—invalid read memory address offset

**FN: 15**—inv.rdm.byct.—invalid read memory data count

**FN: 16**—inv.wrm.ofst.—invalid write memory address offset

**FN: 17**—inv.wrm.byct.—invalid write memory data count

**FN: 18**—inv.wrm.data.—invalid write memory data (RAM didn't change)

**FN: 19**—inv.exc.ofst.—invalid execute memory address offset

**FN: 1A**—inv.exc.byct.—invalid execute memory data count

**FN: 1B**—emp.exc.buf.—empty execute command buffer (no arguments)

**FN: 1C**—ful.exc.buf.—full execute response buffer

**FN: 1D**—inv.fnc.num.—invalid SWI "trap" function number

**FN: 1E**—tst.und.ftt.—tsthdr module undefined fault

**FN: 1F**—tst.und.ftt.—tsthdr module undefined fault

**Most Probable Cause:** ECM



**E2—Firmware Detected Fault - OCP Handler**

**Error Description:** The I/O processor firmware has detected an inconsistency in the OCP driver. This driver provides the interface to the operator control functions and determines what type of device is connected to the drive's remote front panel connector.

**FN: 21—rxp.seq.err.—**receive packet sequence error

**FN: 22—rxp.ovr.run.—**receive packet overrun error

**FN: 23—inv.syn.by. —**invalid 'sync' byte

**FN: 24—inv.rxp.cnt.—**invalid receive packet count

**FN: 25—rxp.by.ovr.—**receive packet byte overrun

**FN: 26—inv.rxp.sum.—**invalid receive packet checksum

**FN: 27—inv.txp.cnt.—**invalid transmit packet byte count

**FN: 28—exp.txb.tmr.—**expired transmit byte timer

**FN: 29—exp.rxb.tmr.—**expired receive byte timer

**FN: 2A—rxb.frm.err.—**receive byte framing error

**FN: 2B—rxb.ovr.run.—**receive byte over run error

**FN: 2C—ocp.und.flt.—**ocpdrv module undefined fault

**FN: 2D—ocp.und.flt.—**ocpdrv module undefined fault

**FN: 2E—inv.fls.ers.—**invalid flash memory erase

**FN: 2F—inv.fls.pgm.—**invalid flash memory program

**Most Probable Cause:** ECM, OCP, SA7x logic

### E3—Firmware Detected Fault - OCP Driver

**Error Description:** The I/O processor firmware has detected an inconsistency in the OCP driver. This driver provides the interface to the operator control functions and determines what type of device is connected to the drive's remote front panel connector.

**FN:** 30—ocp.ft.num.—invalid OCP logical state

**FN:** 31—inv.cmd.opc.—invalid command opcode

**FN:** 32—exp.rsp.tmr.—expired response packet timer

**FN:** 33—rtx.lst.rsp.—retransmit last response

**FN:** 34—inv.rsp.cnt.—invalid response packet byte count

**FN:** 35—inc.rsp.opc.—incorrect response packet opcode

**FN:** 36—inv.rsp.opc.—invalid response packet opcode

**FN:** 37—inv.ocp.lck.—invalid OCP interlock

**FN:** 38—exp.rsp.tmr.—expired response packet timer

**FN:** 39—rtx.lst.rsp.—retransmit last response

**FN:** 3A—ocp.und.ft.—ocphdr module undefined fault

**FN:** 3B—ocp.und.ft.—ocphdr module undefined fault

**FN:** 3C—ocp.und.ft.—ocphdr module undefined fault

**FN:** 3D—ocp.und.ft.—ocphdr module undefined fault

**Most Probable Cause:** ECM, OCP, or SA7x logic

**E4—Firmware Detected Fault - Fault Handler**

**Error Description:** The I/O processor firmware has detected an inconsistency in the fault handler. This handler monitors and controls the drive's error logging functions, both internal and external.

**FN:** 40—inv.driv.ftt.—invalid or spurious drive fault

**FN:** 45—sft.svo.ftt.—soft servo fault

**Most Probable Cause:** ECM

**E6—Firmware Detected Fault - Spindle Motor Control Driver**

**Error Description:** The I/O processor firmware has detected an inconsistency in the spindle motor control (SMC) driver. The SMC provides the interface to the drive's spindle motor.

