

PRIAM SMART INTERFACE

PRODUCT SPECIFICATION

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## I. INTRODUCTION

### A. Purpose

This specification describes the performance, the logical interface, the electrical interconnection, and the physical interconnection of the PRIAM SMART Interface. This document provides the reference technical specifications required by users to connect the PRIAM SMART Interface to a host system with or without the use of a Direct Memory Access (DMA) port.

### B. General Description

The PRIAM SMART Interface is a complete preprogrammed microprocessor-based controller for the entire line of PRIAM Winchester disc drives. Up to four drives in any combination may be interconnected. The controller supports a variety of Read Sector, Write Sector, and Format commands. The data for the sector operations is transferred across an 8-bit parallel bidirectional data bus. The data transfers may be either programmed I/O or DMA transfers. Thus, the SMART Interface performs the entire function of detailed disc control while presenting to the host a basic and cost effective interface. The SMART Interface board may be mounted separately or attached to a PRIAM disc drive, either 8-inch or 14-inch.

### C. Features

1. Controls up to four PRIAM disc drives.
2. Supports all PRIAM 8-inch and 14-inch disc products in any combination.
3. Designed for easy attachment to the typical microprocessor bus.
4. Does all bit serialization and format related functions. The host uses a simple byte-wide interface.
5. User-selectable sector sizes of 128, 256, 512, or 1024 bytes.
6. Full sector buffering which supports data transfers at any rate below 2 megabytes per second.
7. Both interrupt driven and polled operation are supported.
8. On-board 16-bit CRC on both ID header and data.

9. Automatic alternate sector assignment and read or write sector logic handle media defects transparent to the host.
10. Overlapped commands are supported. For example, three drives may be seeking, while seeking, reading, or writing on the fourth drive.
11. The SMART Interface supports implied operations. For example, issuing a Read Command to a drive in which the disc is not turning will cause the drive to Sequence Up, Restore, Seek to the desired cylinder, Select the appropriate head, and Read the desired sector.
12. Versatile verify functions may be used for seek verification, sector data verification, track data verification, cylinder data verification, and complete disc data verifications.
13. Resident microdiagnostics.

## II. PRODUCT DESCRIPTION\*

### A. Physical Characteristics

The SMART Interface logic is packaged on a single printed circuit board (13.75 by 8.30 inches) which may be mounted on either a 14-inch or 8-inch drive. There are three connectors: one for the host bus connector, one for drive connection, and a third for DC power.

### B. Power Requirements

+ 5 VDC,  $\pm$  5%, 3 AMP maximum

### C. Environmental Characteristics

#### 1. TEMPERATURE

- a. Equipment Operational: 15° C to 40° C (57° F to 104° F).
- b. Equipment Non-operational: -40° C to 60° C (-40° F to 140° F).
- c. 150 feet per minute air velocity must be maintained over base casting of attached drive.

#### 2. HUMIDITY

- a. Equipment Operational: 20% to 80% relative humidity, with a wet bulb temperature limit of 26° C (78° F) without condensation.
- b. Equipment Non-operational: 20% to 80% without condensation.

#### 3. ALTITUDE

- a. Equipment Operational: From 1000 feet below sea level to 7000 feet above sea level.
- b. Equipment Non-operational: From 1000 below sea level to 40,000 feet above sea level.

\* Specifications and characteristics provided in this document are subject to change without notice.

D. Reliability

1. MTBF

The SMART Interface has an expected mean time between failures (MTBF) of 8000 power-on hours.

2. MTTR

The SMART Interface is a field replaceable unit with a mean time to repair (MTTR) of less than 1/4 hour.

E. Controls

1. W1-A Position

If jumper W1 is in the A position PROM 12K is selected as a 2732 (this jumper is selected by a PCB trace).

2. W1-B Position

If jumper W1 is in the B position PROM 12K is selected as a 2716.

3. W2, W3, W4

If these jumpers are out, the PRIAM open loop clock or A level interface is selected.

If these jumpers are in, the PRIAM closed loop clock or B level interface is selected.

4. W5

This jumper enables the Head 4 line, used on the DISKOS 3450 and the DISKOS 15450.

### III. ELECTRICAL INTERFACE

#### A. Interface Signals

The interface signals are defined in this section. Table 2 shows the connector pin assignment. All SMART Interface signal connections are via a single 40 pin ribbon cable connector. See Table 1 for the recommended drivers and receivers.

##### 1. HCBUS0 thru HCBUS7

This is the host bus. It is a high-active 8-bit wide bidirectional bus used to transfer control, status information and data. Data is transferred across this bus by successive operations with the Disc Data Register. The most significant bit is HCBUS7. The bus is TRISTATE bidirectional with the drivers enabled when the HRD signal is active. The receivers are enabled when the HRD signal is inactive.

Recommended termination for this bus is a 330 ohm resistor to +5 volts and a 390 ohm resistor to ground. Note: High current drivers (as listed in Table 1) are required to drive the HCBUS lines.

##### 2. HRD/

This low-active signal gates the contents of the selected register (decode of HAD2, HAD1, HAD0) onto the HCBUS. See Table 3 for register decode assignment. This signal is terminated at the SMART Interface with a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

##### 3. HWR/

This low-active signal gates the contents of the HCBUS into the selected register (decode of HAD2, HAD1, HAD0). See Table 3 for register decode assignment. This signal is terminated at the SMART Interface with a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

##### 4. HAD2, HAD1, HAD0

A high-active 3-bit-wide unidirectional address bus used to select one of eight register pairs. One member of the pair stores the HCBUS contents while the contents of the other may be placed on the HCBUS depending upon the host's manipulation of HRD and HWR.

These signals are terminated at the SMART Interface with a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

5. RESET/

This low-active signal resets the SMART Interface logic and places it into the initialized state. The SMART Interface Busy bit will be set while initialization is in process.

This signal is terminated at the SMART Interface with a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

6. HIR/

This low-active signal may be used by the host as an interrupt request. It is set active coincident with the setting of Command Completion bit in the SMART Interface Status Register and it is cleared upon the receipt of the Completion Acknowledge Command.

Note: Interrupts are disabled by a power-up or controller reset. Interrupts are enabled by the first Command Acknowledge.

Recommended termination for this signal is a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

7. HREAD/HWRITE

This signal from the SMART Interface indicates the direction of data transfer across the HCBUS. If this signal is high, a read (data from SMART Interface to host) is the expected direction. When low, this line indicates that a write (data from the host to the SMART Interface) is expected.

Recommended termination for this signal is a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

8. DBUSENA/

When low, this signal from the SMART Interface to the host indicates that the SMART Interface is enabled and ready to transfer data.

Recommended termination for this signal is a 220 ohm resistor to +5 volts and a 330 ohm resistor to ground.

9. DTREQ/

This low-active signal from the SMART Interface to the host requests data transfers across the host bus (HCBUS).

This line is active when data is required and remains active until the proper number of bytes are transferred.

Recommended termination for this signal is a 220 ohm resistor to +5 volts and 330 ohm resistor to ground.

