

DIAGNOSTIC COMMANDS
Compatible with Drives with >64k Cylinders
January 13, 2003



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SERIAL PORT INPUT PARAMETER REPRESENTATION

Command parameters in this document are represented with single letters, separated by commas.

e.g. Sx,y,z - This signifies a serial port command, "S", that takes in three parameters.

Exception: When one parameter is used to input two different values to the command, field width of each parameter will be shown.

e.g. Dxxy - This signifies a serial port command, "D", that takes in one parameter. The high byte of this parameter (xx) is used to pass one value to the command and the low byte (yy) is used to pass a second value to the command.

The serial port will accept a max of up to one word (ffff) for each parameter. For drives with greater than 64k cylinders, the serial port will accept up to a double word (ffff ffff) for each parameter. See the appropriate command description to determine the valid size of a particular parameter.

Unless otherwise noted, leading zeros are NOT required.

SERIAL PORT OUTPUT DISPLAY REPRESENTATION

Output display values in this document are represented with either letters or numbers and will show exact field width to aid in the creation and maintenance of serial port parsing software.

e.g. When the log is displayed the output to the screen is formatted as shown below.

(Log Type 2)
 Head
vv wwwwww.xxx yyy zz

where wwwwww is physical cylinder

(Log Type 4)
 Head x
vv wwwwww.xxx yyy zz

where wwwwww is physical cylinder

Log format for drives with >64k cylinders:

(Log Type 2)
 Head
vv wwwwww.xxx yyy zz

where wwwwww is physical cylinder

(Log Type 4)
 Head x
vv wwwwww.xxx yyy zz

where wwwwww is physical cylinder

or output formatted as follows:

Zone 0: 0006 - 0B4F 800 389.020

Output format for drives with >64k cylinders:

Zone 00: 0CC84 - 0DE36 884 414.1017



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- !** Display Current R/W Channel Settings..... 70
- %** Show Mux Status. ** (See Appendix B for Description)..... 70
- ‘** Display Transfer Status (See Appendix B Description)..... 70
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ON-LINE COMMANDS

The On-Line commands may be initiated at any time. For the Interface-specific commands, the Interface code must be present in the current memory map for successful execution; the General commands are always available.

Interface-Specific Commands

<u>Command</u>	<u>Description (AT)</u>
^E	Interface State: Error codes, Max C.H.S, Current transfer mode settings
^F	Read Segment Record(s)
^G	Write Queue
^I	Controller Register Dump
^K	Niwot RdWr State
^Q	Resume after ^S (age 50 only)
^S	Pause intf task and swap to diag monitor
^U	Currently unused
^V	Interface Command Echo and Activity Trace Toggle
^X	Interface and Niwot Command History
^Y	Display Raw SMART DST Values (for Serial Port running of DST)
^~	Interface Command State

General Commands

<u>Command</u>	<u>Description</u>
^A	Send Certification Code Rev
^B	(Reserved for Servo Use)
^C	Firmware Reset
^D, ^N	Retry Activity Display Toggle. (See Appendix B. for Retry Display Characters.)
^L	Display Sign-on Message, including firmware version. **
^O, ^J	Advance Servo Tracing



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Online General Commands (Continued)

Command	Description
^P	Power Chop enable/disable toggle.
^Q	Cert Display Debug enable/disable toggle (not age 50)
^R	Restart the Diagnostic Monitor, load overlay from disc.
^T	Restart testing at the current age.
^W	Read/Write statistics gathering enable/disable toggle.
^Z	Restart the Diagnostic Monitor, do not load overlay from disc
!	Display Current R/W Channel Settings
%	Show Mux Status. ** (See Appendix B for Description)
‘	Display Transfer Status (See Appendix B Description)
.	Display Active Status. ** (See Appendix B for Description)
;	Display Machine Status. ** (See Appendix B for Description)
<	Decrement read/write scope synchronization pulse position.
>	Increment read/write scope synchronization pulse position.
?	Show Buffer Allocation. ** (See Appendix B for Description)
^	Show Elapsed Time since start of cert test or last ^Z.
`	Show Read/Write Statistics. (See Appendix B for Description)
{	(Reserved for Servo Diagnostic Use)
}	(Reserved for Servo Diagnostic Use)
ESC	Interrupt Loop, Batch file or SeaDex script execution.

** - Standardized and documented in Test Engineering's Internal Reference Manual, "**Microcode Command Set**".



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COMMON COMMANDS: (Available from All Levels except Level 8)

The Common Commands may be executed whenever the diagnostic monitor prompt is present and the monitor is waiting for a command request, except at level 8. The level 8 commands take precedence over the common commands.

Command	Description
/x	Change Level to Diagnostic Monitor Level x.
CR	Loop Break.
*	Special Function for batch file: *1 Pause batch file execution until input *2,x Delay x milliseconds *3,x Branch to Label x *4,x Increment head and branch to Label x *5 Clear monitor screen *6 Stop on error *7,x Load batch loop counter with x. *8,x Decrement batch loop counter, Branch to Label x if 0.
@x	Batch File Label. During batch file entry, define this location as Label x. x - Single digit numeric label specification.
	Batch file terminator Terminates the entry of batch files.
+x,y	Peek Byte. Display the byte data content of the specified memory address: x - upper bits of a greater-than-16 bit address y - lower 16 bits of a greater-than-16 bit address or the 16 bit address
=x,y,z	Poke Byte. Replace the contents of the specified address with the specified data. x - upper bits of a greater-than-16 bit address y - lower 16 bits of a greater-than-16 bit address or the 16 bit address z - byte data content to be written at the specified address.
-x,y	Peek Word. Display the word contents of the specified address. x - upper bits of >16 bit address y - lower 16 bits of >16 bit address or the 16 bit address



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Common Commands (Continued)

Command Description

Ax,y,z Set Test Space

x	Bit Meanings:	
Bit #	If x = 1	If x = 0
7	Random Data	Existing Buffer Data
6	Sequential Out	Sequential In
5	Odd Cylinders	All Cylinders
4	Even Cylinders	All Cylinders
3	(unspecified)	(unspecified)
2	Random Cylinder/Head	Sequential Cylinder/Head
1	All Cylinders	Current Cylinder
0	All Heads	Current Head

Special Values

A8,y Set Minimum Cylinder to y **>64k cyl compatible***
A9,y Set Maximum Cylinder to y **>64k cyl compatible***
AA,y Set Maximum Head to y
AD Set Mins/Maxs to Defaults
A87 Sets random data, random cylinder, random head, all cyls & hds
AC7 Randomly select 80% Sequential In, 20% Random addresses

IF (Random_Start = TRUE

A,,z Select Random start and length
 Bit0 set = random start sector
 Bit1 set = random length
 Bit0 set = Display above

Lx,y

Loop. Causes the next command to repeat execution, subject to controls specified by x:

x	Bit Meanings:	
Bit #	If = 1	If = 0
7	Looping active (internal use)	Looping not active (internal use)
6	Looping primed (internal use)	Looping not primed (internal use)
5	Stop on Error Code = y	Do Loop Count (y<<=0)
4	Inhibit Error Message on error	Display Error Message on error
3	(unspecified)	(unspecified)
2	Spin Down on Error	Remain spinning on error
1	Stop on No Error	
0	Continue on error	Stop on error

y: Error Code to stop on (if Stop on Error Code is enabled.)
 Loop Count (default is forever.)

*** Will accept up to 8 digits for drives with >64k cylinders**

LEVEL T COMMANDS: Cert Process /Test

Command	Description																								
A	<p>Enable/Disable throttling of drive messaging.</p> <p>Toggles the state of the drive messaging toggling. Power-up state is throttled - once buffer is full, drive messaging system will wait for characters to be transmitted before processing further output information</p>																								
Bx,y	<p>Set Baud Rate</p> <p>x = 0 Set baud rate to POR default, typically 9600</p> <p>x = 1 Display supported baud rates in the format: =xxxx</p> <p>x > 1 Set supported baud rate</p> <p>Typical baud rates (xxxx leading zeros may be omitted)</p> <table border="0"> <thead> <tr> <th>x</th> <th>baud rate</th> </tr> </thead> <tbody> <tr><td>1228</td><td>1,228,000</td></tr> <tr><td>921</td><td>921,000</td></tr> <tr><td>625</td><td>625,000</td></tr> <tr><td>460</td><td>460,000</td></tr> <tr><td>230</td><td>230,000</td></tr> <tr><td>115</td><td>115,000</td></tr> <tr><td>576</td><td>57,600</td></tr> <tr><td>192</td><td>19,200</td></tr> <tr><td>96</td><td>9,600</td></tr> <tr><td>48</td><td>4,800</td></tr> <tr><td>24</td><td>2,400</td></tr> </tbody> </table> <p>y - if entered y contains the delay time in milliseconds. Default is do not wait for host to return CR, just set new baud rate. If y is entered the code will check every millisecond up to y milliseconds for a carriage return to be sent back from the host at the new baud rate. If no CR is seen the drive will default back to 9600 baud.</p>	x	baud rate	1228	1,228,000	921	921,000	625	625,000	460	460,000	230	230,000	115	115,000	576	57,600	192	19,200	96	9,600	48	4,800	24	2,400
x	baud rate																								
1228	1,228,000																								
921	921,000																								
625	625,000																								
460	460,000																								
230	230,000																								
115	115,000																								
576	57,600																								
192	19,200																								
96	9,600																								
48	4,800																								
24	2,400																								
*** C,,z	<p>Reset Certification Test. (available only when overlay is valid)</p> <p>Resets health bits and sets age to 1. Clears Scratch Fill Done flag.</p> <p>z - if z = 22h then reset certification test.</p> <p>- if z <> 22 then ignore this command.</p>																								
*** Dx,y,z	<p>Display Cert Logs sequentially from Log x. (available only when overlay is valid)</p> <p>x - Log to start sequential display; if blank, display only logs of failed tests.</p> <p>y - Displays only log entries with this error code</p> <p>z - Special function:</p> <p>= 40 - Enable fast dump capability for data cataloger capture. Inhibits time delay between log dumps and enables fast, unformatted log dump.</p>																								
Ex,y,z	<p>Display/Edit Cert Log(s)</p> <p>See /2 E for further detail.</p>																								
F	<p>Set Stuff</p> <p>The Set Stuff data may be up to 512 characters long. The Set Stuff data format is defined by the Seagate-Longmont ATA Vendor Specific Stuff document.</p>																								

Command	Description
*** Hx,y,z	<p>Display/Reset Health Status Bits. (available only when overlay is valid)</p> <p>x - (anything entered) - Display Current Health - (nothing entered) - Display Accumulated Health</p> <p>y - (not used)</p> <p>z - if z = 22h then reset both current and accumulated health to 0000. - if z <> 22 then ignore this command.</p>
*** I,y,z	<p>Initialize System Region. (available only when overlay and cert table are valid)</p> <p>Performs all necessary calibrations, formatting and flaw-mapping of the system region to prepare it to receive the Overlay and to prepare for the Certification Tests.</p> <p>y - if entered then retrieve SN from the GC</p> <p>z - if z = 22h then initialize the system region. - if z <> 22 then ignore this command.</p>
Jx,y	<p>Set Scope Sync from Cert Log entries: See /2 E for further detail.</p>
K	<p>Download Congen file.</p>
Nx,y,z	<p>Set Drive Age to x.</p> <p>y - RdWrFeatures word (if specified).</p> <p>z - if z = 22h, set age to x and/or RdWr Features to y, otherwise do nothing.</p>
R	<p>Read System Sector into System RAM</p>
S	<p>Check User Slip List for empty or unordered slip list</p>
Tx	<p>Run Factory Test x</p>
*** Vx,y	<p>Display Defect List(s) to screen and add to active log (available only when overlay is valid)</p> <p>x - bit select for list to display/add bit 0 set, display user track slip list (DEFAULT) bit 1 set, display reserved track slip list bit 2 set, display alt list bits may be combined to initialize more than one list i.e. 1 for user list, 7 for all three lists or any combination in between</p> <p>y - If entered display/add only defects for head X</p>
Wx,y,z	<p>Save System RAM into System Sector.</p> <p>If age <> 60 then x,y,z is not used.</p> <p>If age == 60 then</p> <p>x - (not used)</p> <p>y - (not used)</p> <p>z - if z = 22h then save adaptives to disc - if z <> 22 then ignore this command.</p>

Yx,y

Set Drive Type

- x - New Drive Type
(See 'Drive Type Word Specification' for content definition.)
- y - If entered then do packwriter version of change type command (not try to read from or write to disc). Default is to save the drive type to system tracks, unless the drive cannot read or write to the system area.

a

Drive messaging pause toggle switch

Toggles whether the drive messaging system will pause for the host when the output buffer becomes full or simply overwrite old data

b,,z

Initialize the overlay area of the disc

This command initializes that part of the system area that is used to store overlays.
z – only do initialize if z = 22h

c

Write overlays to the disc

This writes all downloaded overlays (see Level T d command) to the disc. This should be used only after Test 2 has been run. If overlays are downloaded and then Test 2 is run, Test 2 will automatically write any available overlays to the disc at the very end of the test.

dx,y,z

Download Cert Code (for automated use only).

- x – buffer number to download to
- y - blocksize, where:0 = 512
1 = 1024
2 = 2048
3 = 4096
- z - 1 = Suppress spinup after download

This does not write the cert code to the disc. A level T w command must be issued to write the cert code to disc.

ex,y

Download overlay (for automated use only)

- x - Unique overlay number
- y - Any non-zero value indicates that the overlay is immediately executable (i.e. without reading from the disc)

f

Burn new serial flash code that is already downloaded to the buffer and transition to it.

Assumes that the code is already downloaded to buffer 0x400

gx,y,z

Call overlay function

This command calls a specified overlay function. See the Overlay Specifications for more information

- x - Specifies the Overlay Function ID
- y - Specifies the 16K page for the Overlay Function Parameter value
- z - Specifies the page offset for the Overlay Function Parameter value

Command	Description
h	Download cert table (for automated use only) This command downloads the cert tables to the drive. For more information see the Cert Table interface document
*** ix,y,z	Initialize/Reset Defect List(s) (available only when overlay is valid) <ul style="list-style-type: none"> x - bit select for list to initialize bit 0 set, initialize user track slip list bit 1 set, initialize reserved track slip list bit 2 set, initialize alt list bits may be combined to initialize more than one list i.e. 1 for user list, 7 for all three lists or any combination in between y - If entered save list to disc after initialization z - if z = 22 Allow initialization if z <> 22 Disallow initialization; ignore this command.
*** j	Download SeaDex script (for automated use only) (available only when overlay is valid) This command downloads the SeaDex script to the drive. This does not write the cert code to the disc. A level T w command must be issued to write the script to disc.
kx,y,z	Initialize what head to depop <ul style="list-style-type: none"> x head number to depop (cannot be head 0) 0xff will reset the depop head map y drive type the new depop config will be z second head to depop if needed.
*** lx	Initialize and write zone buffers in the overlay to RAM (available only when overlay is valid) <ul style="list-style-type: none"> x <ul style="list-style-type: none"> 01 – copy the overlay zone table to RAM 02 – regenerate the PBA zone table 04 – set the adaptive in ram based on the zone table 08 – run the VCO cal 10 – Save it to disc
*** m,,z	Defect Map System Area (available only when overlay is valid) This command does write/read on system area and slips bad sectors. <ul style="list-style-type: none"> z - if z = 22 Allow defect mapping of system area - if z <> 22 ignore this command.
r	Reload Cert from Disc and report version number
*** sx,y,z	Save Defect List(s) (available only when overlay is valid) <ul style="list-style-type: none"> x - bit select for list to initialize bit 0 set, save user track slip list bit 1 set, save reserved track slip list bits may be combined to save more than one list i.e. 1 for user list, 7 for all three lists or any combination in between y - ignored z - if z = 22 Allow save of defect lists - if z <> 22 Disallow save; ignore this command.

wx,y

Write (Save) Overlay code to Disc (for automated use only).