**FN:** 60—smc.ftt.num.—smcdrv module undefined fault

**FN:** 64—inv.smc.lsn.—invalid spindle motor control logical state number

**FN:** 65—inv.smc.num.—invalid spindle motor control function number

**FN:** 66—inv.smc.lck.—invalid spindle motor control lock

**FN:** 67—inv.smc.ftt.—invalid spindle motor control fault

**FN:** 6A—sup.bkd.ftt.—spinup blocked by drive hard or soft fault

**FN:** 6B—sup.bkd.lsn.—spinup blocked by spin logical state number

**FN:** 6C—smc.und.ftt.—smcdrv module undefined fault

**FN:** 6D—smc.und.ftt.—smcdrv module undefined fault

**FN:** 6E—smc.und.ftt.—smcdrv module undefined fault

**Most Probable Cause:** ECM, HDA

### **E7—Firmware Detected Fault - Spindle Motor Control Handler**

**Error Description:** The I/O processor firmware has detected an inconsistency in the spindle motor control (SMC) handler. The SMC controls and monitors the spindle motor functions via the driver.

**FN: 74**—inc.lhd.rtz.—incorrect load heads return to zero state

**FN: 75**—inc.lhd.sek.—incorrect load heads seek state

**FN: 76**—inc.lhd.rcl.—incorrect load heads recalibrate state

**FN: 78**—exp.spn.tmr.—expired spin timer

**FN: 79**—inc.spn.psn.—incorrect spin physical state number

**FN: 7A**—exp.uhd.tmr.—expired unload heads timer

**FN: 7B**—inc.uhd.psn.—incorrect unloads heads physical state number

**FN: 7C**—exp.sdn.tmr.—expired spindown timer

**FN: 7D**—inc.sdn.psn.—incorrect spindown physical state number

**FN: 7E**—exp.idl.tmr.—expired idle timer

**FN: 7F**—inc.idl.psn.—incorrect idle physical state number

**Most Probable Cause:** ECM, HDA

#### **NOTE**

**If this error occurs on an RA70 disk drive with FN = 7C when the drive is spun down, be sure the ECM revision is J6 or higher (firmware revision 79 or higher).**

**E8—Firmware Detected Fault - DSP Driver**

**Error Description:** The I/O processor firmware has detected an inconsistency in the DSP driver. This driver provides the interface to the DSP processor via the servo gate array.

**FN:** 80—dsp.ft.num.—servo detected fault

**FN:** 86—exp.rmb.tmr.—expired read mailbox timer

**FN:** 87—inv.rmb.rsp.—invalid read mailbox response opcode

**FN:** 88—exp.wmb.tmr.—expired write mailbox timer

**FN:** 89—une.wmb.rsp.—unaccepted write mailbox response

**FN:** 8A—inc.dma.mode.—incorrect DSP memory mode

**FN:** 8B—vrf.dsp.mem.—verify DSP memory data

**FN:** 8C—inc.dsp.bus.—incorrect data bus pattern

**FN:** 8D—inc.dsp.mbx.—incorrect DSP mailbox pattern

**FN:** 8E—inc.h/c.num.—incorrect head/cylinder number

**FN:** 8F—svo.rwr.ast.—servo read/write ready asserted

**Most Probable Cause:** ECM, HDA

### E9—Firmware Detected Fault - DSP Handler

**Error Description:** The I/O processor firmware has detected an inconsistency in the DSP handler. This handler controls and monitors the servo functions via the driver.

- FN:** 90—inc.dst.grp.—incorrect destination group (head) number
  - FN:** 91—inv.dsp.lsn.—invalid DSP logical state number
  - FN:** 92—exp.dsp.tmr.—expired DSP state timer
  - FN:** 93—inc.dsp.psn.—incorrect DSP physical state number
  - FN:** 94—inc.dsp.rsp.—incorrect DSP response opcode
  - FN:** 95—inc.dsp.lsn.—incorrect DSP logical state number
  - FN:** 96—inv.svo.head—invalid servo head number
  - FN:** 97—exp.dtn.tmr.—expired detent state timer
  - FN:** 98—inc.dtn.psn.—incorrect detent physical state number
  - FN:** 99—inv.svo.cyl.—invalid servo cylinder number
  - FN:** 9A—exp.rtz.tmr.—expired return to zero state timer
  - FN:** 9B—inc.rtz.psn.—incorrect return to zero physical state number
  - FN:** 9C—inc.rtz.cyl.—incorrect return to zero cylinder number
  - FN:** 9D—exp.sek.tmr.—expired seek state timer
  - FN:** 9E—inc.sek.psn.—incorrect seek physical state number
  - FN:** 9F—inc.sek.cyl.—incorrect seek cylinder number
- Most Probable Cause:** ECM, HDA

### EA—Firmware Detected Fault - SDI Driver

**Error Description:** The I/O processor firmware has detected an inconsistency in the SDI driver. This driver provides the interface to the controller and the read/write hardware via the SDI gate array.