TABLE 1 - Recommended Drivers/Receivers

<u>Signal</u>	<u>Driver/Receiver</u>
HCBUS7-HCBUS0	Intel 8286,8287, National 8304B or equivalent
All other receivers	74LS14 or equivalent
All Other drivers	75461,75462,75463 or equivalent

TABLE 2 - Interface Connector Pin Assignment (J2)

<u>PIN Number</u>	<u>Signal</u>	<u>PIN Number</u>	<u>Signal</u>
1	Ground	31	Reserved
2	HCBUS0	32	Reserved
3	HCBUS1	33	Reserved
4	HCBUS2	34	Reserved
5	HCBUS3	35	Reserved
6	HCBUS4	36	Reserved
7	HCBUS5	37	Reserved
8	HCBUS6	38	Reserved
9	HCBUS7	39	Reserved
10	Ground	40	Reserved
11	HRD/		
12	Ground		
13	HWR/		
14	Ground		
15	HAD2		
16	HAD1		
17	HAD0		
18	Ground		
19	RESET/		
20	Ground		
21	HIR/		
22	Ground		
23	HREAD/HWRITE		
24	DBUSENA/		
25	Ground		
26	DTREQ/		
27	Ground		
28	Reserved		
29	Reserved		
30	Reserved		

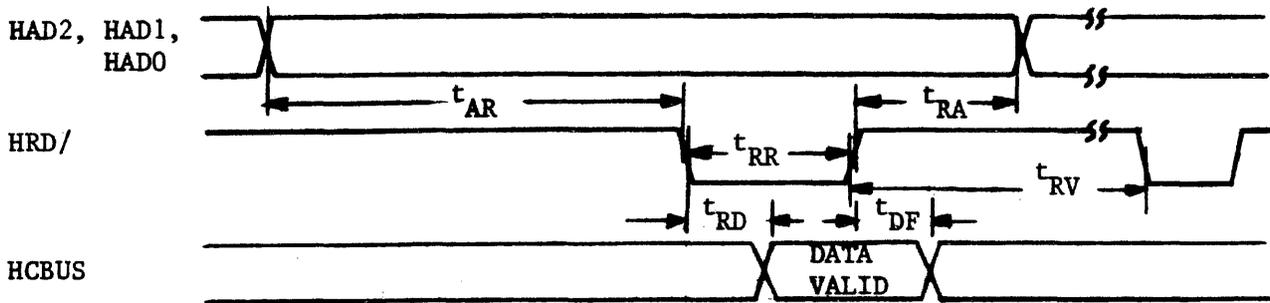
B. Data Transfer to or from the SMART Interface

All data is transferred to or from the SMART Interface on the HCBUS lines under the control of the host-generated HWR and HRD strobe lines. Figures 1 and 2 show the register Read and Write AC characteristics.

Commands and parameters are usually transferred to the SMART Interface through the use of programmed I/O. Under programmed I/O the host processor is in direct control of the I/O operation.

Many of the commands also contain a data transfer phase which may transfer large blocks of data. Some host interface designers may elect to implement Direct Memory Access (DMA) for the data transfer phase of the commands.

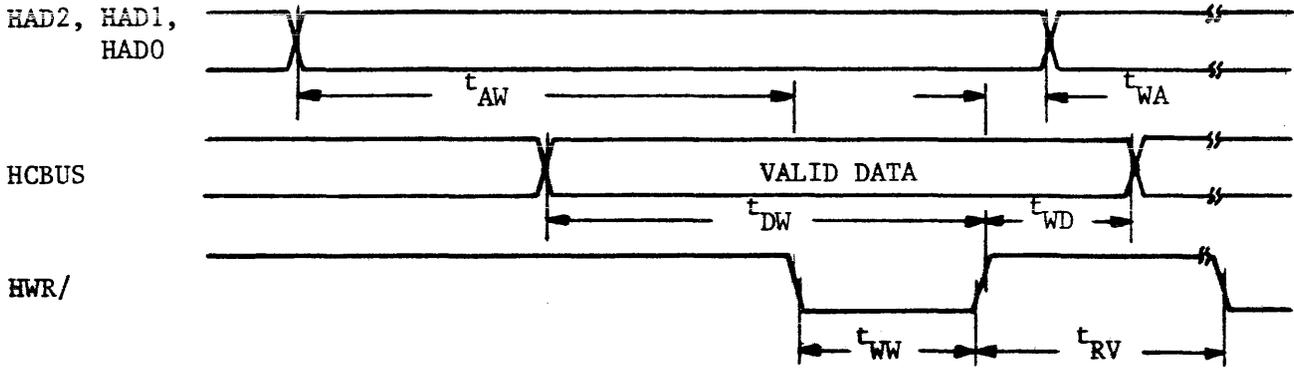
Figures 1, 2, and 3 are valid for command or data transfers using programmed I/O or DMA data transfers.



HCBUS

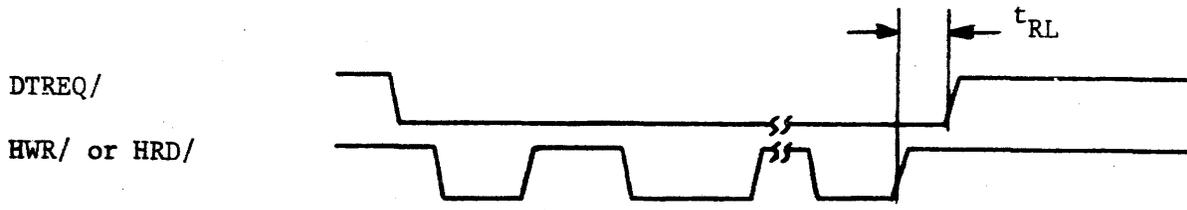
<u>Symbol</u>	<u>Parameter</u>	<u>Min</u>	<u>Max</u>	<u>Units</u>
t <sub>AR</sub>	Address stable before RD	60		ns
t <sub>RA</sub>	Address hold time for RD	30		ns
t <sub>RR</sub>	RD pulse width	250		ns
t <sub>RD</sub>	Data delay from RD		120	ns
t <sub>DF</sub>	RD to data floating		40	ns
t <sub>RV</sub>	Recovery time between RD	250		ns

Figure 1 - Register Read AC Characteristics



<u>Symbol</u>	<u>Parameter</u>	<u>Min</u>	<u>Max</u>	<u>Units</u>
$t_{AW}$	Address stable before WR	60		ns
$t_{WA}$	Address hold time for WR	30		ns
$t_{WW}$	WR pulse width	250		ns
$t_{DW}$	Data set up time for WR	60		ns
$t_{WD}$	Data hold time for WR	30		ns
$t_{RV}$	Recovery time between WR	250		ns

Figure 2 - Register Write AC Characteristics



<u>Symbol</u>	<u>Parameter</u>	<u>Min</u>	<u>Max</u>	<u>Units</u>
$t_{RL}$	Data Transfer Release		200	ns

Figure 3 - Data Request AC Characteristics

## IV. FUNCTIONAL INTERFACE

### A. Command Initiation

Commands and data are transferred across an 8-bit bidirectional bus under control of host-generated HRD and HWR strobes. Registers within the controller are selected by decoding of three address lines: HAD2, HAD1, and HAD0. Information is transferred over the TRISTATE bidirectional bus (HCBUS7 to HCBUS0). An active HRD signal places the bus in the transmit mode; an active HWR signal places the bus in the receive mode.

Table 3 shows the addressing required to select each of the control registers.