- x a bit field for saving code modules to disc (same as level 1 'd')
- if x is entered and = 1 then save cert code only to the disc
 - if x is entered and = 2 then save cert tables only to the disc
 - if x is entered and = 4 then save application code only to the disc
 - if x is entered and = 8 then save SeaDex script only to the disc
- other values for x are treated as a bit field to select which of above to save
- if x is not entered then save all to the disc
- y buffer number to download from

***** xll,ss,nn**

Page Log To Host (available only when overlay is valid)

This command will page the log to the host in DC FORMAT, i.e. raw data. This command

will work for ASCII, Active, and Byte Offset log types (1,2,4). The header and DC

FORMAT message will only be displayed if buffer 0 is requested.

- ll - log number to page to host
- ss - starting buffer offset into log (start at beginning of buffer ss)
- nn - number of buffers to display (end at end of buffer ss + nn)

example usage:

x36,0,1 - display log 36 starting at buffer 0, ending at the end of buffer 0 (display only buffer 0 starting at the first entry after the header, which is 1F0(h) bytes. Because it requests buffer 0 it will display the log header and the DC FORMAT message if it is not an ASCII log.

x36,16,32 - display log 36 starting at buffer 16, ending at the end of buffer 48. Because it does not request buffer 0, no header will be displayed, nor will DC FORMAT be displayed and it will send a full 6400(h) bytes (200 * 32)

#,,z

Enter HDA Serial Number.

The S/N may be up to 8 A/N characters long, left justified, and right padded with spaces until string length is 8 characters.

z must be 22h to change S/N.

\$

Enter PCBA Serial Number.

The S/N may be up to 12 A/N characters long, left justified, and right padded with spaces until string length is 12 characters.

[x,y

ASCII Log Control:

- x = 9 Record line to end of line until Enter is hit
- = A Enables ASCII logging
- = B Disables ASCII logging
- = C Write ASCII Log to log y
- = D Displays ASCII log
- = E Append to ASCII log
- = F,1 Enable hotkey logging
- = F Disable hotkey logging

LEVEL ONE COMMANDS: Memory Manipulation Commands

<u>Command</u>	<u>Description</u>
B _{x,y}	Buffer Display See /2 B for further detail.
D _{x,y,z}	Display Memory. Displays 256 bytes of memory starting at address xy. x - upper bits of >16 bit address y - lower 16 bits of >16 bit address or the 16 bit address z - high-light bytes matching this value.
F	Enable Forced Write Bit This command sets a R/W bit that force (allow) a write when the adaptives are not loaded. The bit will remain set until a load of the adaptives fails in which event it will be cleared. Use this to turn off error code 33.
M	Show Flash ROM Information Show Flash ROM Device Code, Manufacturer Code, User Default Algorithm Selector Word (ASW), and Fallback Default ASW. (Flash ROM implementations only.)
N _{x,y,z}	SMART Serial Port Control x - Level 1 N Subcommand = 00 - Toggle SMART on/off = 01 - Initializes the SMART statistics data, both in RAM and on the SMART system sectors of the disc. = 02 - Update SMART Attributes = 03 - Set/Clear Specified Pre-Failure Warranty Bit y - number of the Attribute to change z - new boolean value for the bit = 04 - Same as 01 - Initialize SMART = 05 - Dump SMART Attributes to Serial Port = 06 - Dump SMART Thresholds to Serial Port = 07 - Dump G-List to Serial Port = 08 - Dump Critical Event Log to Serial Port = 09 - Dump Pending List to Serial Port = 0B - Start Short DST after next Power-Up or ^T = 0C - Start Long DST after next Power-Up or ^T = 10 - Dump 2 hr log to Serial Port
P	Display PCBA Information Displays the PCBA information stored in the ROM

Level One (Continued)

Command	Description
S _{x,y,z}	<p>Edit Memory Byte.</p> <ul style="list-style-type: none"> x - upper bits of >16 bit address y - lower 16 bits of >16 bit address or the 16 bit address z - new data value to be inserted (low byte for U and S, word for m) <p>The uP will continue to read the memory byte and will update the display if the byte changes.</p> <p>After entering desired edit value, the following actions may be taken:</p> <ul style="list-style-type: none"> DEL - Re-edit same byte CR(^M) - Close out and exit LF(^J) - Edit the next sequential location
U _{x,y,z}	<p>Edit Buffer Byte.</p> <p>This is the same command as S except the Buffer Memory is edited.</p>
*** Y _x	<p>Converts desired cylinder number to gray code and display the result.</p> <p>>64k cyl compatible* (available only when overlay is valid) See /3 G for further detail.</p>
*** cx _{y,z}	<p>Compare Buffers (available only when overlay is valid)</p> <ul style="list-style-type: none"> x - Source buffer (default is first read buffer) y - Reference buffer to compare against (default is first write buffer) z - Number of buffers to compare (default is one)
dx	<p>Clear overlay code from disc (for automated use only).</p> <ul style="list-style-type: none"> x a bit field for clearing code modules (same as level T 'w') <ul style="list-style-type: none"> - if x is entered and = 1 then clear cert code only from the disc - if x is entered and = 2 then clear cert tables only from the disc - if x is entered and = 4 then clear application code only from the disc - if x is entered and = 8 then clear SeaDex script only from the disc - other values for x are treated as a bit field to select which of above to clear - if x is not entered then clear all four from disc
m _{x,y,z}	<p>Edit memory word. Operates same as level 1 'S' command, except operates on words.</p>
r	<p>Read cert code from disc.</p>
s	<p>Send Drive Information.</p>
t	<p>Read cert table from disc.</p>
u	<p>Read SeaDex script from disc.</p>
*** y _x	<p>Converts desired gray code to a cylinder number and displays the result.</p> <p>(available only when overlay is valid) See /3 g for further detail.</p>

* Will accept up to 8 digits for drives with >64k cylinders



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LEVEL TWO COMMANDS: Niwot Read/Write Commands

Command	Description
Bx,y	<p>Display Buffer</p> <ul style="list-style-type: none"> x - 512 byte buffer number y - buffer number for Data match. <p>If x is a read buffer and y is not entered, data matching the corresponding write buffer location is low-lighted; non matches are high-lighted.</p>
Cx,y,z	<p>Copy Buffers</p> <ul style="list-style-type: none"> x - Source buffer for the data. y - Destination buffer of the data. z - number of 512 byte buffers to copy (1 is default)
Ex,y,z	<p>Display/Edit Cert Log(s)</p> <ul style="list-style-type: none"> x <ul style="list-style-type: none"> - Log number to display. - If no entry, Display Active Log - if x = 0 Clear Active Log - if x <> 0 Display Log x y <ul style="list-style-type: none"> - Displays only log entries which have Error Code y. - If y = AA, enables Write in Special Log Controls z (if applicable). z <ul style="list-style-type: none"> - Special Log Controls: - z = 04 Show number of empty bytes at the end of the log x This does not display the log, it only prints the message "01234567 empty bytes in log x". The number of bytes is a hex value. - z = 08 Clear and insert ASCII characters from serial port into ASCII log. When CR is entered, save to Log x and close ASCII Log. Note: y must be AA - z = 10 Append characters from serial port to ASCII Log x. Close on receipt of CR. - z = 20 Write Active Log to Log x. Note: y must be AA - z = 40 Enable fast dump capability for data cataloger capture. Inhibits time delay between log dumps and enables fast, unformatted log dump. - z = 80 Display address of Log x (Formerly z = FF)
Fx,y,z,a	<p>Modify Track Defect List</p> <ul style="list-style-type: none"> a <ul style="list-style-type: none"> - parm 1 if entered is to be interpreted as physical sector, not logical sector F <ul style="list-style-type: none"> - Format Track Fx,,a <ul style="list-style-type: none"> - Format Sector x, set good sector flags, if a entered then format logical sector x, else format physical sector x. Fx,A,,a <ul style="list-style-type: none"> - Format Sector x, assigning an alternate for sector x, if a entered then format logical sector x, else format physical sector x. Fx,B,,a <ul style="list-style-type: none"> - Format Sector x, set Bad Sector flag for sector x, if a entered then format logical sector x, else format physical sector x. Fx,D,,a <ul style="list-style-type: none"> - Format Track with Sector x slipped, if a entered then format logical sector x, else format physical sector x. (USER TRACKS ONLY) Fx,E,,a <ul style="list-style-type: none"> - Format Track with Sector x slipped, if a entered then format logical sector x, else format physical sector x. (SYSTEM TRACKS ONLY) Fx,F,,a <ul style="list-style-type: none"> - Format Sector x, unassigning any existing alternate for Sector x, if a entered then format logical sector x, else format physical sector x. <p>*NOTE* -Sectors for F command(x) are logical sectors.</p>



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Gx,y,z,a,b,c

MRT Test (available only when overlay is valid)

This routine executes commands need to do the Manufacturing Reliability Testing (T61-63).

All reads and writes are executed with AT retries. If the command fails and is a read command then it is retried with full retries. If the sector in error can be read with full retries it is added to the active log. If slipping EC53's is enabled then the sector is added to the user slip list. If the error cannot be read with full retries the sector in error is added to the active log with error code from the read. If slipping EC43's is enabled then the sector is added to the user slip list. Write errors are not retried and added to list with error code from the write command. This command gives the option of doing a read or a write, doing a forever or one track at a time, and sequential or random mode. If sequential mode is selected then the count is passed in also. This command also offers the option to check the elapsed time since CTRLZ was issued, the option to check the number of defects dynamically slipped and set health if greater than the limit passed in, and the ability to do a spin down, wait for num seconds passed in, spin up, and wait again for num seconds. Flags can be passed in to slip EC43's, slip EC53's, set health for an EC43, and set health for an EC53. An error code 53 is defined as an error that can fails a read with AT level retries, but passes with full retries. An error code 43 is defined as a read that fails with both AT level retries and full retries.

- x - Read/write option bit
 - if bit 0 set (01) then do read
 - if bit 1 set (02) then do write
 - if bit 2 set (04) then do forever mode, else do one track at a time
 - if bit 3 set (08) then do random mode, else sequential mode
 - if both bit 2 and bit 3 are set then drive will do forever mode
 - default is bit 0,1 set, bit 2,3 clear (do sequential write/read)
- y - Dynamic slip flags
 - if bit 0 set (01) then slip soft errors, clear = don't slip soft errors
 - if bit 1 set (02) then slip hard errors, clear = don't slip hard errors
 - if bit 2 set (04) then set health for any soft error
 - if bit 3 set (08) then set health for any hard error
 - default is bit 0 and bit 1 set (slip hard and soft errors)
- z - Number of random writes/read desired in hexadecimal if one track mode selected in x. If not in one track mode then z = hexadecimal time in minutes to stop test at.
 - default is 8000 hex
- a - Elapsed time limit in hexadecimal minutes. If a is entered the routine will only check the elapsed time and set R2 = CERTTESTPASSEDCODE if time has expired, which will cause the test to exit, otherwise set R2 = 0. If in serial port mode you can use a batchfile *6 to exit the batch file when time has expired.
- b - Limit of errors of type c for the test. The routine will only check if the number of errors is greater than Parm 5 entered, the rwhlth will be set if limit is exceeded, and the routine will return. For example, if DiagParm5 = 6 then 6 defects will pass, 7 will fail
 - The number reported back will only be accurate if the slipping of EC43's or EC53's was enabled in previous MRT testing.
- c - The error code to check the limit for in b
 - default if b entered and c is not is to check for EC43.
 - If no parms are entered then do a single, random, 1 track read, slip 43's and 53's.

Level Two (Continued)

Command	Description
Hx	Select Head x - Physical Head to Select if x not entered, advance to next head
Ix,y,z	Display/Modify Adaptive Settings. See /7 I for further detail.
Jx,y	Scope Sync from Log. x - cert log number to take entries from - Default: use Active Log y - sync only on entries with this error code.
Kx,y	Set Tracking Offset x - signed, 16 bit integer in units of 265/band (band = 2/3 track). Default = 0. y - 0 = x is temporary offset and is cleared with next seek. Default = temporary. - 1 = x is persistent offset and is cleared on power cycle or servo cal.
Mx,y,z,w	Quick Margin Test. See /7 M for further detail.
Nx	Adaptive Test for all Heads in Specified Zone See /7 N for further detail.
Ox,y,z	Seek-Seek on current head: >64k cyl compatible* x - Cylinder to seek from/to. Default is MinCyl y - Cylinder to seek to/from. Default is MaxCyl z - Number of seeks to perform. Default: 1 seek-seek
Px,y,zzww	Set Buffer Pattern: x - Pattern to write into buffer. - Default pattern = random data - 1111 = incrementing pattern - 1212 = random pattern - 1313 = alternating pattern - 1414 = Isolated pulse pattern - 32 bits of Ones - 32 bits of Zeroes ELSE: Pattern bits 0-15 (as needed to support the pattern repeat length). y - Pattern bits 16-31 (as needed to support the pattern repeat length). z - Length (in bits) of repeat pattern on non-random data. Default = 20h (32d) w - Buffer number (no entry => entire Write Buffer)
Qx,y,,a	Write/Read/Read Data. x - Start sector number (default = logical sector 0) y - Number of sectors to transfer (limited to # sectors remaining on track). Default: Number of sectors remaining on track. a - if a entered then x is logical sector , else x is physical sector.

*** Will accept up to 8 digits for drives with >64k cylinders**



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Command Description

Rx,y,z,a

Read Data.

- x - Start sector number (default = logical sector 0)
- y - Number of sectors to read . Default: Number of user sectors on this track.
- z - Enable Dynamic Sparing if entered. Default: Dynamic Sparing disabled.
 Dynamic sparing can only be invoked if drive has interface code active and if the diagnostic monitor has been entered by doing a control Z or a control R from the interface. If active the read command does the read as normal, but with retries set to AT defaults (9F75.23.40). If an error is encountered during the read command then AT dynamic sparing code is invoked and the return condition is logged in certification log 6C as well as the active error log. The AT dynamic sparing code retries the command with full retries, and if it fails it is logged as the error code it failed with. If the command passes with full retries then the AT code does a mini certification on the sector in question. If the mini cert passes then the error is logged as a questionable error (4A) and no further action is taken. If the mini cert fails then the sector is altered and logged as a dynamic spare (4D).
- a - if a entered then x is logical sector , else x is physical sector.

Sx,y,z

Seek Cyl/Head.

- x - Cylinder number **>64k cyl compatible***
- y - Desired destination head. If the most significant bit is set, the command will seek to the physical cylinder number specified in the first parameter; else, the seek will be to the logical cylinder
- z - Track follow offset. Signed 16 bit integer

*** **T**x,y,z

Measure Throughput. (available only when overlay is valid)

x Throughput flag

X Bit #	Bit Meanings:	
	If = 1	If = 0
15	Write transfer rate	Read transfer rate
14	Full pack	(else)
13	All zones	Single zone
12-0	Zone number	

- y - Bits 15-8 minimum cylinder skew
 - Bits 7-0 minimum head skew
 Default: CYL_SKEW and HEAD_SKEW from system.inc
- z - Bits 15-8 maximum cylinder skew
 - Bits 7-0 maximum head skew
 Default: CYL_SKEW and HEAD_SKEW from system.inc

*** Will accept up to 8 digits for drives with >64k cylinders**

Command	Description
U_{x,y}	Spin-Up <ul style="list-style-type: none"> x - spin up options flag - not entered: Normal spin-up until drive ready - 0 spin up with no hold states - 1 advance hold state - 2 release all hold states - 3 hold in warm up state - 4 hold in buzz state - 5 hold in pre-lock state - 6 hold in lock state - all others = no hold state change y - Head number to use to go active.
*** V_{x,y,z}	Read/Compare against corresponding write buffer. (available only when overlay is valid) <ul style="list-style-type: none"> x - Starting sector on each track (default 00) y - Number of sectors to read (default is number remaining on track). z - Buffer to compare data against. Default: first Write Buffer. NOTE: If y > 10 or not entered only last 10 sectors read are compared with data in corresponding write buffers.
W_{x,y,z,a}	Write Data. <ul style="list-style-type: none"> x - Starting sector on each track (default is logical sector 0) y - Number of sectors to write (default is number of user sectors on this track) z - Enable Dynamic Sparing if entered. Default: Dynamic Sparing disabled. Dynamic sparing can only be invoked if drive has interface code active and if the diagnostic monitor has been entered by doing a control Z or a control R from the interface. If active the read command does the read as normal, but with retries set to AT defaults (9F75.23.40). If an error is encountered during the read command then AT dynamic sparing code is invoked and the return condition is logged in certification log 6C as well as the active error log. The AT dynamic sparing code retries the command with full retries, and if it fails it is logged as the error code it failed with. If the command passes with full retries then the AT code does a mini certification on the sector in question. If the mini cert passes then the error is logged as a questionable error (4A) and no further action is taken. If the mini cert fails then the sector is altd and logged as a dynamic spare (4D). a - if a entered then x is logical sector , else x is physical sector.
*** X_{x,y,z}	Display Data IDs on current track. (available only when overlay is valid) >64k cyl compatible* <ul style="list-style-type: none"> x - Physical Cylinder address. Default: Current physical cylinder. y - Physical Head address. Default: Current Physical head. z - Logical sector to display ID from. Default: Entire track's headers.