- FN:** A6—aut.snd.flt.—auto send mode fault
  - FN:** A7—inv.rsp.byct.—invalid response packet byte count
  - FN:** AA—drv.not.rwr.—drive NOT read/write ready
  - FN:** AF—inc.sct.num.—incorrect/invalid sector number
- Most Probable Cause:** ECM

**EB—Firmware Detected Fault - SDI Driver**

**Error Description:** The I/O processor firmware has detected an inconsistency in the SDI driver. This driver provides the interface to the controller and the read/write hardware via the SDI gate array.

**FN:** 10—exp.idx.hsw.—expired index/sector pulse timer (head switch)

**FN:** 11—inv.head.hsw.—invalid physical head switch (head switch)

**FN:** B0—inv.sdi.lsn.—invalid SDI logical state number

**FN:** BA—exp.idx.tmr.—expired index/sector timer

**FN:** BD—inv.spu.IRQ.—invalid or spurious IRQ interrupt

**FN:** BE—inv.head.adr.—invalid physical head address

**FN:** BF—inv.head.num.—invalid logical head number

**Most Probable Cause:** ECM

**ED—Firmware Detected Fault - SDI Handler**

**Error Description:** The I/O processor firmware has detected an inconsistency in the SDI handler. This handler processes and performs SDI level 2 command packets provided by the SDI driver. In addition, it provides the SDI level 2 response packets to the SDI driver.

**FN:** D7—inv.cpy.byct.—invalid buffer copy byte count

**FN:** D8—inc.sub.unt.—incorrect subunit mask bit

**FN:** DA—drv.hrd.ft.—drive hard fault—CANNOT be cleared

**Most Probable Cause:** ECM

**EE—Firmware Detected Fault - Diagnostic Driver**

**Error Description:** The I/O processor firmware has detected an inconsistency in the diagnostic driver. This driver performs the drive's power on reset diagnostics.

**FN:** EB—inv.dsp.dr.—invalid DSP driver response

**Most Probable Cause:** ECM

### **EF—Firmware Detected Fault - Diagnostic Handler**

**Error Description:** The I/O processor firmware has detected an inconsistency in the Diagnostic handler. This handler performs the drive's spinup diagnostics.

**FN:** 28—exp.dgn.bwd.—expired diagnostic drive burst write timer

**FN:** 29—exp.dgn.bwh.—expired diagnostic head burst write timer

**FN:** 2A—exp.dgn.bwk.—expired diagnostic seek burst write timer

**FN:** 2B—exp.dgn.erd.—expired diagnostic drive burst write erase timer

**FN:** 2C—exp.dgn.erh.—expired diagnostic head burst write erase timer

**FN:** 2D—brt&off.trk— burst write and offtrack

**FN:** 2F—inv. head.tbl—invalid head table data (on the head track)

**FN:** DB—exp.dgn.rnd.—expired diagnostic random cylinder state timer

**FN:** DC—exp.dgn.sng.—expired diagnostic single cylinder state timer

**FN:** DD—exp.dgn.avg.—expired diagnostic average cylinder state timer

**FN:** DE—exp.dgn.ful.—expired diagnostic full cylinder state timer

**FN:** DF—exp.dgn.hsw.—expired diagnostic head switch state timer

**FN:** F0—inv.dgn.psn.—invalid diagnostic physical state number

**FN:** F1—inc.dgn.lsn.—incorrect diagnostic logical state number

**Most Probable Cause:** ECM



#### **F2—Soft Servo Fault**

**Error Description:** The DSP firmware has detected an error.

**FN:** 4A—svo.grd.bnd.—soft servo fault or inner or outer guard band

**Most Probable Cause:** ECM, HDA

#### **FD—DSP Reset Failure**

**Error Description:** The DSP is in the reset state and the signal HOLDA L is asserted, or the DSP is in the DMA/HOLD state and the signal HOLDA L is not asserted.

**FN:** 81—ast.hld.ack.—asserted hold acknowledge from DSP processor

**FN:** 82—inv.dma.num.—invalid DMA space number

**FN:** 83—neg.hld.ack.—negated hold acknowledge from DSP processor

**Most Probable Cause:** ECM

#### **FF—Debug Error Trap**

**Error Description:** This error code is reserved for engineering to test and debug the drive internal firmware operations. Normally this error will not show up in the field.

**FN:** FF—failed.test.—general failed test

**Most Probable Cause:** ECM