A command is issued whenever the host loads the command register. Therefore, all the appropriate parameter registers must be loaded prior to loading the Command Register. When the Command Register is loaded, the Busy bit in the SMART Interface Status Register will be set and will remain set until the command is validated and the parameter registers are copied into the SMART Interface local memory.

A Command Reject will be set if any of the following errors occur:

1. The command is invalid.
2. The drive number is invalid.
3. The selected drive already has a command pending.
4. The command was written to the command register while busy was set.

The Host Interrupt Request (HIR) is not activated if the command is rejected during the initial command validation phase.

After the command has been accepted, a command completion is indicated through the Controller Completion Request bit in the SMART Interface Status Register (see Table 4).

When the Command Completion Request Bit is set, the Host Interrupt Request line (HIR) is activated.

TABLE 3 - Control Register Assignment

<u>HAD2</u>	<u>HAD1</u>	<u>HAD0</u>	<u>HRD</u>	<u>HWR</u>	<u>Register</u>
0	0	0	1	0	SMART Interface Status
0	0	1	1	0	Read Disc Data
0	1	0	1	0	Result 0 (Transaction Status)
0	1	1	1	0	Result 1
1	0	0	1	0	Result 2
1	0	1	1	0	Result 3
1	1	0	1	0	Result 4
1	1	1	1	0	Result 5
0	0	0	0	1	Command
0	0	1	0	1	Write Disc Data
0	1	0	0	1	Parameter 0
0	1	1	0	1	Parameter 1
1	0	0	0	1	Parameter 2
1	0	1	0	1	Parameter 3
1	1	0	0	1	Parameter 4
1	1	1	0	1	Parameter 5

TABLE 4 - SMART Interface Status Register

<u>Bit</u>	<u>Name</u>	<u>Description</u>
CS7 (MSB)	Command Reject	An undefined or invalid command was received.
CS6	SMART Interface Command Completion Request	The SMART Interface has performed the requested function and the transaction status is available in the Transaction Status Register.
CS5,4	--	Not Used
CS3	SMART Interface Busy	The SMART Interface has received a command and is busy parsing the requested command.
CS2	Data Transfer Request	This bit indicates the state of the DTREQ interface line.
CS1	Read/Write Request	If this bit is active and the Data Transfer Request line is active, a read data operation is required. If this bit is not active and the Data Transfer Request line is active, a write data operation is required. This high active bit indicates the state of the HREAD/HWRITE interface line.
CS0 (LSB)	Data Bus Enable	The Data Bus Enable bit indicates that the SMART Interface has successfully completed its self test. This high active bit indicates the state of the DBUSENA interface line.

## B. Transaction Status (Result Register 0)

The Transaction Status Register (Result 0) indicates the result of a SMART Interface command. The format of the Transaction Status Register is shown in Table 5. When the SMART Interface Status Register indicates that a completion request is pending, the host processor should read the Transaction Status Register to determine the outcome of the command. The four major completion types are listed below:

### 1. Good Completion - 0

This type of completion indicates that the command was successfully completed, but some steps may have been retried.

The following codes are generated if the automatic retry logic is unable to recover from the error.

### 2. System Error - 1

These errors result from a system, controller or drive problem.

### 3. Operator Intervention - 2

These types of errors require human intervention for recovery.

### 4. Command/Drive Error - 3

Command errors are usually due to a user program error.

Table 6 provides more detailed information about completion types and completion codes.

TABLE 5 - Transaction Status Register

Bit Number:	7	6	5	4	3	2	1	0
Bit Designation:	D1	D0	T1	T0	CC3	CC2	CC1	CC0

<u>Bit</u>	<u>Name</u>	<u>Description</u>
D1, D0	Drive	This field indicates to which drive the transaction status applies.
T1, T0	Completion Type	This field defines the four major classes of completion. See Table 6.
CC3, CC2, CC1, CC0	Completion Code	The completion codes provide a detailed definition of the command termination. See Table 6.

TABLE 6 - Completion Code Summary

<u>Completion Type</u> (Bits 5-4)	<u>Completion Code</u> (Bits 3-0)	<u>Definition</u>
0	0	No Retries Required
	1	Motion Retry Required
	2	Data Retry Required
1	0	Not Used
	1	CRC Error
	2	Seek Fault - Drive Reported
	3	Drive Fault
	5	Seek Fault - Cylinder Mismatch
	6	Initialization Complete
	7	Stack Error
	8	Hardware Trap
	9	Read Loss Synchronization
	A	RAM Failure
B	ID Buffer Failure	
2	0	Drive Not Ready
	1	Write Protect
	2	Drive Not Present
	3	Sector Size Invalid
	4	Alternate Area Overflow
3	0	Sector Not Found
	1	SMART Command Reject
	2	Drive Busy Command Time-Out
	3	Data Transfer Time-Out
	4	Illegal Cylinder/Head
	5	Invalid Drive Number
	6	Sector Number Invalid
	7	Command Already In Progress
	8	Command Double Write
	9	Drive Command Reject
A	Multisector Operation Error	

The following section provides a summary of the completion codes and a detailed description of each code.

<u>Transaction Status (Bits 5-0)</u>	<u>Definition</u>
00	<b>No Retry Required</b> This status code indicates that the command completed successfully without any retries.
01	<b>Motion Retry Required</b> This status code indicates that an automatic retry was used to recover from an error and then the command completed successfully.
02	<b>Data Retry Required</b> This status code indicates that a data error occurred (CRC) but an automatic retry recovered from the error and completed the command successfully.
11	<b>CRC Error</b> This status code indicates that a CRC error was detected on a read operation.
12	<b>Seek Fault - Drive Reported</b> This status code indicates that a seek was attempted and the seek failed. The seek error was indicated in the disc drive status.
13	<b>Drive Fault</b> This status code indicates that the operation was terminated due to one of the conditions in Table 7.
15	<b>Seek Fault - Cylinder Mismatch</b> This status code indicates that a seek was performed and completed by the drive, but a comparison of the drive current cylinder registers with the intended address indicated that the wrong cylinder was selected.
16	<b>Initialization Complete</b> This status code indicates that the SMART Interface has successfully completed a restart operation (power up or interface line reset). This completion provides the following Result Register values:

Transaction Status  
(Bits 5-0)

Definition

Result 1 = AA  
Result 2 = 55  
Result 3 = F0  
Result 4 = 0F  
Result 5 = 00

This completion does not generate an interrupt request, but it must be acknowledged by a completion acknowledge command.