*** Will accept up to 8 digits for drives with >64k cylinders**



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Command Description

Yx,y,zzaa,b Show/Set Retry Controls
 x (not entered) - Show current settings

Bit # (if 1)	Meaning	Bit # (if 1)	Meaning
15	Erasure Pointer Retry Enable	7	MR Bias Retry Enable
14	Thermal Asperity Retry Enable	6	Boost Retry Enable
13	PLL Bandwidth Adjust Enable	5	Servo Threshold Retry Enable
12	Offtrack Read Retry Enable	4	Runout Comp Recal Enable
11	Early Read Retry Enable	3	Max ECC Retry Enable
10	Head Sw/Seek Away Enable	2	ECC Level Control Bit 2
9	Channel Reload Retry Enable	1	ECC Level Control Bit 1
8	VCO Recal Retry Enable	0	ECC Level Control Bit 0

y - data retry count
 zz - ID retry count (updated only when not 0)
 aa - write retry count
 b -if entered then set retries to AT level retries
 NOTE - if b is entered it overrides x,y,z,a

Z Spin-Down.

***** cx,y,z** Compare Buffers (available only when overlay is valid)

x - Source buffer (default is first read buffer)
 y - Reference buffer to compare against (default is first write buffer)
 z - Number of buffers to compare (default is 1)

***** dx,y,z,a** Re-assign Errors from Log. (available only when overlay is valid)

x -if entered don't display messages to screen, else display messages
 y -if entered assign from display log, else from active log
 z -Hit Count Minimum for reassign (default is 3)
 a -if entered slip error code 50's, else don't slip 50's

***** ex,y** Save Log to Cert Log y. (available only when overlay is valid)

x - Source Log type: 1 = ASCII log, 2 = Active Log (data sector format),
 4 = Active log (byte offset format)

NOTE: since display log and active log share same buffer space the display log can be saved to log y if it was read into the buffer with the previous command. The following keystrokes would read log 30 and save it to log 60.

/2
 2>E30
 2>e2,60

y - Destination Cert Log number

***** fx,y,z** Wedge Defect Map Current Track (available only when overlay is valid)

x - if entered
 x = 1 to do wedge read only
 x = 0 to do wedge write only
 y -loop count (default is 1)
 z -if entered then use current pattern, else use 4T pattern



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Level Two (Continued)

Command	Description
*** gx,y	Slip Servo Wedge (available only when overlay is valid) x - servo wedge to slip y - # of servo wedges to slip
*** hx	Translate Physical sector to Logical sector. (available only when overlay is valid) x - Physical sector number of current track to translate to Logical sector number.
*** ix,y	Show Track Defect List in Active Log . (available only when overlay is valid) >64k cyl compatible* x - Logical Cylinder Address. Default: Current logical cylinder. y - Physical Head address. Default: Current Physical head.
*** j,y	Read Wedge (available only when overlay is valid) >64k cyl compatible* y - if entered, read only one track, else read all tracks sequentially. - if not entered, wedge read whole pack, scanning for servo errors, applying Zap and skipping cylinders as required.
*** lx	Translate Logical sector to Physical sector. (available only when overlay is valid) x - Logical sector number of current track to translate to Physical sector number.

* Will accept up to 8 digits for drives with >64k cylinders



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For Internal Use Only

Command

Description

px

Full Pack Read Or Write (available only when overlay is valid)

Read or Write entire pack using infinite read/write with option for display BER by zone, and / or throughput profile. If throughput profile is enabled, that profile can optionally be evaluated to predict whether or not the drive will pass Apple Computer's "Blue Nun" test.

x Mode flags

x Bit #	Bit Meanings:	
	If = 1	If = 0
6	If write error, then retry with full retries. Set health only if hard error repeats and bit 4 is set.	If write error, then log it and set health if bit 4 is set.
5	Predict if drive will fail Apple Computer's "Blue Nun" test. This bit is only valid if throughput profiling (bit 1) is enabled. Throughput degradation and disk failure Blue Nun case defined as 5 or more regions within 10 ¹⁰ bits which exhibit throughput degradation of 20% or greater.	Do not evaluate Blue Nun criteria
4	Set health 2000 if any hard error	Do not set health bits for hard errors
3	After full pack read or write is complete, display a log of all hard errors.	Do not show log of hard errors after command complete (errors will still be present in the active log, they just won't be displayed automatically).
2	Write the pack	Read the pack
1	Show throughput profile for drive. The drive is divided into approximately 1000 regions. At the end of reading or writing each region, the number of revs taken to write/read that region is compared against a prediction. If the number of revs exceeds the prediction, a line of data is output with the starting track of the region, end track, number of extra revs taken, and the percentage degradation. This throughput drop represents a Blue Nun failure. If Blue Nun evaluation is enabled (bit 5), then an asterisk (*) will be displayed at the end of any line representing a Blue Nun failure.	Do not show the throughput profile of the drive.
0	At conclusion of the full pack read or write, display the BER statistics for each zone. (See appendix « Statistics Display Description »)	Do not show zone BER statistics

rx,y,z,a

Read Long from current track

- x - Sector to read (including ECC Syndrome bytes)
 - y - if x not entered then y is sector to read on the current track.
**This is the only command that will allow specific track reads in the system area of drive.
 - z - if y is entered then z is the number of sectors to READ on the current track
 - a - if a is entered and x is entered then x is logical sector, else x is physical sector (USER TRACKS ONLY).
- To read a system track the format is r,x,y where x is the sector to read and y is the length (physical sector = logical sector on system tracks).
- To read long a user track the format is rx,,,a where x is the sector to read, if a is entered then x is physical sector, else x is logical sector.



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Level Two (Continued)

Command	Description
sx,y,z	Seek to Physical Cyl/Head. >64k cyl compatible* x - Physical Cylinder number y - Physical head. z - Track follow offset. Signed 16 bit integer
*** tc,hhss,o	Translate Physical Cylinder, Servo Sector, Byte offset to LPL (available only when overlay is valid) >64k cyl compatible* c - Physical Cylinder number hh - Physical Head ss - Servo Sector oooo - Byte offset from ServoSector
ux,y,z	Enable display of channel and preamp registers during retry. >Under Flag in code. For debug only. x - beginning retry to display regs. - 0 or not entered disable display y - ending retry to display regs - 0 or not entered only display for beginning retry. z - Display registers after Untweak retries. - 0 or not entered no display after Untweak.
wx	Write Long to current track x - Sector to write (including ECC Syndrome bytes) y - if x not entered then y is sector to write on the current track. This is the only command that will allow specific track writes in the system area of drive. NOTE: use of this command with this parameter could render drive inoperable z - if y is entered then z is the number of sectors to write on the current track a - if a is entered and x is entered then x is logical sector , else x is physical sector (USER TRACKS ONLY). To write a system track the format is w,x,y where x is the sector to write and y is the length (physical sector = logical sector on system tracks). To write long a user track the format is wx,,,a where x is the sector to write, if a is entered then x is physical sector, else x is logical sector.

*** Will accept up to 8 digits for drives with >64k cylinders**



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For Internal Use Only

Command

Description

x

Show Zone Boundaries and system cylinders as well as the last LBA of the drive output formatted as follows:

ZoneX: start cyl – end cyl sectors per track(decimal) NRZ data rate

Example

```
Zone 0: 0006 - 0B4F 800 389.020
Zone 1: 0B50 - 161B 785 382.415
Zone 2: 161C - 25B5 768 367.059
Zone 3: 25B6 - 314F 729 355.294
Zone 4: 3150 - 3B07 704 342.588
Zone 5: 3B08 - 4622 672 325.378
Zone 6: 4623 - 4F15 640 311.634
Zone 7: 4F16 - 55ED 614 301.176
Zone 8: 55EE - 5AD9 595 292.318
Zone 9: 5ADA - 6272 576 276.706
Zone A: 6273 - 6965 537 265.412
Zone B: 6966 - 6FBC 512 251.641
Zone C: 6FBD - 72C8 493 244.706
Sys= 42FD-4323 02C3 SPTK on sys trks
Total LBAs = 0130216B
```

Output format for drives with >64k cylinders:

```
Zone 00: 00018 00BE8 1100 (044C) 683.439
Zone 01: 00BE9 027FE 1056 (0420) 666.63
Zone 02: 027FF 04707 1026 (0402) 646.275
Zone 03: 04708 06CA3 990 (03DE) 622.431
Zone 04: 06CA4 08B66 953 (03B9) 602.353
Zone 05: 08B67 0A479 916 (0394) 580.392
Zone 06: 0A47A 0C405 880 (0370) 545.882
Zone 07: 0C406 0D99A 836 (0344) 527.59
Zone 08: 0D99B 0ECD9 806 (0326) 506.144
Zone 09: 0ECDA 10337 770 (0302) 480.724
Zone 0A: 10338 11397 733 (02DD) 461.672
Zone 0B: 11398 12854 691 (02B3) 437.423
Zone 0C: 12855 13F38 660 (0294) 410.353
Zone 0D: 13F39 14AE7 623 (026F) 396.401
Zone 0E: 14AE8 155D6 605 (025D) 383.316
Zone 0F: 155D7 16358 572 (023C) 363.922
Sys= 0F68E-0F70D 0280 SPTK on sys trks
Total LBAs = 04A96402
```

yx,z

Set Direct Write Mode

- x - Ignore track IDs
- z - Ignore 16/17 encoder

No Params to re-enable track Ids and 16/17 encoder

***** z,y**

Write Wedge

(available only when overlay is valid) **>64k cyl compatible***

- y - if entered, write only one track, else read all tracks sequentially.
- if not entered, wedge write whole pack, scanning for servo errors, applying Zap and skipping cylinders as required.



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For Internal Use Only

*** Will accept up to 8 digits for drives with >64k cylinders**



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LEVEL THREE COMMANDS: Servo Seeking Commands

Command	Description
Cx,y	Acceleration Constant Measurement Test >64k cyl compatible* x - ID cylinder limit for test <i>Note: x > y</i> y - OD cylinder limit for test
Dx,y,z,a,b,c	Seek Access Times >64k cyl compatible* x - If set and != 0, specifies length of seek to perform If set and 0, do random access test. y - If set, do write (slow) settles, else do read (fast) settles, If set, specifies loop count (number of seeks to perform), else default loop count is used. a - If set, do random access test on all heads. b - If set, do the seek length tests on head 0 only. c - If set, record and display a histogram for each seek length test that Shows distribution of the number of servo bursts needed for each seek.
Ex,y,z	Display/Edit Certification Test Log(s) See /2 E for further detail.
*** Gx	Translate Hex Cylinder to Gray Code (available only when overlay is valid) x - Cylinder number to translate to Gray
Hx	Head Select x - head to select
*** Jx	Head Switch Offsets (available only when overlay is valid) >64k cyl compatible* x - Desired Logical Cylinder (available only when overlay is valid).
*** Mx,y	Actuator Open-loop Move (available only when overlay is valid) x - DAC output value y - DAC control value (Drive specific)
Ox,y,z	Seek-Seek on current head: See /2 O for further detail.
Px,y,z	Position Error Display x - 1 Do continuous loop - 8 Switch head ¼ the way through the display y - Desired disturbance level z - Desired starting servo burst number (from Index)

*** Will accept up to 8 digits for drives with >64k cylinders**



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Level Three (Continued)

Command	Description
Qxx,yy	Certification Write/Read. xx - Start sector # on each track Default: Sector 000 y - Number of sectors to transfer (limited to # sectors remaining on track). Default: Remainder of track
*** Rx,y,z	Read Grey Code (available only when overlay is valid) x = 0: Read one burst <0: Read full track y - Desired logical cylinder number (Default: current cylinder) z - Burst Number (Default: Burst 00)
Sx,y,z	Seek Cyl/Head. >64k cyl compatible* See /2 S for further detail.
T	Servo Transducer Calibrations
Ux	Spin-Up See /2 U for further detail.
Vx,y,z	Read GC123 registers (available only when overlay is valid) x = register number to read or write y = value to write (needed only on writes) z = 1 (key needed only on writes)
*** W	Read physical Grey Code (available only when overlay is valid)
*** Y	Hysteresis (available only when overlay is valid) Performs Hysteresis test across the entire pack and displays the results graphically. In addition the inward seek integrator value is plotted. * = Hysteresis value o = -Integrator value x = +Integrator value Note: Integrator values are scaled , /4 .
Z	Spin-Down
*** c	Test Air Latch Closed (available only when overlay is valid) Tests the air latch is closing properly when the drive is spinning down,.
*** gx	Translate Gray to Hex (available only when overlay is valid) x - Gray code value to translate to Cylinder number

* Will accept up to 8 digits for drives with >64k cylinders



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Command	Description
j x,y,z	<p>Ramp Test. (Ramp Load drives only – currently Saturn)</p> <p>Performs <i>r</i> ramp load/unload operations. After each load operation, the unload current and VBEMF calibration time are displayed. The unload current is in units of mA, while the VBEMF calibration time is in units of approximately 700µS. At the conclusion of <i>r</i> load/unload operations, a table is displayed showing the minimum, maximum, and average values of the unload current and VBEMF calibration time.</p> <p>x - Number of times to repeat ramp load/unload y - Time, in milliseconds, to delay after each ramp operation (default = 2000mS) z - 0 = Show results non-0 = Suppress results (nothing displayed)</p>
k	Measure Head Position
*** m	<p>Servo Actuator Geometry Test for MDW (available only when overlay is valid)</p> <p>Compares the Actuator Sweep Geometry between the MDW writer actuator arm and the actuator arm in the hard drive.</p>
*** o	<p>Test Air Latch Open (available only when overlay is valid)</p> <p>Tests the air latch is opening properly when the drive is spinning at 87hz.</p>
*** px,y	<p>Translate Physical sector to Logical sector. (available only when overlay is valid)</p> <p>See /2 h for further detail.</p>
*** qx,y	<p>Translate Logical sector to Physical sector. (available only when overlay is valid)</p> <p>See /2 l for further detail.</p>
s x,y,z	<p>Seek to Physical Cyl/Head.</p> <p>>64k cyl compatible*</p> <p>x - Cylinder number y - Desired destination head. If the most significant bit is set, the command will seek to the physical cylinder number specified in the first parameter; else, the seek will be to the logical cylinder z - Track follow offset. Signed 16 bit integer</p>