- 17           Stack Error  
              This status code indicates that a hardware failure occurred that resulted in an instruction fetch from a nonexistent program memory location.
- 18           Hardware Trap  
              This status code indicates that an unexpected processor interrupt (trap) occurred.
- 19           Read Loss Synchronization  
              This status code indicates that read operation was terminated before the expected number of data bytes were read from the disc.
- 1A           RAM Failure  
              This status code indicates that the micro-diagnostics have detected a bad RAM location.
- The result registers have the following meanings:
- Result 1 = Expected Data  
                  Result 2 = Received Data  
                  Result 3 = Memory Address MSB  
                  Result 4 = Memory Address LSB
- 1B           ID Buffer Failure  
              This status code indicates that the micro-diagnostics have detected an error in the ID buffer.
- The result registers have the following meanings:
- Result 1 = Expected Data  
                  Result 2 = Received Data  
                  Result 3 = Buffer Location

Transaction Status  
(Bits 5-0)

Definition

- |    |  |
|----|--|
| 20 | Drive Not Ready<br>This status code indicates that the SMART Interface attempted to sequence up the drive and the drive did not indicate that it was ready within the expected period of time. |
| 21 | Write Protect<br>This status code indicates that a write operation was attempted on a write-protected drive.   |
| 22 | Drive Not Present<br>The drive specified is not connected or not powered up.   |
| 23 | Sector Size Invalid<br>The sector switches on the drive are set incorrectly.   |
| 24 | Alternate Area Overflow<br>This status code indicates that there are more defective sectors or tracks than there are spare sectors or tracks on the disc.                                      |
| 30 | Sector Not Found<br>This code indicates that the specified logical sector could not be located.  |
| 31 | SMART Command Reject<br>The received command is not supported by the SMART Interface.  |
| 32 | Drive Busy Command Time-out<br>This status code indicates that the SMART Interface issued a command to the drive and the drive did not properly complete the command.                          |
| 33 | Data Transfer Timeout<br>This status code indicates that the SMART Interface requested a data transfer and the transfer was not completed within 3 seconds.                                    |
| 34 | Illegal Cylinder/Head<br>This code indicates that a head number or cylinder number greater than the maximum supported was specified as a parameter.  |

Transaction Status  
(Bits 5-0)

Definition

35	Invalid Drive Number This code indicates that a drive number greater than three was specified as a parameter.
36	Sector Number Invalid This code indicates that a physical operation, as distinguished from a logical operation, failed to find the specified sector.
37	Command Already In Progress This code indicates that the specified drive already had a command in progress.
38	Command Double Write This error occurs if the host writes to the command register when the SMART Interface Busy bit is set.
39	Drive Command Reject This error code indicates either a SMART Interface or drive hardware failure.
3A	Multisector Operations Error This error code indicates that a read or write data command was issued with a multisector count equal to zero or greater than 7F HEX.

TABLE 7 - Drive Fault Conditions

1. WRITE GATE without write current at the head.
2. Write current at the head without WRITE GATE.
3. WRITE GATE without READY.
4. More than one head selected.
5. No transitions during write (MFM format).
6. WRITE GATE with WRITE PROTECT.
7. WRITE GATE between INDEX and the first SECTOR MARK.

### C. Command Descriptions

This section defines each of the SMART Interface commands.

Each command description specifies the parameters required and the results obtained.

There is a common format used for both parameter and result registers used in most commands.

The formats of the most common parameter registers are as follows:

#### Parameter Register 0

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	0	0	0	0	0	D1	D0

where:

<u>D<sub>1</sub></u>	<u>D<sub>0</sub></u>	
0	0	Drive 1
0	1	Drive 2
1	0	Drive 3
1	1	Drive 4

#### Parameter Register 1

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	H2	H1	H0	C11	C10	C9	C8

where: H2, H1, H0 define the target head address and C11, C10, C9, C8 are the upper binary bits of the target cylinder address.

#### Parameter Register 2

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	C7	C6	C5	C4	C3	C2	C1	C0

where: C7 through C0 are the 8 least significant bits of the target cylinder address.

### Parameter Register 3

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	S6	S5	S4	S3	S2	S1	S0

where: S6 through S0 are the 7 binary bits defining the target sector.

### Parameter Register 4

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	M6	M5	M4	M3	M2	M1	M0

where: M6 through M0 are the 7 binary bits defining the total number of consecutive logical sectors to be written.

The formats of the most common result registers are as follows:

### Result Register 0

See Table 5 for the Result Register 0 definition.

### Result Register 1

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	H2	H1	H0	C11	C10	C9	C8

where: H2, H1, H0 define the current selected head address and C11, C10, C9, are the upper binary bits of the current cylinder address

### Result Register 2

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	C7	C6	C5	C4	C3	C2	C1	C0

where: C7 through C0 are the 8 least significant bits of target cylinder address.

Result Register 3

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	S6	S5	S4	S3	S2	S1	S0

where: S6 through S0 define the number of the last sector.

Result Register 4

Bit Number	7	6	5	4	3	2	1	0
Bit Designation	0	M6	M5	M4	M3	M2	M1	M0

where: M6 through M0 indicate the residual sector count (non-zero if an unrecovered error occurred).

## Command Definitions

Using the parameter and result register formats provided, the following command definitions apply to the SMART Interface.

Command: Completion Acknowledge

Command Code: 00 HEX

Parameters: None

Results: None

Data Transfer: None

Function: Upon completion of a previously issued command the Command Completion Request bit in the SMART Interface Status Register will be set. When this bit is set, the host system should read the appropriate result registers, and reset the Command Completion Request bit by issuing the Completion Acknowledge command.

If a command for another drive has been completed, i.e., overlapped seeks, the bit will be set immediately after updating the result registers, requiring another Completion Acknowledge command to clear it.

Command: Read Drive Type

Command Code: 86 HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status  
Result 1 - Drive Type (see Table 8)

Data Transfer: None

Function: This command is used to determine the type of drive attached to the SMART Interface. (See Read Drive Parameters Command.)

The drive type is not returned if the transaction status indicates an error occurred. Table 8 lists the drive ID assignments.

TABLE 8 - Drive ID Assignment

<u>ID Code (HEX)</u>	<u>Drive Designation</u>
00	Invalid
01	DISKOS 3350-01 or -10 (20,160 bytes/track)
02	DISKOS 3350-01 (19,960 bytes/track)
03	DISKOS 3450 (12,960 bytes/track)
04	DISKOS 3450 (13,440 bytes/track)
05	DISKOS 2050 (13,440 bytes/track)
06	DISKOS 6650
07	DISKOS 15450
08-0F	Reserved
10	DISKOS 570-1
11	DISKOS 1070-1
12	CD8005
13	CD8010
14	DISKOS 570-2
15	DISKOS 1070-2
16-1F	Reserved
20-FF	Reserved

Command: Read Drive Parameters

Command Code: 85 HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status  
Result 1 - Number of Heads/Number of Cylinders MSB  
Result 2 - Number of Cylinders LSB  
Result 3 - Number of Sectors Per Track  
Result 4 - Logical Sector Size MSB  
Result 5 - Logical Sector Size LSB

Data Transfer: None

Function: This command may be used by a software driver that is set up to handle multiple disc types. Through the use of this command, the driver can determine the parameters required to use the disc.

The Read Drive Parameters command returns the number of user data cylinders available. If defect mapping is enabled, the cylinders reserved for alternate sectors or tracks are not included in the number of cylinders reported.

Command: Format Disc With Defect Mapping

Command Code: A8 HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command is used to format the disc with defect mapping enabled. The format phase of this command sets up the disc format described in Appendix A.

Appendix B defines the defect mapping features.

This command performs the following major operations:

1. Formats disc by writing the ID fields for all sectors.
2. Identifies and flags all defective sectors and tracks.
3. Builds the defect directory.
4. Assigns alternate sectors and tracks for all defective areas.

Command: Specify Bad Sector

Command Code: AA HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Physical Sector

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command is used by a host routine to request that the SMART Interface flag a bad sector and assign an alternate.