*** Will accept up to 8 digits for drives with >64k cylinders**

LEVEL FOUR COMMANDS: Servo Tracking Commands

Command	Description
C xyy,z,a,b	<p>Tracking Test. (available only when overlay is valid)</p> <p>Checks the current track for missing sector marks, bad gray codes, position errors greater than the test threshold, and position errors greater than the write threshold.</p> <p>Default for Level 4 'C' command without sending any parameters is to perform the Pre ZAP Scan followed by RRO ZAP followed by Post ZAP Scan on the current track.</p> <ul style="list-style-type: none">x - Digital servo threshold (always 0 for Napa)y - Test threshold setting if non-zeroz - Position settle delay, if non-zeroa - If Valid,<ul style="list-style-type: none">- Bits 15-8 - Loop count for each track- Bit 7 - Run Post ZAP Scan.- Bit 6 - Run Read Position Scan.- Bits 0-5 - Zap enable flag (if non-zero)b - Parm4, if sent overrides Parm3 control bits<ul style="list-style-type: none">- If bit 0 (1) is set - Run Pre ZAP Scan as called in cert.- If bit 1 (2) is set - Run RROZAP test as called in cert.- If bit 2 (4) is set - Run Post ZAP Scan as called in cert- If bit 3 (8) is set - Run Read Position Scan as called in cert.- If bit 7 (80) is set - Display ZapTable after running command.
D x,y,z,a,b,c	<p>Seek Access Times</p> <p>>64k cyl compatible*</p> <ul style="list-style-type: none">x - If set and != 0, specifies length of seek to perform If set and 0, do random access test.y - If set, do write (slow) settles, else do read (fast) settlesz - If set, specifies loop count (number of seeks to perform), else default loop count is used.a - If set, do random access test on all heads.b - If set, do the seek length tests on head 0 only.c - If set, record and display a histogram for each seek length test that Shows distribution of the number of servo bursts needed for each seek.
E x,y,z	<p>Display Active Log.</p> <p>See /2 E for further detail.</p>
*** G x	<p>Set Tracking/Seek Gain (available only when overlay is valid)</p> <ul style="list-style-type: none">x - Tracking gain value to set (default is to display current gain).
H x	<p>Select Head x</p>
*** I x,y,z	<p>Head Stability Test for Heads (default is All Heads) (available only when overlay is valid)</p> <p>>64k cyl compatible*</p> <ul style="list-style-type: none">x - disturbance in DAC bits (default 40h)y - Test Cylinder (default is first user cyl)z - The Gain increment (default = 666h) <p>Display is the average of 160d iterations</p>

*** Will accept up to 8 digits for drives with >64k cylinders**



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For Internal Use Only

Level Four (Continued)

Command	Description
Kx	Servo Offset See /2 K for further detail.
*** Mx,y	Actuator Open-loop Move (available only when overlay is valid) x - DAC output value y - DAC control value (Drive specific)
Nx	Napa Servo Adaptive Test for all Heads in Specified Zone x - Zone in which to perform the test
O	Show MR Head Offset (for current head).
Px,y,z	Position Error Display for current track. See /3 P for further detail.
Sx,y,z	Seek Cyl/Head >64k cyl compatible* See /2 S for further detail.
Tx,y,z	Napa Servo Adaptive Test at the Specified Track x - Zone number y - Head number z - Logical Cylinder number No default parameters, the user must pass the zone, head, and cylinder numbers.
*** W	Read physical Grey Code (available only when overlay is valid)
Xx	Display 1 rev of servo burst information for current track x ---starting sector, default is 0 Sctr xx display format: xxxxx A xxxx B xxxx C xxxx D xxxx Xpred xx Xabs xx (*) Sctr --- serco sector Pfr --- prefix Gry --- grey code A --- the sum of amplitude of servo burst A (same for B, C and D) Xpred --- predicted (expected) read head position Xabs --- absolute (actual) read head position * --- if there is an *, use predicted position to compensate.
*** Zx	Zap Servo Burst x of the current track. (available only when overlay is valid)
*** a	Slip error code 90's from the log (available only when overlay is valid) Scan the active buffer for error code 90's and slip all data sectors that fall within the servo burst with the error or within the servo burst after the one with the 90. An error code 8A will replace the 90 in the log to show the wedge data sectors were slipped. An error code 50 will be added to the log for every data sector that is slipped.

*** Will accept up to 8 digits for drives with >64k cylinders**



COMPANY CONFIDENTIAL

For Internal Use Only

Level Four (Continued)

Command	Description
*** cx	<p>Track 0 Cal for MDW (available only when overlay is valid)</p> <p>Calibrate and display the Grey Code Cylinder for Physical Cylinder 0 on all available heads. The Grey Code values are stored in the MDW Radial Offset Table and displayed in hex.</p> <ul style="list-style-type: none"> - x = 0 (default) to calibrate the drive. Automatically detects MDW/HDW drive. - x = 1 to display the MDW Radial Offset Table without calibrating the drive. - x = 2 Sets drive type to MDW. - x = 3 Sets drive type to HDW.
dx	<p>Disable/Enable servo from using the ZAP coefficients in the ZAP table.</p> <p>x - 1 to disable engine - no parameters to enable engine</p>
*** f	<p>Fill Skipped Cylinders (NOT IMPLEMENTED) (available only when overlay is valid)</p>
ix	<p>Enable/disable ZAP reads (available only when overlay is valid)</p> <p>x - 1 to disable ZAP reads - no parameter to enable ZAP reads</p>
j,x	<p>Adaptive Coherent Feedforward Compensator (ACFC) calibration (MDW only)</p> <p>x=1 : Enables ACFC for corrections previously stored in RAM x=2 : Performs a single track ACFC cal x=3 : Performs a single zone ACFC cal x=4 : Performs a drive ACFC cal x=5 : Displays current ACFC correction values (ACFC_TBL) x=6 : Performs a single track ACFC iterative cal x=7 : Performs a single zone ACFC iterative cal x=8 : Performs a drive ACFC iterative cal x=9 : Clears the local ACFC table in fast RAM</p>
k	<p>Skip MDW serial number cylinders (available only when overlay is valid) (MDW only)</p> <p>Skip the cylinders containing over-sampled MDW media serial number tracks plus 3 guard tracks on each side. On MDW drives, each head will have 2 s/n tracks at a unique physical location (this location is product specific, and is hard-coded into the firmware). Adding 3 guard tracks on each side means a total of 8 cylinders will be skipped for each head.</p>
lxx	<p>Will scan the current position for servo defects and zap the track. xx - if entered will do the read position, otherwise write position is scanned.</p>
*** m	<p>RRO ZAP System cylinders (available only when overlay is valid)</p>
ny,,x	<p>Calculate the zap coefficients at the current position. Can only be run if reading of zap fields are disabled. Calculates the ZAP values for the current track and writes the values to the ID field.</p> <p>y - 1 - will write the learned coefficients in the write position 2 - not write the zap IDs not entered, will write the read position zap coefficients.</p>
x	<p>- displays the ZAP values if entered</p>



For Internal Use Only

Level Four (Continued)

Command	Description
px,y,z	<p>Display Spin Error</p> <p>x -</p> <p>Bit 3 2 1 0</p> <p>. . . +----- 1 = loop, 0 = no loop</p> <p>. . +----- 1 = trap threshold violation</p> <p>. +----- 1 = Measure spin error per burst; 0 = spin error per revolution</p> <p>+----- 1 = Spin speed step to normal</p> <p>y - Spin threshold (0.1% increments)</p> <p>z - Speed Offset (0.1% increments) (if spin speed step is enabled)</p>
*** qx	<p>Change Spin Speed (available only when overlay is valid)</p> <p>x - Speed Offset (0.1% increments)</p>
rx	<p>Reads and displays the specific Track ID contents.</p> <p>x - the sector number to read. (If no parameter is entered, it will read and display all track Ids of the current track.)</p>
***sx,y,z	<p>Show error count for given log (available only when overlay is valid)</p> <p>This test will read the log x in to the active buffer. It reads all error codes in buffer and stores each UNIQUE error code on the stack. For each error codes of the stack, it will scan through the active buffer and display the counts for the error codes on each head.</p> <p>x - the log to show error count for</p> <p>y - first zone to show error count for (default is 0)</p> <p>z - last zone to show error count for (default is last)</p>
tx,y	<p>Modifies and views the ZAP RAM table</p> <p>x - the table entry to modify; an FFFF means modify all values</p> <p>y - the value to use</p> <p>If no parms entered it will display the ZAP table</p>
vx,y,z,a	<p>ButterFlySeekTest</p> <p>Do a butterfly seek starting at OD and ID cylinders.</p> <p>x - if entered, used as OD start cylinder.</p> <p>y - if entered, used as ID start cylinder.</p> <p>z - test duration,</p> <p>a - if entered, then 'z' value is the test duration in seconds. If not entered, then 'z' value is the test duration in number of seeks to perform.</p>
wx	<p>Writes the ZAP values in the ZAP RAM table to the Track Ids of the current track.</p> <p>x - entered, the write position ZAP values (odd bursts) will be written.</p> <p>- not entered, the read position ZAP values (even bursts) will be written.</p>

*** Will accept up to 8 digits for drives with >64k cylinders**



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Level Four (Continued)

Command	Description
xc,,z	Skip Cylinder >64k cyl compatible* c - Cylinder to skip z - if z = 22h then skip cylinder - if z <> 22 then ignore this command.
y	Show Skipped Cylinders
zc,,z	Unskip Skipped Cylinder(s) >64k cyl compatible* c - Cylinder to unskip - ffffh unskip all skipped cylinders (ffffffh for drives with >64k cylinders) - (default) display skip cylinder list z - if z = 22h then unskip cylinders - if z <> 22 then ignore this command.

*** Will accept up to 8 digits for drives with >64k cylinders**



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LEVEL SIX COMMANDS: Batch File Commands

See also the common commands *, @, and |. These commands define the batch file flow control.

<u>Command</u>	<u>Description</u>
Bx	Run Batch File x - Batch file number 0 through 2, default = batch 0
Dx	List Batch File x - Batch file number 0 through 2, default = batch 0
Ex	Enter Batch File x - Batch file number 0 through 2, default = batch 0
*	Special Function for batch file: *1 Pause batch file execution until input *2,x Delay x milliseconds *3,x Branch to Label x *4,x Increment head and branch to Label x *5 Clear monitor screen *6 Stop on error *7,x Load batch loop counter with x. *8,x Decrement batch loop counter, Branch to Label x if not 0.
@x	Batch File Label. During batch file entry, define this location as Label x. x - Single digit numeric label specification.
 	Batch file terminator Terminates the entry of batch files.

***Note: For commands Bx, Dx, and Ex above, if x is greater than 2, batch #0 will be used.**



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LEVEL SEVEN COMMANDS: Read Channel Adaptive Commands

These commands provide tools for determining and modifying the read/write channel adaptive parameters.

Command	Description
Bx,y	Display Buffer See /2 B for further detail.
Cx,y,z	Copy Buffers See /2 C for further detail.
Dx	Display Temperature Diode Values displays YYZZ where YY = temp diode reading at cert time ZZ = current temperature x if entered forces cert temperature to equal current temperature. This makes drive think it is currently at cert temperature. 7>D TempDiode 3456 7> D1 TempDiode 5656
Ex,y	Display Log(s) See /2 E for further detail.
Fx,y	Format Sector/Track See /2 F for further detail.
Gx,y,z	Toggle ECC Seed Finder tool x = Seed Cylinder number (default = current setting) y = Seed Head (default = current setting) z = Seed Sector (default = current setting)
Hx	Select Head x
Ix,y,z,a	Display/Modify Adaptive Settings for the Current Head (no parameters) - Display current head's adaptive values x = zone number if x = the number of zones then modify all zones y = parameter number to modify a = 1, display adapties and FIR taps a = 2, display FIR taps
Mx,y,z	Napa Single Adaptive Parameter Test x - Napa Parameter (Index number displayed with 7>I command) y - Parameter Lower Limit (Defaults to parameter lower limit defined in the code) z - Parameter Upper Limit (Defaults to parameter upper limit defined in the code) Runs the individual Napa data adaptives at the current zone, head, and cylinder. The lower and upper limit parameters will default to the drives, if none are passed. ASSUMPTIONS: The current track has been written with the desired pattern with 7>M0 command. MR reader/write offset has been calibrated for this zone and the next.



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For Internal Use Only

Level Seven (Continued)

Command Description

Valid Napa Parameters are:

- 0 Napa Test Track writes and reads the current track and displays QM count.
- 1 MR read bias
- 2 Write Pre-compensation
- 3 Filter (CTTFR)
- 4 Boost (ZFR)
- 5 Tap Delta (TDTARGR)
- 6 Write Current
- 7 MR Asymmetry
- 8 MR reader/writer OD offset
- 9 MR reader/writer ID offset
- A Napa Attenuation
- B Reserved
- C Read gain (VGAR)
- D Reserved
- E Reserved
- F Reserved
- 10 Calibrate Noise Level (DTHR) to QM count. QM Count = 0 turns off noise.

Nx Napa Data Adaptive Test for all Heads in Specified Zone

- x - Zone in which to perform the test

Oh,z,s Read/Write Coarse Offset Calibration

- h - Head number (default = head 0)
- z - Zone number (default = all)
if z is not entered then calibration is done for all the zones
- s - if entered, suppress display of both tab values

Best offset value is updated in RAM.

Example 1:

```
7>00,1,1 ( Test head 0, zone 1, simplified form )
Zone 1
[0DCA.0,FDC0,FF6A,1c, 3] -->Min=023C (FE47) BL=7FFF BR=7FFF Range=0000 Pick=FE47
[0DCA.0,FDC0,FF6A, 1, 3] -->Min=000C (FE41) BL=FE23 BR=FE59 Range=0037 Pick=FE3E
```

This means that it ran the offset cal in zone 1 head 0. It ran the test at 0DCA.0, and it tested the offset range from 0xFDC0 – 0xFF6A. It read 0x1C revs at the track. It also incremented the offsets by 3 each tick. I.e. it tested offset 0xFDC0, then 0xFDC3, 0xFDC6 etc... The results are, in the first test, it got a Min of 0x23C at location 0xFE47. There was not bathtub curve (got a 0x7FFF for bath tub left, and bathtub right). Since there was no bath tub curve, the range is 0. The pick would be then the position where the min occurred as there is no bathtub curve.

As there was no bathtub curve, a retry was initiated, but with a lower read count. As you can see on the second line, we are testing the exact same parameters, except we are reading 1 rev instead of 0x1c revs. With that we have a bath tub curve, ranging from 0xFE23 to 0xFE59, hence giving us a range of 0037. We pick the center of the bathtub giving us a 0xFE3E.



For Internal Use Only

Level Seven (Continued)

Command Description

Z Spin Down Command

ax,y,z MR Bias Backoff.

- x - The number of times to read the test track (default = 30h)
 - y - "Goodness" threshold for each setting. The sector error count after *x* reads must be below this for a setting to be considered "good" (default = 20h).
 - z - Number of settings to attempt backoff (default = 4).
- This routine attempts to find a lower setting for MR Bias by testing sector error rate at various settings of MR Bias. The test is performed at track <Zone 0 ID - 10h>. This track is written with a zero pattern (randomizer on) and then read back several times at each candidate setting of MR Bias. The candidate settings are from <Current MR Bias - z> to <Current MR Bias>. Note: the lowest setting will not drop below 2. Every setting that produces a sector error count lower than *y* is considered part of the "good range". Once all settings have been tried, the middle setting in the "good" range is chosen (round-off will be in the direction of higher MR Bias). If no settings yielded a "good" error rate then the original MR Bias value will be kept.

bx,y PE and OTC measurements

- x - Number of steps +1 to take across the track width (default = 20hex)
- y - Flag, if a 1 is entered, test at current track
- If flag not entered, test at id of zone 0

PE data are taken first, then OTC.