This command should only be used when the host logic identifies a bad sector that is not specified in the Skip Defect Field.

Before this command may be executed, the disc must be formatted with defect mapping enabled.

Command: Specify Bad Track

Command Code: A9 HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 3 - Cylinder LSB

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command is used by a host routine to request that the SMART Interface flag a bad track and assign an alternate.

This command should only be used when the host logic identifies a bad track that is not specified in the Skip Defect Field.

Before this command may be executed, the disc must be formatted with defect mapping enabled.

Command: Format Disc

Command Code: A0 HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command is used to format the disc without defect mapping. This command or the Format Disc with Defect Mapping should be used whenever a new sector size is selected through the sector switches on the disc drive.

The disc format is described in Appendix A.

Command: Format Cylinder

Command Code: A1 HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command is used to format a single cylinder on the disc or discs (see Format Disc command).

Command: Format Track

Command Code: A2 HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command is used to format a single track on the disc (see Format Disc command).

Command: Build Defect Directory

Command Code: A7 HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status

Data Transfer: None

Function: This command performs the Defect Directory initialization portion of the Format Disc with Defect Mapping command. Appendix B describes the defect map format.

This command is not required if the Format Disc with Defect Mapping command is issued.

Command: Read Defect Directory

Command Code: A6 HEX

Parameters: Parameter 0 - Drive Address  
Parameter 3 - Directory Entry (0 or 1)

Results: Result 0 - Transaction Status

Data Transfer: 128 bytes of data are transferred from the SMART Interface to the host.

Function: This command may be used to read the Defect Directory if the disc has been formatted with defect mapping enabled (see Appendix B).

Command: Write Data

Command Code: 52 HEX - Retry Enabled  
42 HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Sector  
Parameter 4 - Multisector Count

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector  
Result 4 - Multisector Count

Data Transfer: This command will cause data to be transferred from the host to the SMART Interface.

If the user requested data will fit in the 1024-byte buffer, all the data is transferred in one block.

If the total data to be written is greater than 1024 bytes, the data transfer is broken into multiple 1024-byte block data transfers from the host with the data being written to the disc between block transfers.

If a Write Data Command requires a head switch or a seek because the multisector operation crossed a track boundary, the data transfer request is broken at the head switch or seek operation even if more data could have been placed in the buffer.

Function: The Write Data command causes data to be written to the disc in accordance with the parameters specified. The parameters specify which drive, which cylinder, which head, which logical sector, and how many contiguous logical sectors. The command defines whether or not the write operation will be retried if the first attempt is unsuccessful. Also, Sequence Up, Seek, and Head Select are implied by this command.

The command execution sequence is described below:

- A. A Fault Reset is issued to the drive if the Drive Fault status bit is active.
- B. If the drive is not ready the SMART Interface will issue a Sequence Up command to the drive and wait for a drive Ready or time-out. If time-out occurs, a retry or error termination will be performed.

- C. If the read/write head is not over the desired cylinder, a seek is issued to the drive to position the head at the target cylinder.
- D. Data is transferred from the host (see Data Transfer described above) to the SMART Interface.
- E. The correct head is selected and consecutive ID fields on the target track are read until a match is found between the recorded logical sector number and the parameter-specified sector number.
- F. The data field is written from the buffer.
- G. The multiple sector count from Parameter Register 4 is decremented.
- H. If the multiple sector count has terminated, then command is complete and the appropriate Result Registers are updated.
- I. If the multiple sector count is non-zero, the sector number is incremented (modulo the number of sectors per track); then the buffer contents are checked. If the buffer is empty, then Step D is executed. Since the buffer is 1024 bytes, and sectors may be 128, 256, or 512 bytes; the ensuing sector data may be resident in the buffer. If the sector number is zero, then the next head is selected unless currently on the last head of the cylinder. If not, Step E is executed. If the last head is selected, the head address is set to zero and the cylinder address is incremented. Step C is then performed.

The Command Completion bit is set whenever the command is completed or an unrecoverable error occurs.

Command: Read Data

Command Code: 53 HEX - Retry Enabled  
43 HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Sector  
Parameter 4 - Multisector Count

Results: Result 0 - Transaction Status  
Result 1 - Heads/Cylinders MSB  
Result 2 - Cylinders LSB  
Result 3 - Sector  
Result 4 - Multisector Count

Data Transfer: This command will cause data to be transferred from the SMART Interface to the host.

If the user requested data will fit in the 1024 byte buffer, all the data is read into the buffer before a data transfer request is made to the host.

If the total data to be read is greater than 1024 bytes, the data transfers are broken into multiple 1024 byte blocks read from the disc and then transferred to the host.

If a Read Data Command requires a head switch or a seek because the multisector operation crossed a track boundary, the data transfer request is broken at the head switch or seek operation even if more data could have been placed in the buffer.

Function: The Read Data command causes data to be read from the disc in accordance with the parameters specified.

The command execution sequence is described below:

- A. A Fault Reset is issued to the drive if the Drive Fault status bit is active.
- B. If the drive is not ready the controller will issue a Sequence Up command to the drive and wait for a drive Ready or time-out. If time-out occurs, a retry or error termination will be done.
- C. If the access arm is not over the desired cylinder, a seek is issued to position the arm at the target cylinder.
- D. The desired head is selected.

- E. Consecutive ID fields on the target track are read until a match is found between the recorded logical sector number and the parameter specified sector number.
- F. Then the data field is read from the disc into the buffer.
- G. The multiple sector count in Parameter Register 4 is decremented.
- H. If the multiple sector count is zero, then a data transfer request from the controller to the host is signalled. The controller waits for the data transfer to complete and when complete, the Command Completion bit is set and the Result Registers are updated.

If the multiple sector count is non-zero, then the sector count is updated; also head and cylinder address are updated as required. If buffer space is available for the next sector, step E is repeated and the sequence is continued.

If the buffer is full, a data transfer operation is requested as discussed above. When the data transfer is done, Step C is repeated and the sequence is continued.

Command: Read Internal Status  
Command Code: 05  
Parameters: None  
Results: Result 0 - Transaction Status  
Result 1 - Internal Status (Described below)  
Data Transfer: None  
Function: If the command reject bit in Controller Status Register is set, the Read Internal Status Command may be used to determine why the command was rejected. The Internal Status Code returned in Result Register 1 will be one of the transaction status codes listed in Table 6.

Command: Read Drive Status  
Command Code: 06 HEX  
Parameters: Parameter 0 - Drive Address  
Results: Result 0 - Transaction Status  
Result 1 - Drive Status (see Table 9)  
Data Transfer: None  
Function: The Read Drive Status command is used to obtain the status of the drive selected by parameter register 0.  
Only one read status command may be outstanding at a time.

TABLE 9 - Drive Status Bit Definition

Result Register 1

<u>Bit</u>	<u>Name</u>	<u>Description</u>
B7 (MSB)	Command Reject	Control or Register Load command received while drive is not ready, or improper command received.
B6	Write Protect	The head selected is write protected. Write protection is set by switches in the drive or when the drive is not sequenced up.
B5	Drive Fault	A fault was detected during a write operation or a drive unsafe condition was detected.
B4	Busy	The drive is in process of executing a command.
B3	Cylinder Zero	The access arm is set to Cylinder 0.
B2	Seek Fault	A fault was detected during a seek operation.
B1	Seek Complete	This bit is set when a seek operation is completed.
B0 (LSB)	Ready	The drive is up to speed, servo system is locked onto a servo track, and the unit is in a state to read, write, or seek.