Example #1

```
7>bC
Num Steps = 000C
07FF 07FF 0004 0000 0000 0003 0170 07FF 07FF 07FF 07FF 07FF 07FF

Min Pos  BL  BR   Rng Pick
0000 0028 0014 0032 001F 0023

07FF 00DF 0001 0000 0000 000A 00CA 07FF 07FF 07FF 07FF 07FF 07FF

Min Pos  BL  BR   Rng Pick
0000 0028 0014 0032 001F 0023
```

Example #2

```
7>S3C25
7>H0 (Head 0)
7>b,1
Num Steps = 0020
07FF 07FF 07FF 07FF 07FF 07FF 0005 0000 0000 0000 0000 0000 0000 0000 0000
0005 013A 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF
07FF

Min Pos  BL  BR   Rng Pick
0000 003C 0018 0040 0029 002C
07FF 07FF 07FF 07FF 07FF 00EC 0002 0000 0000 0000 0000 0000 0000 0000 0000
0004 00E0 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF 07FF
07FF

Min Pos  BL  BR   Rng Pick
0000 003C 0018 0040 0029 002C

7>Pgm=00 Trk=3C26(3C26).0.106 Zn=9 Err=00 ErCt=0000 Hlth=1000 CHlth=0000 Ready
```



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Level Seven (Continued)

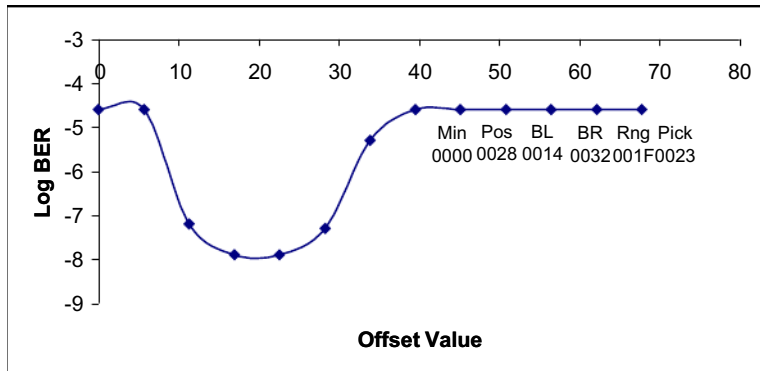
Min = Minimum error count
 Pos = Position of minimum error count
 BL = Position of left side of bathtub curve intersecting 1^{e-6} log bit error rate
 BR = Position of right side of bathtub curve intersecting 1^{e-6} log bit error rate
 Rng = Number of steps between BL and BR
 Pick = Error rate based read offset pick

Calculating PE and OTC from Rng: Durango conditions
 One full track width = 60.9uin. = 384 DAC settings
 Read offset ranges from 0 to 80h values represent range of 464 DAC settings
 Read offset range = $464/384 = 1.21 * 60.9uin. = 73.5uin.$
 80h range = 128 settings $73.5uin./128$ settings = .57uin. per step
 Rng = $0029h = 41 * .57uin. = 23.3uin.$

Calculating error rate from non-zero byte count: Durango zone 0 id conditions
 Each offset range setting is read 25h times
 75% of the track is read in non-zero byte count
 NRZ = 323.7Mb/s 1 revolution = 8.33^{e-3} seconds $((323.7^{e6} * 8.33^{e-3}) * .75) * 37 = 74.8^{e6}$ bits read/setting

From example #1

Offset value	00	0C	13	1D	27	31	3B	45	4F	59	63	6D	76
Offset distance (uin.)	0.0	5.7	11.3	17.0	22.6	28.3	33.9	39.6	45.2	50.9	56.5	62.2	67.8
Non-zero bytes (h)	07FF	07FF	4	0	0	3	170	07FF	07FF	07FF	07FF	07FF	07FF
Non-zero bytes (d)	2047	2047	4	0	0	3	368	2047	2047	2047	2047	2047	2047
Number of bits read	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$	$7.48E+7$
Log BER	-4.6	-4.6	-7.2	-7.9	-7.9	-7.3	-5.3	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6



Level Seven (Continued)

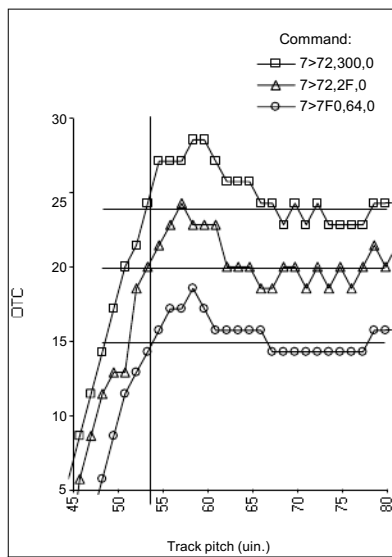
Command	Description
x	Show Zone Boundaries
yx,z	Set Direct Write Mode
x	- Ignore track IDs
z	- Ignore 16/17 encoder
	No Params to re-enable track Ids and 16/17 encoder
z	Toggle Data Randomizer
7x,y,z	Generate 747 curve
x	-Number of times to read the track at each offset
y	-Error count to use in determining width of bathtub curve
z	-0 for graph display of curve
	-1 for numerical display of curve

Example #1

Left column shows write offset (track pitch in Hex DAC bits), right column shows OTC in Decimal DAC bits
 Where write offset = 0020: Track pitch = $60.9 - [(60.9/384) * 32] = 55.8 \text{uin}$. OTC = $(126/384) * 60.9 = 19.9 \text{uin}$.

```

7>S3C25
7>
7>725,2F,0
FF80| ..... 144
FF88| ..... 144
FF90| ..... 144
FF98| ..... 144
FFA0| ..... 144
FFA8| ..... 144
FFB0| ..... 144
FFB8| ..... 144
FFC0| ..... 144
FFC8| ..... 144
FFD0| ..... 144
FFD8| ..... 153
FFE0| ..... 153
FFE8| ..... 153
FFF0| ..... 162
FFF8| ..... 162
0000| ..... 153
0008| ..... 153
0010| ..... 144
0018| ..... 144
0020| ..... 126
0028| ..... 117
0030| ..... 99
0038| ..... 81
0040| ..... 72
0048| ..... 54
0050| ..... 27
0058| ..... 0
0060| ..... 0
    
```



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Command	Description
9x,y,z	Adapt Write Delay
x	- Target delay from AM to sector start (in bytes). <i>Default is product specific</i>
y	- Hexadecimal number of samples to average. <i>Default is 0A₁₆ = 10₁₀</i>
z	- Zero = test at zone OD; non-zero = test at zone ID (<i>default is OD</i>)

This test calibrates the reader-writer delay (separation between the reader and writer in the spin direction) on a per-zone, per-head basis. The test accomplishes this by adding a delay to the time from AM detect to write gate (*see Sector Write Timing diagram on next page*). The amount of this delay, in bytes, is stored as adaptive parameter **PLO Phs (B)**. The write gate delay is accomplished by adding to the following registers during a write: SPLIT_WIDTH (desired width of a split), TRKID_POS (the expected position of the track ID sector pulse from the previous AM), and SPHS (the delay from the detection of the last servo address mark to the first hard sector pulse. These three registers are only modified during a write operation.

Fine-tuning **PLO Phs** allows us to adjust for variances in reader/writer separation in the direction parallel to the actuator arm. The goal is to achieve a uniform delay from AM detect to sector start during a read operation, given that the reader / writer separation will vary from head to head.

Algorithm:

For each zone on the drive, try each setting of **PLO Phs** from 0 to F. At each setting of **PLO Phs**, write sector zero of a test track and read it back several times. The test track is the OD (or, optionally the ID) of the zone. Every time the test reads back the test sector, it calculates and stores the elapsed time (in bytes) from **read gate (RG)** to **sync byte (SB)** (*see Sector Read Timing diagram on next page*). The RG to SB delay is calculated by reading register EDD8 (MR_CNT_AT_SYNC) of the **Saratoga II** or later controller.

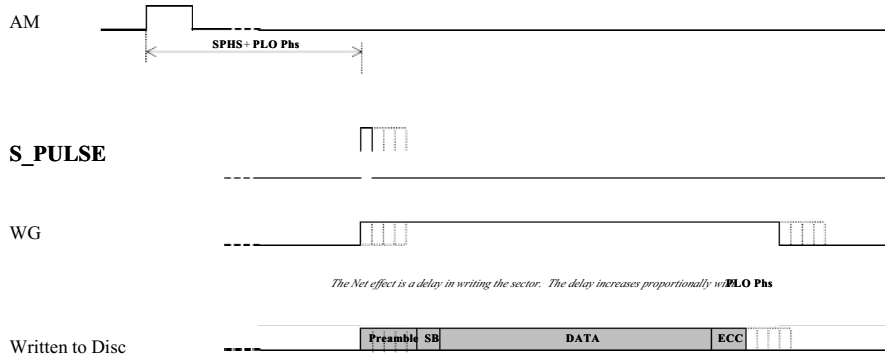
This cycle (read the sector, calculate and store the RG to SB delay) is repeated ten times. The number of read/compute/store cycles can be changed using the second parameter (*i*). The average RG to SB delay is then computed and saved as the data point for the **PLO Phs** setting under test.

After all settings of **PLO Phs** have been tried for a particular zone, the routine determines which setting came the closest to the desired RG to SB delay without exceeding it. That setting then becomes the "pick" for that zone. The default target value is drive specific. (Aspen = 16, Saturn = 15).

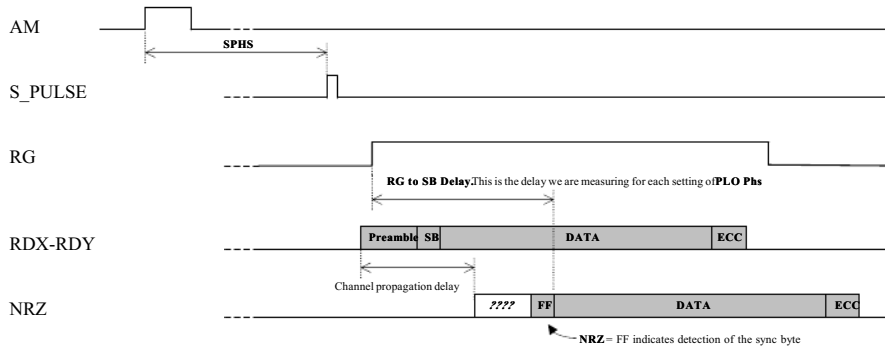
This entire process is repeated for each head.

Error handling: If there is any error reading or writing a test sector, then an alternate track will be tested. The alternate will be 25₁₀ tracks towards the MD of the zone. This alternate track retry will occur a maximum of 20 times for each **PLO Phs** setting. If the test was never able to read a sector successfully after exhausting the 20 retries, then a period (':') will be displayed as the result for that setting.

Sector Write Timing (no split)



Sector Read Timing (no split)



Sample Output

```
7>914
      PLO Phase (target = 20)
Head0 0 1 2 3 4 5 6 7 8 9 A B C D E F Pick
Zone 0: 15 17 17 19 20 21 22 22 24 25 26 26 28 28 30 31 4
Zone 1: 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 4
Zone 2: 16 17 18 19 20 21 22 23 24 26 26 27 28 29 30 31 4
Zone 3: 15 17 18 18 19 21 21 22 24 24 25 26 27 29 29 31 5
Zone 4: 16 17 18 19 20 21 22 23 24 25 26 27 27 29 30 31 4
Zone 5: 16 17 18 19 20 21 22 23 24 25 26 27 28 29 31 31 4
Zone 6: 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 32 4
Zone 7: 16 17 18 19 20 21 22 23 24 25 26 27 28 30 30 32 4
Zone 8: 1 7 17 1 9 19 2 0 22 2 2 23 2 4 25 2 6 27 2 8 29 . . 4
Zone 9: 16 18 18 20 20 21 23 23 25 25 27 27 28 30 30 32 4
Zone A: 16 17 18 19 20 22 23 23 25 25 27 27 28 29 . . 31 4
Zone B: 16 17 18 18 20 21 22 23 24 25 25 26 28 . . . 4
Zone C: 16 17 18 19 20 21 22 22 24 25 26 27 28 28 . . 32 4
```

Target is 14₁₆ = 20₁₀

If no match, higher setting is chosen

LEVEL EIGHT COMMANDS: Servo Track Writer Commands

Note: Assume PACKWRITER = FALSE, unless otherwise noted.

Command	Description	Set Flags
A	Abort any pending servo diagnostic command	REDUCED_DIAG==TRUE/FALSE
B	Set the read head bias to the serial preamp	PACKWRITER==TRUE
Cx,y,z	Execute the servo diagnostic sub commands x = diagnostic number y = optional diagnostic parameter z = optional diagnostic parameter	
C00,x,y	Flex bias cal x = optional cylinder y = optional head	REDUCED_DIAG==TRUE/FALSE
C01	PES_AVG routine	RO_ZAP==TRUE
C02,x,y	Set access display and reset rate masks x = optional display rate mask y = optional reset rate mask	REDUCED_DIAG==FALSE
C03,x,y	Set min and max cylinder limits x = min cylinder y = max cylinder	REDUCED_DIAG==FALSE
C04	Run Acceleration constant cal	REDUCED_DIAG==TRUE/FALSE
C05,x,y	Set seek delay x = seek delay in servo bursts y = (1= force slow settle)	REDUCED_DIAG==TRUE/FALSE
C07,x	Head switch up and down the stack x = optional cylinder (default = current cylinder)	REDUCED_DIAG==FALSE
C08,x	Random seeks x = optional heads only	REDUCED_DIAG==TRUE/FALSE
C09,x,y	Seek to and from inward and outward within the min and max cylinder limits x = optional seek length (default = 1) y = optional cylinder (default = current cylinder)	REDUCED_DIAG==FALSE
C0A,x,y	Seek to and back inward and outward within the min and max cylinder limits x = optional max seek length (default = max length) y = optional min seek length (default = 1)	REDUCED_DIAG==TRUE/FALSE



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Level Eight (Continued)

Command	Description	Set Flags
C0B,x,y (32 bit)	Serpentine seeks inward up and down the head stack within the min and max cylinder x = optional cylinder (default = current cylinder) y = optional head (default = current head)	REDUCED_DIAG==FALSE
C0C,x,y (32 bit)	Seek to seek between cylinders x = optional 1st cylinder (default = min cylinder) y = optional 2nd cylinder (default = max cylinder)	REDUCED_DIAG==TRUE/FALSE
C0D,x,y	Head switches from 1 st to 2 nd head x = optional 1st head (default = head 0) y = optional 2nd head (default = max head)	REDUCED_DIAG==FALSE
C0E,x,y	Set servo gains x = Ka y = Kt ^f	REDUCED_DIAG==FALSE
C0F,x,y	Encode cylinder/ decode gray code x = optional cylinder or gray code (default = current cylinder/ gray code) y = (0 = encode, 1 = decode)	REDUCED_DIAG==TRUE/FALSE
C10,x,y (32 bit)	Head switch offset measurement routine x = starting cylinder (default = current cylinder) y = target servo sector	REDUCED_DIAG==TRUE/FALSE CHANGESG011199_00==TRUE
C11,x	Head linearization cal routine x = # of tracks to average (default: 4 tracks (max))	REDUCED_DIAG==TRUE/FALSE
C12,x,y	AFC commands x = 0; AFC weights are zeroed and stored as zero for present head 2; AFC weights are updated and stored for present head 5; ALL AFC weights are displayed 6; AFC weights are updated and stored for all heads 7; AFC learning/compensation enable y (only applicable with x = 7) = 0 1; enable 1x AFC 1 0; enable 2x AFC 1 1; enables 1x and 2x AFC	REDUCED_DIAG==TRUE/FALSE
C14,x	Change spin tolerance threshold Spin tolerance = STV_LIMIT (in srvo clks) / AMTIME (in srvo clks) x entered = new STV_LIMIT x not entered = displays current STV_LIMIT	NON-MDW ONLY
C15,x,y	Change write threshold x = X_Threshold y = X_plus_V_Threshold	REDUCED_DIAG==TRUE/FALSE
C16,x	Disable prediction stuffs on zapped servo samples x = 0; allow stuffs 1; disable stuffs	REDUCED_DIAG==TRUE/FALSE
C18	Calibrate servo (Runs C0 , C4 , C11)	REDUCED_DIAG==TRUE/FALSE
C19,x	Display 1 rev of tangential PES x = starting sector	REDUCED_DIAG==TRUE/FALSE CHANGESG011199_00==TRUE
C1F	Display servo calibration data	REDUCED_DIAG==TRUE/FALSE