Command: Software Reset  
Command Code: 07 HEX  
Parameters: None  
Results: Result 0 - Transaction Status  
Data Transfer: None  
Function: This command causes the SMART Interface to abort all inprogress commands and run the microdiagnostics.

Command: Sequence Up - Return  
Command Code: 83 HEX  
Parameters: Parameter 0 - Drive Address  
Results: Result 0 - Transaction Status  
Result 1 - Drive Status (see Table 9)  
Data Transfer: None  
Function: The Sequence Up - Return command will cause the disc drive defined by the contents of Parameter Register 0 to power-up its spindle motor. When the command is accepted by the selected drive the Command Completion bit is set and the drive status will be in Result Register 1. The operation is similar to that in Sequence Up - Wait command but the controller does not wait until the drive is up to speed and the heads are positioned over Cylinder 0 before posting the command completion.

Command: Sequence Up - Wait  
Command Code: 82 HEX  
Parameters: Parameter 0 - Drive Address  
Results: Result 0 - Transaction Status  
Result 1 - Drive Status (see Table 9)  
Data Transferred: None

Function: The Sequence Up - Wait command causes the disc drive defined by the contents of Parameter Register 0 to power its spindle motor. The disc drive will monitor the rotational speed of the disc and when it is at speed and stable, the drive will position the heads at cylinder zero. When this is completed the Command Completion bit will be set with the drive status in Result Register 1.

The Sequence Up - Wait command is similar to the Sequence Up - Return command except this command will require about 30 seconds to complete.

Command: Sequence Down  
Command Code: 81 HEX  
Parameters: Parameter 0 - Drive Address  
Results: Result 0 - Transaction Status  
Result 1 - Drive Status (see Table 9)  
Data Transferred: None

Function: The Sequence Down command causes the disc drive defined by the contents of Parameter Register 0 to position the heads over the landing zone. The spindle motor's dynamic braking is initiated. The drive will set the Write Protect status bit and clear the Ready bit. When dynamic braking is initiated the Command Completion bit will be set with the drive status in Result Register 1.

Command: Write ID

Command Code: 55 HEX - Retry Enabled  
45 HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Physical Sector Number  
Parameter 4 - Multisector Count (1 to number of  
sectors/track)

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder Address MSB  
Result 2 - Cylinder Address LSB  
Result 3 - Physical Sector Address  
Result 4 - Residual Multisector Count

Data Transferred: The 4 byte ID field data is transferred from the host to the SMART Interface.

Byte 0 - Logical Sector Number  
Byte 1 - Head/Cylinder MSB  
Byte 2 - Cylinder LSB  
Byte 3 - ID Control Value = FF HEX (See Appendix B.)

A 4 byte ID field will be transferred for each ID field written.

Function: This command causes the 4 byte ID field to be written at the physical sector location specified. The logical sector number is recorded from the buffer data. The command execution sequence is similar to the Write Data command with the following exception. The writing is enabled when the physical sector count (number of sector marks past index) matches the sector number.

The multiple sector count may not be greater than the number of sectors on a track.

Command Completion is set when the multiple sector count is zero.

Generally the disc is formatted using the Format Disc command. If a user requires a special format (i.e., interleave format), the Write ID command may be used.

If an error occurs the result registers specify which sector contains the error.

Command: Read ID

Command Code: 56 HEX - Retry Enabled  
46 HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Physical Sector Number  
Parameter 4 - Multisector Count (1 to number of sectors/track)

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder Address MSB  
Result 2 - Cylinder Address LSB  
Result 3 - Physical Sector Address  
Result 4 - Residual Multisector Count

Data Transferred: The 4 byte ID field data is transferred from the SMART Interface to the host.

Byte 0 - Logical Sector Number  
Byte 1 - Head/Cylinder MSB  
Byte 2 - Cylinder LSB  
Byte 3 - ID Control Value (see Appendix B)

A 4 byte ID field will be transferred for each ID field read.

Function: This command causes the 4 byte ID field to be read from the physical sector location specified.

The multisector count may not be greater than the number of sectors on a track.

If an error occurs, the result registers specify which sector contains the error.

Command: Read ID Immediate

Command Code: 57 HEX - Retry Enabled  
47 HEX - Retry Disabled

Parameters: Parameter 0 - Drive  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status

Data Transferred: The 4 byte ID field data is transferred from the SMART Interface to the host.

Byte 0 - Logical Sector Number  
Byte 1 - Head/Cylinder MSB  
Byte 2 - Cylinder LSB  
Byte 3 - ID Control Value (see Appendix B)

Function: This command causes the ID field at the next physical sector encountered to be read.

Command: Read Skip Defect Field

Command Code: 59 HEX - Retry Enabled  
49 HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 4 - Multisector Counter = 1

Results: Result 0 - Transaction Status

Data Transferred: The 8 byte Skip Defect Record is transferred from the SMART Interface to the host. See Appendix A for the Skip Defect Field format.

Function: This command causes the 8 byte Skip Defect Field to be read from the location specified. If the record checksum is incorrect a CRC error is reported.

Command: Write Skip Defect Field

Command Code: 5A HEX - Retry Enabled  
4A HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 4 - Multisector Count = 1

Results: Result 0 - Transaction Status

Data Transferred: The 8 byte Skip Defect Record is transferred from the host to the SMART Interface. See Appendix A for the Skip Defect Field format.

Function: This command causes the 8 byte Skip Defect Field to be written to the location specified. The record checksum is automatically computed and appended to the record.

A Write Fault will occur if this command is attempted without disabling the drive's Skip Defect Field protection feature.

Command: Write Disc - Full Track

Command Code: AB HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector

Data Transferred: This command will cause data to be transferred from the host to the SMART Interface.

128, 256, 512, or 1024 bytes of data are transferred depending upon the selected sector size.

Function: This command is used to initialize the disc data fields. The data pattern transferred is written to all data fields on the disc.

If an error occurs the result registers indicate the sector that was being transferred when the error occurred.

Command: Write Cylinder - Full Track

Command Code: AC HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector

Data Transferred: This command will cause data to be transferred from the host to the SMART Interface.

128, 256, 512, or 1024 bytes of data are transferred depending upon the selected sector size.

Function: This command is used to initialize the disc data fields on a cylinder of the disc. The data pattern transferred is written to all data fields on the cylinder selected by Parameters 1 and 2.

Command: Write Full Track

Command Code: AD HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector

Data Transferred: This command will cause data to be transferred from the host to the SMART Interface.

128, 256, 512, or 1024 bytes of data are transferred depending upon the selected sector size.

Function: This command is used to initialize the disc data fields on one track. The data pattern specified is written to all data fields on the track selected by Parameters 1 and 2.

Command: Verify Disc

Command Code: A3 HEX

Parameters: Parameter 0 - Drive Address

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector

Data Transferred: None

Function: This command is used to verify that a disc is formatted properly. Every ID and Sector on the disc is read and the CRC is performed. If an error is detected, the operation is terminated and the result registers indicate which sector is in error.

Command: Verify Cylinder

Command Code: A4 HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector

Data Transferred: None

Function: This command is used to verify that a single cylinder of the disc is formatted properly. Every ID and Sector on the specified cylinder is read and the CRC is checked. If an error occurs, the operation is terminated and the result registers indicate which sector is in error.

Command: Verify Track  
Command Code: A5 HEX  
Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector

Data Transferred: None

Function: This command is used to verify that a single track of the disc is formatted properly. Every ID and sector on the specified track is read and the CRC is performed. If an error is detected, the operation is terminated and the result registers indicate which sector contains the error.

Command: Verify Data  
Command Code: 44 HEX  
Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Sector  
Parameter 4 - Multisector Count

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector  
Result 4 - Residual Multisector Count

Data Transferred: None

Function: This command is used to verify that the specified sectors indicated by the parameter registers are formatted properly. Every ID and data sector specified is read and the CRC is checked. If an error occurs, the operation is terminated and the result registers indicate which sector contains the error.

Command: Verify ID

Command Code: 48 HEX

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB  
Parameter 3 - Sector  
Parameter 4 - Multisector Count

Results: Result 0 - Transaction Status  
Result 1 - Head/Cylinder MSB  
Result 2 - Cylinder LSB  
Result 3 - Sector  
Result 4 - Residual Multisector Count

Data Transferred: None

Function: This command is used to verify that the ID fields on a track are readable. Every ID field specified by the parameter registers is read and the CRC is checked. If an error is detected, the operation is terminated and the result registers indicate which ID field contains the error.

Command: Seek

Command Code: 51 HEX - Retry Enabled  
41 HEX - Retry Disabled

Parameters: Parameter 0 - Drive Address  
Parameter 1 - Head/Cylinder MSB  
Parameter 2 - Cylinder LSB

Results: Result 0 - Transaction Status  
Result 1 - Current Cylinder MSB  
Result 2 - Current Cylinder LSB

Data Transferred: None

Function: The Seek Command uses the drive address defined in Parameter Register 0 and the contents of Parameter Registers 1 and 2 for the target cylinder address and head address.

The SMART Interface will command the drive to seek to the target cylinder and select the specified head. When this is complete, the Command Completion bit will be set with the current cylinder MSB in Result Register 1 and current cylinder LSB in Result Register 2 as discussed in the Restore Command section.

If the Retry bit is set, the seek will be retried if the first attempt is unsuccessful. This retry will be reported in the Transaction Status Register.

Also, Sequence Up is implied upon the receipt of this command if the selected drive is sequenced down when this command is received by the SMART Interface.

The seek command is automatically issued by the SMART Interface as required.

Command: Drive Restore  
Command Code: 40 HEX  
Parameters: Parameter 0 - Drive Address  
Results: Result 0 - Transaction Status  
Result 1 - Current Cylinder MSB  
Result 2 - Current Cylinder LSB

Data Transferred: None

Function: The Restore Command causes the access arm on the drive defined by the contents of Parameter Register 0 to be positioned over Cylinder 0.

Upon completion of the disc's restore operation, the Command Completion bit is set with the current cylinder MSB in Result Register 1 and current cylinder LSB in Result Register 2.

If the application program is using the SMART Interface with retries enabled, the Restore command is automatically issued when required.

Command: Write Buffer  
Command Code: 04 HEX  
Parameters: None  
Results: Result 0 - Transaction Status

Data Transferred: 1024 bytes of data are transferred from the host to the SMART Interface.

Function: This command may be used in conjunction with the Read Buffer command to test the SMART Interface data buffer. Data may be transferred either via DMA or by successive writes of the Disc Data Register. The command completion bit is set when the last byte required to fill the buffer is transferred.

The write buffer command is used to transfer data from the host to the SMART Interface data buffer.

The Write Buffer command is not required for normal SMART Interface operation.

Command: Read Buffer

Command Code: 03 HEX

Parameters: None

Results: Result 0 - Transaction Status

Data Transferred: 1024 bytes of data are transferred from the SMART Interface to the Host.

Function: The Read Buffer command may be used to list the buffer contents, to verify the buffer or in error recovery operations. Data may be transferred either via a DMA channel or by successive reads of the Disc Data Register. The Command Completion bit is set when the last byte in the buffer is read.

The Read Buffer Command is not required for normal SMART Interface operation.

#### D. Error Retry Technique

If an error occurs during the execution of the command and the retry feature is selected (i.e., retries are enabled), the SMART Interface will automatically retry the command.

The command is aborted and the appropriate transaction status is immediately returned to the host if retries are not enabled. Table 10 outlines the retry strategies employed.

All of the commands that require accessing data are preceded by a seek to the correct cylinder before the data transfer is begun. If the command is a logical data access, the disc cylinder is verified by reading the ID field information.

TABLE 10 - Error Recovery Strategy

<u>Error Type</u>	<u>Retry Procedure</u>
CRC Error	b
Seek Fault	c
Drive Fault	d
Drive Not Ready	d
Write Protect	None
Sector Not Found	e
Command Reject	None
Command Timeout	d
Data Transfer Timeout	a
Illegal Cylinder/Head	None

1. Retry Procedures

- a. The command must be reissued by the host.
- b. The SMART Interface will automatically reissue a transaction that results in a CRC error four times.
- c. If a seek fault occurs, the SMART Interface will reset the seek fault and retry the seek four times.
- d. A reset is issued to the drive and the command is retried four times.
- e. The defect mapping logic is initiated when a sector is not found (see Appendix B).

APPENDIX A - Disc Format

1. Sector Format

The sector format used by the SMART Interface is shown in Figure A1.

Each track starts with an INDEX pulse, which corresponds to a certain position on the servo track. The servo track also provides rotational position information for the generation of SECTOR pulses. A sector pulse precedes each record and successive records are separated by gaps within which the sector pulses occur.

a. Pre-Record Gap (Gap 1)

The Pre-Record Gap, or Gap 1, appears at the beginning of every record. It consists of 23 bytes of zeros. The length of Gap 1 never varies. The first Gap 1, after INDEX, is followed by the Skip Defect Record. All other Gap 1's, after SECTOR pulses, are followed by ID records.

b. Skip Defect Record

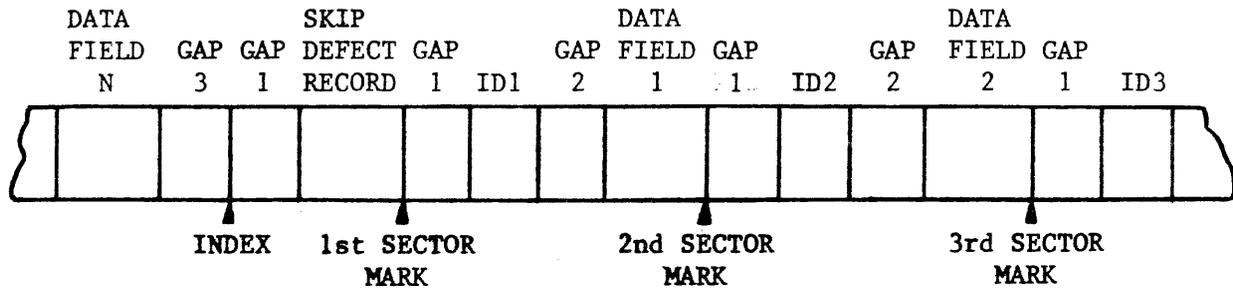
The Skip Defect Record (Table A1) consists of 11 bytes: a Data Sync using the hexadecimal pattern FB, the physical address of the first defect using 2 bytes, the physical address of the second defect using 2 bytes, the physical address of the third defect using 2 bytes, a checksum across the previous 6 bytes using 2 bytes, and fill characters of zeros using 2 bytes.