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Level Eight (Continued)

Command	Description	Set Flags
C20,x,y	Read Embedded HDA Serial Number. SN is read into RAM. The cert process can then use this value to determine drive type. x = Head to read MDW disk serial number. (MDW only) y = If set read MDW disk serial number from alternate track. (MDW only)	REDUCED_DIAG==TRUE OVERSAMPLING==TRUE
C23,x,y	Special case measuring of RRO on a STW. The user must first bias the actuator against the push pin on the STW by using the Level 8>P cmdnd. Then use the C23 command to display the NRRO and RRO. x = optional number of samples in hex (default: 64 hex = 100d) y = display sums flag (= 0; display sums, (default) 1; don't display sums, (this is faster))	PACKWRITER==TRUE MEASURE_PES==TRUE
C24,x,y	Measure the PES synchronously at every sector on the present track and head. x = optional number of samples in hex (default: 64 hex = 100d) y = display sums flag (= 0; display sums, (default) 1; don't display sums, (this is faster))	REDUCED_DIAG==TRUE/FALSE MEASURE_PES==TRUE
C25	Redisplay results of C23 and C24	REDUCED_DIAG==TRUE/FALSE MEASURE_PES==TRUE
C26	DAC offset cal	REDUCED_DIAG==TRUE/FALSE
C28,x	Write servo DACs x = 12 bit signed value	REDUCED_DIAG==TRUE/FALSE ECKickOffTest==TRUE
C33,x	Repeatable Timing Error (RTE) Calibration (MDW only) x = 0; Execute calibration and display result x = 1; Display result x = 2; Same as x=0 and additionally the RTE of each sector of each track is displayed	
C36,x	Head Switch Calibration for prewritten media (MDW only) x = 0; Execute calibration and display result x = 1; Display result	
C37	AFC Zoned (AFCZ) Calibration (MDW only)	
C3B,x	Greycode Index Calibration (Multi-disk MDW only) x missing; Execute calibration on all heads and display result x anything; Display calibration result only	
D	Dump Drive Configuration Dump the drive configuration to the Cancun packwriter = +c hh b 0000 ff c = max cylinder (excluding guard band cylinders) hh = max head number b = number of bursts 0000 = oscillator clocks per bursts ff = oscillator frequency in MHz	PACKWRITER==TRUE



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E	Lock Spindle Motor Lock Spindle Motor to external timing provided by packwriter	PACKWRITER==TRUE
F	Write Pack-writer Auto Stamp Formats the log tracks, and writes the HDA and PW serial numbers. The command will prompt for HDA and PW serial numbers.	PACKWRITER==TRUE
Gx	Set Spin Gain x = spin gain (0800h default)	PACKWRITER==TRUE

Level Eight (Continued) Command	Description	Set Flags
Hx	Select head directly x = head number (0..7)	REDUCED_DIAG==FALSE
Ix	Push-Inward Actuator x = 12 bit DAC command	PACKWRITER==TRUE
Jx	Spin Speed Adjust x = signed number of timer ticks (fe00 .. 0200)	PACKWRITER==TRUE
Kx	Added track offset in track follow state x = track offset	REDUCED_DIAG==FALSE
Lx	Load Head Mask x = head mask	PACKWRITER==TRUE
M	Increment Head (current head + 1)	PACKWRITER==TRUE
N	Report Logical Spin State Report Logical Spin State 00 = reset 01 = fault 02 = initialize 03 = stopped 04 = spindown 05 = spinup 06 = wait (held need refer) 07 = open loop (lost refer) 08 = close loop (found refer) 09 = ready (spinning at speed) 10 = busy (recovery) 11 = invalid	REDUCED_DIAG==FALSE
Ox	Message Display x = 0 is display output off, x = 1 is display output on (default).	PACKWRITER==TRUE
Px	Push-Out Actuator x = 12 bit DAC command	PACKWRITER==TRUE
Qx	Read channel x = 0 is channel off, 1 = channel on	PACKWRITER==TRUE
Rx	Read Gray Code x = expected gray code (non-modulo gray code drives only)	REDUCED_DIAG==FALSE

Level Eight (Continued)

Command	Description	Set Flags
S _{x,y,z}	Seek Cyl/Head	REDUCED_DIAG==TRUE/FALSE
(32 bit)	<ul style="list-style-type: none"> x - Cylinder number y - Desired destination head. If the most significant bit is set, the command will seek to the physical cylinder number specified in the first parameter; else, the seek will be to the logical cylinder - If bit 10 is set, seek to Grey code cylinder. (MDW only) z - Track follow offset. Signed 16 bit integer 	
U _x	Spin-Up Motor x hold state(optional)	REDUCED_DIAG==FALSE
V _x	Spin-Up x = actuator bias direction, (0 = outward, 1 = inward)	PACKWRITER==TRUE
W _x	Set Write Current x = preamp write current	PACKWRITER==TRUE
Z	Spin-Down	REDUCED_DIAG==FALSE
c	Crash test the Actuator/Crashstops/HDA Crash command test the Actuator/ crashstops/ HDA	PACKWRITER==TRUE SMASH==TRUE
f _{x,y}	Set bank write mode x = 0; bank write ON, 1; bank write OFF y = write current register value	PACKWRITER==TRUE
g	IMRON signal polarity Returns a 01 if the IMRON preamp signal is active high and a 00 if active low.	PACKWRITER==TRUE

LEVEL A COMMANDS: Niwot Read/Write LBA Commands(FULLSLIP)

Command	Description
Cx,y	Convert LBA to LPL and display to screen. x - upper word of >16 bit address y - lower word >16 bit address or the 16 bit address
Dx,y	Convert LBA to PCHS and display to screen. x - upper word of >16 bit address y - lower word >16 bit address or the 16 bit address
Ex,y	Display Log(s) See /2 E for further detail.
Mx,y	Set GrandB Test ports x - Test port to set y - Value to set it to (0xff will disable the port)
Q,x	Write/Read/Read LBA. x - # of sectors to read default - # of unslipped sectors on this LPL - this sector # (rest of track , no wrap)
R,x	Read LBA Command. x - # of sectors to read default - # of unslipped sectors on this LPL - this sector # (rest of track , no wrap)
Sx,y,z	Seek LBA Command. x - upper word of >16 bit address y - lower word >16 bit address or the 16 bit address z - Track follow offset. Signed 16 bit integer
W,x	Write LBA Command. x - # of sectors to read default - # of unslipped sectors on this LPL - this sector # (rest of track , no wrap)
Yx,y,za	Show/Set Retry Controls See /2 Y for further detail.
cx,y,z	Convert LPL to LBA and display to screen. x - Logical Cylinder y - Physical Head z - Logical Sector
dx,y,z	Convert PCHS to LBA and display to screen. x - Physical Cylinder y - Physical Head z - Physical Sector



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Level A (Continued)
Command

Description

Ix,y,z

Display # of unslipped sectors for LPL to screen.
x – Logical Cylinder
y – Physical Head
z – Logical Sector



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LEVEL C COMMANDS: Cert Diagnostic CTS Commands

Command	Description
D	Display the Cert Test sequence.
Fvwww,x,yzz	<p>Run Cert CTS Test F with input parameters. No Logs are generated but Write Current adaptives are updated</p> <p>Entering No Parm or zeros for fields within a Parm causes Parm Field Defaults to be used. Parms entered or generated internally as Defaults are printed at start of test.</p> <p>vv - hi byte = Adjacent Tracks Write count range min = 00h = use default range max = FFh writes</p> <p>ww - lo byte = Error Rate KEVs to Read Loop count range min = 0000h = use default range max = 00FFh reads</p> <p>x - Read Error Rate test Bathtub Min Threshold range min = 0000h = use default range max = 07FEh</p> <p>y - hi byte = Write Current Pick skew factor added to final Write I Pick range min = 00h = Default range max = 07h Write I limited to 07 regardless of skew</p> <p>z - lo byte = Write Current Delta for Pick criteria Delta to be used for pick criteria between current Zeros and old highest Zeros range min = 00h = use default = 01 range max = 07h</p> <p>NOTE: If test is to be terminated early before completion use Online command ^R instead of ^Z to ensure repeatability if test is restarted without power cycling.</p>
***P	Load Buffers 10-1A with NAPA specific 127 bit pattern, load buffers 1B-1F with 0's (available only when overlay is valid)
***Ixxxxx,y	<p>Perform Lazy Write / On-Track-Erasure Screen. (available only when overlay is valid)</p> <p>Algorithm:</p> <ol style="list-style-type: none">1. Write test track2. Read sectors 100-107 140h times (Rbit=7.0), Save Raw BER for baseline3. Write sectors 0-7 using single sector writes (one sector per rev)4. Read sectors 0-7 and save the data for BER15. Read sectors 100-107 and save the data for BER26. Repeat steps 3-5 140h (Rbit 7.0) times7. Rewrite track to clean up <p>Failure Criteria:</p> <p>If Baseline-BER1 is > 1.5 decades, then cold-write failure If Baseline-BER2 is > 1.5 decades, then OTE failure</p> <p>Parameters:</p> <p><i>xxxx</i> Track number to test. <i>Default = current track</i></p> <p><i>y</i> Head to test. <i>Default = all heads.</i></p>



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*** pxx,yy

Parse Cert Log for Errors by Head (available only when overlay is valid)

This routine will read log xx and total error code yy by head and print the results to the screen.

xx - the cert log number to parse
yy - the error code to count by head

Notes: Max head is 3 and the number of errors for a specific head is a decimal number.

Example usage/Output:

C>p39,43

head 0: 1

head 1: 7

head 2: 3

head 3: 3



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*** **sx,y,z,a**

CTSSpinUpandDn (available only when overlay is valid)

This routine executes the routine CTSSpinUpandDn, which spins the drive down and back up the number of times in x.

- x - the number of times to repeat the start/stop cycle
- y - how much time (in milliseconds) to wait for ready after spinup command is issued
- z - how much time (in milliseconds) to pause after issuing spindown command
- a - if entered then delay y and z seconds, even after ready, if not entered then x is a max time to ready rather than a fixed delay.

LEVEL D COMMANDS: SeaDex Commands

All the commands at this level were designed for use by SeaDex script debugger, DxDebug, though others may find them useful also.

(All available only when overlay is valid)

Command	Description
Ex,y,z	Display SeaDex Log, level-T E-command style This command is styled after the earlier level-T 'E' command. x – Log number If no x Display trace log y – (Any value for y) Display log in hexadecimal If no y Display log in text z – (Any value for z) Display size and location of all logs (x and y are ignored)
Ix	SeaDex Information tables If x == 0 Display current SeaDex status word (dxstat) If x == 1 Display list of buffers for SeaDex If x == 2 Display zone table If x == 3 Display SeaDex cylinder use If x == 4 Display list of split sectors If x == 5 Display version of SeaDex firmware If x == 6 Display version of SeaDex script If no x Display help on parameters
Sx	Single Step SeaDex script If no x Same as x == 0 If x == 0 Step into: execute one script instruction, then break If x == 1 Step over: execute one script instruction; If this is a call instruction, then treat as s2: If x == 2 Step out: execute script until next jmp (return) instruction After script execution, the current SeaDex instruction pointer is displayed in the form: =0000 ip
Tx,y,...	SeaDex Test Step x – Test step number (00 through FF) If x == 0 Continue script, or start main script from beginning If no x Display list of test steps y,z,a – Parameters passed to test step When displaying the list of steps, the test step and assembly instruction address is displayed in the form: Test-step 0x02 t\$ 0000

Level D (Continued)

(All available only when overlay is valid)

Command	Description
bx,y,z	Script assembly Breakpoint
x	– 0 to clear breakpoint, 1 to set breakpoint
y	– assembly address for breakpoint
z	– 1 for break at checkpoints. If z is set, y is ignored
b	Display all breakpoints currently set
b1,y	Set breakpoint at assembly address y
b0,y	Clear breakpoint at assembly address y
b0	Clear all breakpoints
b1,,1	Break at checkpoints
b0,,1	Don't break at checkpoints
cx	SeaDex Checkpoint
c	Write checkpoint to disc
c2	Use checkpoint in memory if possible, else go to c1...
c1	Load checkpoint from disc if possible, else go to c0...
c0	Initialize checkpoint (start over)
lx,y	Display SeaDex Log
l	Display log table information (size and location of all logs)
lx	Display log xx
lbe	Display the trace log of the back-end (BE) process script
lfa	Display the trace log of the failure-analysis (FA) script
lx,y	Display log xx in unformatted hex
px	Display SeaDex Tune Parameter
x	– Display values of tune parameter x (C0 through FF) for all heads and zones
If no x	– Display all tune parameter values for current head and zone
sx,y	Set or Display SeaDex System Variable
x	– System variable (00 through FF)
y	– Value to set system variable to

Values displayed are in the form:
=00000000

Level D (Continued)

(All available only when overlay is valid)

Command

Description

tx

SeaDex Trace Levels

x – Set trace levels to x (bit field)

Bit 0 – 001 Log 1: High-level trace log messages
Bit 1 – 002 Log 2: Intermediate-level trace log messages
Bit 2 – 004 Log 3: Detail-level trace log messages
Bit 3 – 008 Data log messages and headers
Bit 4 – 010 I/O command assembly instructions
Bit 5 – 020 Source lines with Call instructions
Bit 6 – 040 (Not used)
Bit 7 – 080 Source lines
Bit 8 – 100 Assembly lines
Bit 9 – 200 SeaDex buffer accesses
Bit 10 – 400 SeaDex hardware interface
Bit 11 – 800 SeaDex log allocation table usage

If no x Display trace levels
Trace levels displayed are in the form:
=00000000

When bit 7 of trace is set, as each assembly instruction is executed, or when bit 4 of trace is set as each Call assembly instruction is executed, the SeaDex firmware will display the assembly address of that instruction in the form:

tS 0000

v

Verify SeaDex Script

This runs the consistency checks that SeaDex uses to verify the validity of the script. Any errors are displayed.

This command also displays script version information. Example:

```
SeaDex script verification Passed
Script assembled from PROCESS .ASM on 03/13/2002 at 11:50:33, DxAsm ver 0.17
Script CRC 0x9F9A27E0
```



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Level D (Continued)

(All available only when overlay is valid)

Command	Description
wx,y,z,a	Set or Display SeaDex Word
x	– SeaDex Address Range
If x == 100	Buffer address range
If x == 200	Code (script assembly) address range
If x == 300	Frame (SeaDex stack) address range
If x == 400	Global variable address range
If x == 500	System variable address range
y	– SeaDex word (32-bit) offset within the given address range
z	– Number of SeaDex words; default is one.
wx,y	display SeaDex word at address xy
wx,y,z	display z SeaDex words starting at address xy
wx,y,,a	Set SeaDex word at xy to a
wx,y,z,a	Set z SeaDex words starting at xy to a

Values displayed are in the form:
=00000000

Level E Commands: Drive Zone and Format Commands

All the commands at this level were designed for use in viewing and/or modifying the drive zone and format parameters.

Command

Description

ax,y

Displays / modifies drive zone parameters. (available only when overlay is valid)

>64k cyl compatible*

Assumes zone table information is already read from overlay to RAM (use /T>11 (that's the level T little "L" - one command) to force the read. Use /T>110 (level T little "L" - one - zero command) to write changes to overlay.

Four columns are displayed:

1. Reference number for each parameter
2. Parameter name
3. Parameter's hex value
4. Parameter's decimal value

The display is formatted as:

1. Zone:	0009	9
2. Start Cyl:	0000cc89	52361
3. End Cyl:	0000de3b	56891
4. NRZ Freq:	00069646	431686
5. Secs Per Trk:	02a4	676
6. Write Split Pos:	0230	560
7. Read Split Pos:	0216	534
8. Sec Freq:	086e	2158
9. Base Ctr:	0003	3
10. Read ID Pos:	0148	328
11. Write ID Pos:	0162	354
12. Wedge Sec Size:	07fc	2044
13. Sec Info Tbl Add:	b460	46176
14. Phase Off:	02	2
15. PLO Offset:	02	2
16. NReg:	0e	14
17. MReg:	ab	171
18. DRRReg:	61	97
19. PLO Len:	0a	10
18. DRRReg:	61	97
19. PLO Len:	0a	10
20. Write Off Delay:	1d	29
21. Byte / SPHSConvNum:	3a	58

If x == 0, display parameters only

If x == valid reference number from display, y sets parameter's value. y will set values in hex only, and does support > 64k inputs. The zone table information is displayed again with the changed parameter.

If x == invalid reference number, "Invalid Selection" is displayed along with the srcinal information.

If x == reference number for a parameter that cannot be changed, "

If End Cyl of zone X is changed, Start Cyl of zone X+1 will follow, unless End Cyl of zone X is set greater than End Cyl of zone X+1 (don't do this; bad things may happen).

*** Will accept up to 8 digits for drives with >64k cylinders**



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Description

Similarly, if Start Cyl of zone X is changed, End Cyl of zone X – 1 will follow, unless Start Cyl of zone X is set less than Start Cyl of zone X – 1 .

The following parameters cannot be modified:

1. Zone
2. NRZ Freq
3. Byte / SPHSConvNum

bx,y,z

Displays / modifies frame format information. (available only when overlay is valid)

Assumes frame format information is already read from overlay to RAM (use /T>11 (that's the level T little "L" - one command to force read). Use /T>110 (level T little "L" – one – zero command) to write changes to overlay.

The display is formatted as (for zone 9):

Frame Info for Zone 09

Wedge	Phase	Col 1 SpltCnt	Col 2 SecCnt	Col 3 CummSecCnt
	0	4246	008e	04 00
	1	08a6	011e	03 04
	2	0695	01ae	03 07
	3	0485	0227	03 0a

Data Sec Per Frame: 13

Srvo Sec Per Frame: 04

If y == 0 (x and z become don't cares), display only.

Else, x selects the Wedge to modify, y selects the column, and z sets the value.

For example, to modify Wedge 1's SpltCnt from 11e to 222, use b1,2,222

If y = ffff, x will determine the last wedge's information remaining. For example, if you wish to remove wedge information for wedges 2 and 3 (leaving only 0 and 1), use b1,ffff

Boot Code Diagnostic Commands

The following commands are only available thru the boot code diagnostic monitor.

All Boot Code Diagnostic Commands are compatible with drives with >64k cylinders.

Online Commands, Boot Code

<u>Command</u>	<u>Description</u>
^D, ^N	Retry Activity Display Toggle. ** (See Appendix B. for Retry Display Characters.)
^L	Display Sign-on Message, including firmware version.
^O, ^J	Advance Servo Tracing
^Z	Restart the Diagnostic Monitor, do not load overlay from disk
!	Display Current R/W Channel Settings
%	Show Mux Status. ** (See Appendix B for Description) Note: the serial number is not displayed.
'	Display Transfer Status (See Appendix B Description)
.	Display Active Status. ** (See Appendix B for Description)
;	Display Machine Status. ** (See Appendix B for Description)
<	Decrement read/write scope synchronization pulse position.
>	Increment read/write scope synchronization pulse position.



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Level F Commands: Limited Boot Code Debug Support

Command	Description
+x,y	Peek Byte. Display the byte data content of the specified memory address: x - upper bits of a greater-than-16 bit address y - lower 16 bits of a greater-than-16 bit address or the 16 bit address
=x,y,z,w	Poke memory. Replace the contents of the specified address with the specified data. x - upper bits of a greater-than-16 bit address y - lower 16 bits of a greater-than-16 bit address or the 16 bit address z - byte data content to be written at the specified address. OR Byte write: word data content word write: F>=27,ec5c,,0104
-x,y	Peek Word. Display the word contents of the specified address. x - upper bits of >16 bit address y - lower 16 bits of >16 bit address or the 16 bit address
Bx,y	Display Buffer x - 512 byte buffer number y - buffer number for Data match. If x is a read buffer and y is not entered, data matching the corresponding write buffer location is low-lighted; non matches are high-lighted.
Cx,y,z	Copy Buffers x - Source buffer for the data. y - Destination buffer of the data. z - number of 512 byte buffers to copy (1 is default)
Dx,y,z	Display Memory. Displays 256 bytes of memory starting at address xyyyy. x - upper bits of >16 bit address y - lower 16 bits of >16 bit address or the 16 bit address z - high-light bytes matching this value.
Px,y,zzww	Set Buffer Pattern: x - Pattern to write into buffer. Default: 1212h repeating every other word ELSE: Pattern bits 0-15 (as needed to support the pattern repeat length). y - Pattern bits 16-31 (as needed to support the pattern repeat length). zz - Length (in bits) of repeat pattern on non-random data. Default = 20h (32d) ww - Buffer number (no entry => entire Write Buffer) Note: specific buffer number does not work in mask ROM code.

Command

Description

Rx

Read system sectors information

- x - Specifies what to read
 - 1 – Reserve track defect list
 - 2 – Boot adaptives
 - 4 – Application code

No parameter reads all of the system sector information

Ux

Spin-Up

- x - spin up options flag
 - 5 hold in pre-lock state

Z

Spin-Down.

bx,y

Set Baud Rate

- x = 0 Set baud rate to POR default, typically 9600
- x = 1 Display supported baud rates in the format: =xxxx
- x > 1 Set supported baud rate:

Typical baud rates (xxxx leading zeros may be omitted)

x	baud rate
1229	1,228,000
921	921,000
626	625,000
460	460,000
231	230,000
115	115,000
576	57,600
192	19,200
96	9,600
48	4,800
24	2,400

- y - if entered y contains the delay time in milliseconds. Default is do not wait for host to return CR, just set new baud rate. If y is entered the code will check every millisecond up to y milliseconds for a carriage return to be sent back from the host at the new baud rate. If no CR is seen the drive will default back to 9600 baud.

Note: level T "B" in application code.**dx,y**

Download code, used in conjunction with SDDL

- x - buffer to download to
- y - block size
 - 0 512 bytes (default)
 - 1 1024 bytes
 - 2 2048 bytes
 - 3 4096 bytes

ex,y,z,w

Serial flash access routines

x - 0 display size, type of serial flash
 1 write a byte
 y offset
 z byte value
 w segment number
 2 read a byte
 y offset
 z segment number
 3 program entire serial flash page method.
 y number of pages
 z Window C page
 w byte offset
 4 read the serial flash into buffer
 y number of pages
 z Window C page
 w byte offset
 5 init the port pins used for serial flash communication
Warning: doing this command twice will disable the ability of the drive to spinup
 6 shut down the port pins used for serial flash communication
 7 run the patch mechanism
 8 read the status register
 9 erase the entire serial flash
 a transition to new serial flash code without power cycling
 FF generate quick test signals on GPIO and port pins
 -

jx,y

Jump to address to execute. If no parameter entered it will transition to the application code in the buffer if it is valid.

x - segment number
 y - segment offset

Note: new command to ROM code

r,y,z

Reserve tracks read

y starting sector number
 z length in sectors

Note: works similar to level 2 "r" in application code

sx

Seek to Physical Cyl (FULLSLIP)

x - Physical Cylinder number

Note: works similar to level 2 "s" in application code, without track offset option

tx,y,z

Write to serial device

x = <RegisterAddress>

y = <Data>

z = Device selection

00 = PREAMP
 01 = CHANNEL
 02 = SERVO_CHIP
 03 = SATA

Appendix A: Error Codes

00h	No error	5Eh	Pad and fill defects
03h	Calculated CRC doesn't match	5Fh	Entire defect span was not found in User Defect List
11h	Spin error	60h	No spares available
12h	Ramp load error	61h	Write blocked w/o a reason
13h	Offtrack	62h	Write gate came on early
14h	Write fault	63h	Write gate went off late
15h	Rd/wr seek timeout code	64h	GC thermal sensor fault detected
16h	Seek timeout	65h	Shock sensor fault detected
17h	'False' AMDET (mis-timed)	66h	Attempt made to write at the wrong target location.
18h	Bad burst error code	68h	FW initiated disc sequencer reset
19h	Bad grey code	69h	FW sequencer abort; split sector runaway RG
1Ah	Early sync code	70h	Bad disc resident cert/diag code
1Bh	Missed am	71h	Unable to read system sectors code
1Ch	Failed the servo defect screen threshold	72h	Unable to read packwriter auto-stamp
1Eh	Target generator sector error	73h	Invalid defect info loaded
1Fh	Physical sector error	74h	Invalid alt info table
20h	Skip write detected using servo burst	88h	Unable to learn good zap on track
22h	NRZ freeze occurred (A=A')&(B=B')&(C=C')&(D=D')	89h	Cylinder to be skipped out in loopback test
29h	Thermal Asperity errors padded in test 36.	8Ah	Wedge slipped
30h	Data mismatches	8Bh	Write ID failed
32h	Slipped write error	8Ch	Cylinder padded
33h	Adaptives are not loaded	8Dh	Cylinder filled in
34h	Unexpected ECC verify read failure	8Eh	Cylinder skipped out
35h	Unexpected ECC verify read success	8Fh	Max cylinder skips has been reached
36h	Pending block encountered during a write	90h	Zapped burst
37h	Pending block encountered and read successfully	91h	2 consecutive zapped bursts
41h	Long ECC error correction code	92h	Too many zapped bursts on a track
42h	Non zero byte detected	93h	Unable to zap - 2 consecutive bad bursts
43h	Data ECC error	94h	Sumsquare of PES on this track exceeds limit
44h	FIFO over/underrun	95h	Unable to zap bad burst
45h	Track ID mismatch error	96h	Too many position plus velocity threshold breaks
46h	Track ID read TO code	97h	Zapped splice code
47h	Missed data sync byte	98h	Encroachment code
48h	Missed data sync after a split	99h	Max number of slipped tracks have been reached
49h	Thermal asperity code	9Ah	The slipped cyl requested does not exist.
4Ah	Error didn't repeat during dynamic sparing mini cert	9Bh	Head switch timeout error code
4Bh	Error log full	A0h	Preamp miscommunication
4Ch	Controller stopped without a reason	A1h	Reserve track defect list bad
4Dh	Error reassigned during dynamic sparing	A2h	Boot adaptives bad
4Eh	Block release timeout error	A3h	Bad application code
4Fh	Buffer ready error	A4h	Not enough sectors saved to the disc for adaptives
50h	Slipped sector	A5h	Application code check sum error
51h	Alternated sector	A6h	Application code not compatible
52h	Pad and fill defects	CEh	Cert test passed
53h	Hard error w/AT retries no error with full retries	CFh	Cert test failed
54h	Error during scratchfill	EDh	Attempt to write the user slip list but no valid list
55h	Bad alt dest ID info	FBh	Missing critical parameter
56h	Unable to find valid alt dest	FCh	Command aborted (internal only)
57h	Unable to delete alt dest	FDh	R/w command rejected
58h	Too many defects per head	FEh	Invalid address passed to Niwot
59h	Too many defects per track	FAh	Un-initialized preamp code for new preamp interface
5Ah	Too many dynamic slips	FFh	Unsupported code in the new preamp interface
5Ch	Unknown full slip failure		



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Appendix B: Special and Retry Display Characters

A	spin up AMDET time out
B	boost char
C	EP ECC retry char
C	coarse offset (servo)
D	detector threshold
E	partial erasure factor
F	data filter
G	coarse gain
H	if preamp not identified
I	ID offset (servo)
I	track ID timeout error
L	long correction retry char
M	MR bias tweak retry char
O	fine offset (servo)
O	OD offset (servo)
P	precomp
R	bias current
R	fast learn runout retry char
S	MR asymetry character
S	Splash retry
T	TA retry char
W	write current
W	write buffer retry char
X	Read sequence detector retry
Z	spin up zero crossing time out
Z	zero phase restart
a	data correction
b	bad block mark encountered
b	boost retry
c	on the fly correction performed
c	coarse offset
d	physical sector miscompare code
e	physical sector miscompare code
f	filter retry
f	FIFO error retry performed
g	write gate block detected
h	AGC retry
i	track ID miscompare code
k	AGC Level tweaked retry character
n	MR Reset "pulse" applied
o	fine offset character
p	write delay/plo phase char
p	power chop retry character
q	chip unsafe error detected
r	alt relocatable block found
s	seek retry performed
t	write gate early error detected
u	write gate late error detected
v	Timeout recovery
w	block release timeout recovery performed
w	write retry performed
x	PLL shift retry
y	sync retry performed
!	verify block failed
"	group delay retry wp5
\$	missed AM while locked to burst
%	read verify block
&	ID splash retry char
&	preamp gain
*	commutation advance during spin up
*	bad AMs during normal operation
.	data retry performed
?	slipped write retry char
—	no commutation advance during spin up
⏏	Turn off AFC1/2X comp.
~	Sync byte tolerance retry
+	boost offset
+	boost offset
<	display MR bias retry char
>	Wrong head retry char

Appendix C: Online Command Display Descriptions

Statistics Display Description()

When the drive is running diagnostic commands, certain statistics are logged and may be displayed while operations are in process. Statistics for each head are displayed in decilog form.
(e.g. 10.3 = $10^{**}10.3 = 2 \times 10^{**}10$)

Rbit	This column displays the number of bits read in decilog.
Hard	This column displays the hard error rate for reads using the specified retry options. (If no retries are selected any error is a hard error). Any error displayed to the terminal using the level 2 R or Q commands will be counted in the hard error rate.
Firm	This column displays the firm error rate for reads using the specified retry options. A firm error is defined as an error that is recovered with rereads > once through the retry table, currently 46. Hard errors will also count against firm.
Soft	This column displays the soft error rate for reads using the specified retry options. A soft error is defined as an error that is recovered with 5 to 46 rereads. Hard or firm errors will also count against soft.
OTF	This column displays the On-The-Fly error rate for reads. An OTF error is defined as an error that is recovered with 1-5 rereads. Hard, firm, or soft errors will also count against OTF.
Raw	This column displays the error rate of any data error condition. It may be corrected by OTF or retry actions. This column is the key indication of the drive performance. Hard, firm, soft, and OTF errors will also count against raw.
Rhdr	This column displays the ID reread rate for reads.
Wbit	This column displays the number of bits written in decilog.
WHrd	This column displays the hard error rate for writes using the specified retry options. (If no retries are selected any error is a hard error). Any error displayed to the terminal using the level 2 W or Q commands will be counted in the hard error rate.
Wrtv	This column displays the write retry rate for writes.
Whdr	This column displays the ID rewrite rate for writes.

RBIT and WBIT are the common logarithm of the total number of bits transferred during reads and writes. For example, if Head 0 read 7.88×10^9 bytes, then RBIT for Head 0 is

$$\log_{10}(8 \text{ bits/byte} * 7.88 * 10^9) = 10.8$$

The remaining numbers represent the negative of the common logarithm of the error recovery usage rate on a sector-by-sector basis. This usage rate is scaled by the number of bits per sector to yield an approximate bit error rate that is relatively accurate at low error rates. Mathematically, "HARD," "FIRM," "SOFT," "OTF," "RAW" equal

$$-\log_{10}\left\{\frac{\text{Number of sectors in which controller invoked specified error recovery scheme}}{\text{Number of sectors transferred}} * (512 \text{ bytes/sector}) * (8 \text{ bits/byte})\right\}$$

"Error Recovery Usage Rate" means how often different error recovery schemes (e.g., HARD = multiple retries invoked and failed, FIRM = multiple retries invoked, SOFT = five retries invoked, OTF = one retry invoked, RAW = OTF ECC invoked) are utilized as reported by the controller. Because the controller can only report *that* an error recovery scheme was used, and not the *number of bytes* causing the invocation of the scheme, a single RAW error could be created by 1 bit in error or 4096 bits in error.