If a physical address is 0000, then there are not any additional defects on the track.

If the physical address of the first defect is FFFF HEX, the track is defective.

TABLE A1 - Defect Record Format

<u>Decimal Location</u>	<u>Data</u>
000-022	Gap 1 - 23 Zeros
023	Defect Record Sync (FB Hex)
024	1st Address MSB
025	1st Address LSB
026	2nd Address MSB
027	2nd Address LSB
028	3rd Address MSB
029	3rd Address LSB
030	Checksum MSB
031	Checksum LSB
032	Fill (Zero)
033	Fill (Zero)



Index:	Derived from servo track	
Gap 1:	Zeros	23 Bytes
Skip Defect Record:	Data Sync, FB Hex	1 Byte
	1st defect address	2 Bytes
	2nd defect address	2 Bytes
	3rd defect address	2 Bytes
	Checksum	2 Bytes
	Fill characters - zeros	2 Bytes
Sector Mark:	Derived from INDEX and servo clock	
ID Field:	ID Sync, F9 Hex	1 Byte
	Sector address	1 Byte
	Head and high cylinder address	1 Byte
	Low order cylinder address	1 Byte
	ID Control	1 Byte
	CRC	2 Bytes
	Fill characters - zeros	2 Bytes
Gap 2:	Zeros	11 Bytes
Data Field:	Data Sync, FD Hex	1 Byte
	Data	128, 256, 512, or 1024 Bytes
	CRC	2 Bytes
	Fill characters - zeros	6 Bytes
Gap 3:	Zeros (size depends on data field size)	

Figure A1 - Sector Format

C. ID Field

The Identification Field contains 9 bytes: an ID sync using the hexadecimal pattern F9, the sector number of 1 byte, the head address and high order cylinder address of 1 byte, the low order cylinder address of 1 byte, an ID control field of 1 byte, 2 CRC (cyclic redundancy check) bytes, and 2 bytes of zeros for filling. The cylinder and head address, along with the sector number, verify that the drive has addressed the correct track and sector. The ID control field is discussed in Appendix B.

D. ID Gap (Gap 2)

The ID Gap, or Gap 2, separates each successive Identification Field from its Data Field. It contains 11 bytes of zeros.

E. Data Field

Following Gap 2, the Data Field consists of 135, 263, 519, or 1031 bytes depending on the selected data length. The first byte is the data sync (hexadecimal pattern FD), while the last 4 bytes consist of 2 bytes of CRC and 4 bytes of zeros for filling.

F. Pre-Index Gap (Gap 3)

The Pre-Index Gap, or Gap 3, is used only once on a track. It appears at the end of the last data field and persists until INDEX. This gap contains zeros.

The sector size is selected by setting the sector switches on the drive to the decimal physical sector size.

The following tables define the sector switch settings required to select 128, 256, 512, or 1024 byte logical sector sizes on each of the PRIAM drive types.

TABLE A2 - Sector Format Summary - 3350-01

<u>Logical Size</u>	<u>Physical Size</u>	<u>Sectors/Track</u>	<u>Switch Setting</u>
128	192	104	5, 6
256	320	62	4, 6
512	576	34	3, 6
1024	1088	18	2, 6

TABLE A3 - Sector Format Summary - 3350-10/6650/15450

<u>Logical Size</u>	<u>Physical Size</u>	<u>Sectors Per Track</u>	<u>Switch Setting</u>
128	181	111	7, 6, 4, 3, 2, 1
256	309	65	7, 1
512	574	35	6, 2, 1
1024	1118	18	5, 4

TABLE A4 - Sector Format Summary - 3450/2050

<u>Logical Size</u>	<u>Physical Size</u>	<u>Sectors Per Track</u>	<u>Switch Setting</u>
128	181	74	7, 4, 2
256	311	43	6, 4, 2, 1
512	582	23	5, 3, 2, 1
1024	1117	12	4, 3

TABLE A5 - Sector Format Summary - 1070

<u>Logical Size</u>	<u>Physical Size</u>	<u>Sector Per Track</u>	<u>Switch Setting</u>
256	324	44	3, 2
512	648	22	4, 2
1024	1296	11	4, 3

There are two defect directory entries created. The Format Disc with Defect Mapping command proceeds as follows:

- a. The entire disc is formatted including the alternate areas defined in Table B3.
- b. The skip defect records are read and the bad tracks and sectors are flagged by reformatting the sectors and tracks with the ID codes shown in Table B4.
- c. The defect directory entries are created on the first available good sectors on the first cylinder of the alternate area.
- d. The disc is scanned for flagged sectors or tracks and alternates are assigned.

TABLE B4 - ID Control Field Definition

<u>ID Control Value (HEX)</u>	<u>Definition</u>
FF	User Data
FD	User Alternate
F5	Bad Track
FB	Bad Sector
F0	Defect Directory Entry

### 3. Read/Write Operations - Defect Handling

Read or Write requests that are performed on sectors that are not defective do not encounter any overhead due to the defect mapping feature. Defect mapping is only performed when the SMART Interface cannot locate the specified sector. The major steps in the defect mapping logic are outlined below.

- a. Attempt to perform the operation on the sector as specified.
- b. If the sector is not found, read the defect map.
- c. Scan the defect map for the sector required.
- d. If the required sector is found, operate on the alternate sector specified.
- e. If the alternate sector is a member of a bad track, complete the entire multisector operation. Otherwise seek back to the user data track.

APPENDIX B - DEFECT MAPPING

1. Defect Mapping

During the operation of the Format command the SMART Interface may encounter a defective sector on a track. The defect mapping capabilities of the SMART Interface allow it to assign alternate areas for the defective areas. The SMART Interface creates a defect directory described in the next section during the Format operation. Each drive has an area reserved for alternate sectors.

2. Defect Map Format

If the disc is formatted with defect mapping enabled the defect directory is created on the first cylinder of the alternate sector/track area. (See Tables B1 through B3.)

TABLE B1 - Defect Directory Format

<u>Location (HEX)</u>	<u>Description</u>
0	Configuration Level
01-0F	Configuration Data (to be defined)
10-FF	Defect Directory Entries (See Table B2)

TABLE B2 - Defect Directory Entry Format

<u>Location</u>	<u>Description</u>
0	Defect Cylinder MSB
1	Defect Head/Cylinder MSB
2	Defect Sector Number (If FF HEX = End of directory; if FE HEX = defective track.)
3	Alternate Cylinder LSB
4	Alternate Head/Cylinder MSB
5	Alternate Sector Numbers

TABLE B3 - Alternate Areas (Cylinders) by Drive Type

<u>Drive Type</u>	<u>User Cylinder</u>	<u>Alternate Area (Cylinders)</u>
3350	0-554	555-560
6650/15450	0-1107	1108-1120
3450	0-514	515-524
1070	0-184	185-189