For example, a test transfers 16×10^6 sectors on Head 1.



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$$\text{RBIT} = \log_{10}(16 \times 10^6 \text{ sectors} \times 512 \text{ bytes/sector} \times 8 \text{ bytes/bit}) = 10.8$$

During this test five sectors experienced 1 error, ten sectors experienced 9 errors, and three sectors experienced 20 errors. Assuming that the controller can correct 16 errors per sector, the three sectors with 20 errors required retries. In the experiment, one of the three was uncorrectable, two of the three required six retries, and all three required a first retry. The results of this test are

$$\text{HARD} = -\log_{10}((1 \text{ sector}) / (16 \times 10^6 \text{ sectors} \times 512 \text{ bytes/sector} \times 8 \text{ bits/byte})) = 10.8$$

$$\text{FIRM} = -\log_{10}((2 \text{ sectors}) / (16 \times 10^6 \text{ sectors} \times 512 \text{ bytes/sector} \times 8 \text{ bits/byte})) = 10.5$$

$$\text{SOFT} = -\log_{10}((2 \text{ sectors}) / (16 \times 10^6 \text{ sectors} \times 512 \text{ bytes/sector} \times 8 \text{ bits/byte})) = 10.5$$

$$\text{OTF} = -\log_{10}((3 \text{ sectors}) / (16 \times 10^6 \text{ sectors} \times 512 \text{ bytes/sector} \times 8 \text{ bits/byte})) = 10.3$$

$$\text{RAW} = -\log_{10}(((5 + 10 + 3) \text{ sector}) / (16 \times 10^6 \text{ sectors} \times 512 \text{ bytes/sector} \times 8 \text{ bits/byte})) = 9.6$$

The 'Limit' identifies the pass/fail limits...



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Mux Status Display Description(%)

Returned data format:

:aabbcccddeeffgg hh'iiiiiii ' "jjjjjjjjjj"

aa	Age
	bb Program
ccc	Accumulated health
dd	Drive type
ee	Error flag byte B7 - B4 = for inter - proc communication - Not Used B3 = spin error - set when drive not spinning - Not Used B2 = seek mode - set when drive is seeking - Not Used B1 = Initialization error - set when error - Not Used B0 = Allow write gate - USED BY MUX - set when drive ready
ff	Error code byte
gg	Maximum number of heads for this type
hh	Interface SA = Asynchronous SCSI SS = Synchronous SCSI AT = AT Interface AX = AT with auto translate
iiiiiii	Drive serial number
jjjjjjjjjj	PCBA serial number

example:

:50500000E7000007 AX'GR00072 ' "123456789012"



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Transfer Status Display Description(†)

Returned data format:

```
Cmd Cyl Hd Sct Cnt Stbuf Segl Cset Cbuf Actv Ercd Rtry Flags
xx xxxx xx xxxx xxxx xxxx xx xxxx xxxx x xx wxxx.yy.zz xx
```

Cmd xx	Last command type
Cyl	Cylinder of current command
xxx Hd xx	Head of current command
Sct xxxx	Start sector of current command
Cnt xxxx	Length or block count EVER = R/W Forever
Stbuf xxxx	Start buffer number
Segl	Buffer size
Cset xx	Current Sector
Actv x	Command in progress
Ercd	Error code from current command
Rtry wxxx.yy.zz	Retry parameters (see level 2 Y command) ww retry control xx data retries yy write retries zz id retries
Flags xx	Flags

example:

```
Cmd Cyl Hd Sct Cnt Stbuf Segl Cset Cbuf Actv Ercd Rtry Flags
5A 0828 00 0000 0001 0000 10 0120 0001 N 00 0000.01.10 00
```



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Output format for drives with >64k cylinders:

Returned data format:

```
Cmd Cyl Hd Sct Cnt Stbuf Segl Csct Cbuf Actv Ercd Rtry Flags
xx xxxxx xx xxxx xxxx xxxx xx xxxx xxxx x xx wxxx.yy.zz xx
```

Cmd xx	Last command type
Cyl xxxxx	Cylinder of current command
Hd xx	Head of current command
Sct xxxx	Start sector of current command
Cnt xxxx	Length or block count EVER = R/W Forever
Stbuf xxxx	Start buffer number
Segl	Buffer size
Csct xx	Current Sector
Actv x	Command in progress
Ercd	Error code from current command
Rtry wxxx.yy.zz	Retry parameters (see level 2 Y command) ww retry control xx data retries yy write retries zz id retries
Flags xx	Flags

example:

```
Cmd Cyl Hd Sct Cnt Stbuf Segl Csct Cbuf Actv Ercd Rtry Flags
5A 0828 00 0000 0001 0000 10 0120 0001 N 00 0000.01.10 00
```


Active Status Display Description(.)

(FULLSLIP)

Returned data format:

Pgm=xx Trk=xxxx(yyyy).a(b).zzz(www) Zn=x Err=xx ErCt=xxxx Hlth=xxxx CHlth=xxxx sssss LBA=xxxxxxxx

Pgm=xx	Active program 00 is diagnostic monitor. 50 is interface program All other numbers are current test running.
Trk=xxxx(yyyy),a(b), zzz(www)	Currently selected logical cylinder (physical cylinder), logical head (physical head), logical sector (physical sector). Trk will normally point to one sector past the last sector read or written.
Err=xx	Error code from current operation
ErCt=xxxx	Error count since last reset of drive or last reset error log command
Hlth=xxxx	Accumulated health bits - four digits
CHlth=xxxx	Current health bits - four digits
sssss	Drive status. Can be Ready or Ntrdy
LBA=xxxxxxxx	Current LBA

example:

Pgm=50 Trk=0300(0301).2(0).034(068) Err=00 ErCt=0000 Hlth=0000 CHlth=0000 Ready LBA=00123492

Output format for drives with >64k cylinders:

Pgm=xx Trk=xxxxx(yyyyy).a(b).zzz(www) Zn=x Err=xx ErCt=xxxx Hlth=xxxx CHlth=xxxx sssss LBA=xxxxxxxx

Pgm=xx	Active program 00 is diagnostic monitor. 50 is interface program All other numbers are current test running.
Trk=xxxxx(yyyyy), a(b), zzz(www)	Currently selected logical cylinder (physical cylinder), logical head (physical head), logical sector (physical sector). Trk will normally point to one sector past the last sector read or written.
Err=xx	Error code from current operation
ErCt=xxxx	Error count since last reset of drive or last reset error log command
Hlth=xxxx	Accumulated health bits - four digits
CHlth=xxxx	Current health bits - four digits
sssss	Drive status. Can be Ready or Ntrdy
LBA=xxxxxxxx	Current LBA

example:

Pgm=00 Trk=00040(00040).0(0).253(15E) Zn=0 Err=00 ErCt=0000 Hlth=0000 CHlth=0000 Ready LBA=00000000

Machine Status Display Description(;

Returned data format:

Age=xx Type=xx MxCyl=xxxx MxHd=x MxSct=xxx Bsz=xx TCode=xxxx

Age=xx	Current drive age
Type=xx	Current drive type
MxCyl=xxxx	Maximum cylinders for this drive type in hex
MxHd=x	Maximum heads for this drive type in hex
MxSct=xxx	Maximum Sector for this drive type in hex
BSz=xx	Buffer size in hex
Tcode=xxxx	Test code for T.E. Hda Test

example

Age=50 Type=A4 MxCyl=1387 MxHd=3 MxSct=10D Bsz=80 Tcode=0000

Output format for drives with >64k cylinders:

Age=xx Type=xx MxCyl=xxxx MxHd=x MxSct=xxx Bsz=xx TCode=xxxx

Age=xx	Current drive age
Type=xx	Current drive type
MxCyl=xxxxx	Maximum cylinders for this drive type in hex
MxHd=x	Maximum heads for this drive type in hex
MxSct=xxx	Maximum Sector for this drive type in hex
BSz=xxxx	Buffer size in hex
Tcode=xxxx	Test code for T.E. Hda Test

Example

Age=50 Type=40 MxCyl=13833 MxHd=0 MxSct=362 BSz=0800 TCode=0000

Buffer Allocation Display Description(?)

Returned data format:

RD:xxxx:yy
 WR:xxxx:yy
 AC:xxxx:yy
 AS:xxxx:yy
 SC:xxxx:yy
 DP:xxxx:yy
 BA:xxxx:yy
 ST:xxxx:yy
 logbps:xxxx
 codebps:xxxx

FM:xxxx:yy
 AD:xxxx:yy
 RL
 SC AL

RD:xxxx:yy	xxxx = Buffer number for read buffer yy = Buffer size in sectors
WR:xxxx:yy	xxxx = Buffer number for write buffer yy = Buffer size in sectors
AC:xxxx:yy	xxxx = Buffer number for active log buffer yy = Buffer size in sectors
AS:xxxx:yy	xxxx = Buffer number for ascii log buffer yy = Buffer size in sectors
DP:xxxx:yy	xxxx = Buffer number for display log buffer yy = Buffer size in sectors
SC:xxxx:yy	xxxx = Buffer number for scratch buffer (general purpose use) yy = Scratch buffer size in sectors
BA:xxxx:yy	xxxx = Buffer number for batch file buffer
ST:xxxx:yy	xxxx = Buffer number for statistics log buffer yy = Buffer size in sectors
logbps:xxxx	Bytes per sector in cert log area
codebps:xxxx	Bytes per sector in code area
uP:xxxx:yy	xxxx = Buffer number for microprocessor ram yy = Buffer size in sectors
FM:xxxx:yy	xxxx = Buffer number for format operations (moving alts) yy = Buffer size in sectors
AD:xxxx:yy	xxxx = Buffer number for reading/saving adaptives yy = Buffer size in sectors
RL	Reserve slip test
SL	User slip list
AL	User Alt list

Health Bits Definitions:

The health byte is in the following format: X X X X . X X X X

The first 4 nibbles are the Current Health Bit and the last 4 are the Accumulated Health Bits.

The bits in the health byte description follows:

Bit # (if 1)	Meaning	Bit # (if 1)	Meaning
15	Excessive Skips or Alts	7	(internal use- abort test flag)
14	Hardware Error	6	(internal use- error 13 or 14)
13	Serious R/W Error	5	(internal use- too many dfcts/tk
12	Error Rate Health	4	Servo warning
11	Offtrack Error	3	Read/Write warning
10	Activate Error	2	Spindle Assist Skip or Alt
9	Servo Error	1	Spin Current Warning
8	Spin Error	0	Spin Error During Seek



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Error Log Display

Header Format:

All Drives Prior To VAIL:

```
Log 3A - Health 0000 - Cert Rev = 0.01 - Rom Rev = 0.05 - Time = 00:00:15
0075 Entries:
  Head_0_      Head_1_      Head_2_      Head_3_
43 007F.1EB 164 03  43 2238.18B 0A6 03  43 02B6.1FE 154 03  43 0261.249 145 03
```

All Drives After Durango:

```
Log 3A - Health 0000 - Cert Rev = 0.01 - Rom Rev = 0.05 - Time = 00:00:15 Log Type = 02
0075 Entries:
  Head_0_      Head_1_      Head_2_      Head_3_
43 007F.1EB 164 03  43 2238.18B 0A6 03  43 02B6.1FE 154 03  43 0261.249 145 03
```

Output format for drives with >64k cylinders:

```
Log 3A - Health 0000 - Cert Rev = 0.44 - Rom Rev = 0.44 - Time = 00:16:38 Log Type = 02
0004 Entries:
  Head_0_      Head_1_      Head_3_      Head_4_
90 00254.136 12E 01  90 10237.136 12E 01  90 05250.126 12E 01  90 10456.136 13E 01
```

Defect List Format:

All Drives Prior To VAIL:

After reading a cert log the defect information will be placed at the beginning of the display(active) buffer.

List Format:

Byte 0: Log number
Byte 1: Log Type
 0 = active log
 1 = ascii log
Byte 2-3: Major Health
Byte 4-5: Time of test in seconds
Byte 6-7: Next Entry Pointer
Byte 8-11: Cert Revision
Byte 12-15: Rom Revision
Bytes 16-22: First entry as follows:
Byte 16: error code
Byte 17: cylinder low
Byte 18: xyz
 x = bit 8 of logical sector #
 y = bit 8 of deskewed sector #
 zz = cylinder high
Byte 19: head
Byte 20: logical sector # bits 7:0
Byte 21: sense byte/deskewed sector # bits 7:0
Byte 22: count
Bytes 23-29: Second Entry etc.

When the log is displayed the output to the screen is formatted as shown below.

```
  Head  x
www.xxx.yyy.zz
where www is cylinder
xxx is logical sector #
```



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yyy is sense byte/deskewed sector #
zz is count



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All Drives After Durango:

After reading a cert log the defect information will be placed at the beginning of the display(active) buffer.

List Format:

- Byte 0: Log number
- Byte 1: Log Type
 - 1 = ascii log
 - 2 = active log
 - 4 = byte offset format for active log
- Byte 2-3: Major Health
- Byte 4-5: Time of test in seconds
- Byte 6-7: # of defects in log
- Byte 8-11: Cert Revision
- Byte 12-15: Rom Revision
- Bytes 16-23: First entry as follows:
 - Byte 16: error code
 - Byte 17: physical cylinder low
 - Byte 18: physical cylinder high
 - Byte 19: physical head
 - (If log type 4)
 - Byte 20: servo sector # bits 7:0
 - Byte 21: byte offset from servo sector # bits 7:0
 - Byte 22: xy
 - x= bits 11:8 of servo sector #
 - y=bits11:8 of byte offset #
 - Byte 23: count
 - (If log type 2)
 - Byte 20: logical sector # bits 7:0
 - Byte 21: deskewed sector # bits 7:0
 - Byte 23: count
- Bytes 24-31: Second Entry etc.

When the log is displayed the output to the screen is formatted as shown below.

<p>(Log Type 2)</p> <p> <u> </u>Head</p> <p>vv wwwwww.xxx yyy zz</p> <p>where wwww is physical cylinder xxx is logical sector # yyy is deskewed sector #</p>	<p>(Log Type 4)</p> <p> <u> </u>Head <u> </u>x <u> </u></p> <p>vv wwwwww.xxx yyy zz</p> <p>where wwww is physical cylinder xxx is servo sector # yyy is byte offset from servo sector #</p>
--	---

```
Log 3A - Health 00 00 - Cert Rev = 0.01 - Rom Rev = 0.05 - Time = 00:00:15 Log Type = 02
0075 Entries:
    Head_0                    Head_1
43 007F.1EB 164 03  43 2238.18B 0A6 03
43 02B6.1FE 154 03  43 0261.249 145 03
```

```
Log 31 - Health 00 00 - Cert Rev = 0.01 - Rom Rev = 0.05 - Time = 01:09:34 Log Type = 04
0D21 Entries:
    Head_0                    Head_1
43 0148.06A 14D 02  43 0024.017 669 0243 01D3.032 3CF 02  43 01DE.027 0C9 0143 020F.074 3A7 01  43
01FA.02C 21B 01
```

Output format for drives with >64k cylinders:

(Log Type 2)

Head
vv wwwwww.xxx yyy zz

where wwwwww is physical cylinder
xxx is logical sector #
yyy is deskewed sector #

(Log Type 4)

Head x
vv wwwwww.xxx yyy zz

where wwwwww is physical cylinder
xxx is servo sector #
yyy is byte offset from servo sector #

```
Log 31 - Health 0000 - Cert Rev = 002b - Rom Rev = 0.02b - Time = 01:57:22 Log Type = 04
0071 Entries:
    Head 0
43 002D0.02C 96D 01
43 004CD.0AC 651 02
43 004CE.0AC 651 02
```

```
Log 3A - Health 0000 - Cert Rev = 002b - Rom Rev = 0.02b - Time = 00:51:59 Log Type = 02
0040 Entries:
    Head 0
43 0002F.04D 22D 03
43 01187.2C1 111 03
```