S66G-8102-02

OEM INTERFACE SPECIFICATIONS

for

DHAA-2270 / DHAA-2405 / DHAA-2540

2.5-Inch Hard Disk Drive with ATA Interface

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1. General

1.1 Introduction

This specification describes the host interface to DHAA-2540, DHAA-2405 and DHAA-2270.

The interface conforms to the CAM draft proposal ver 3.2 for an AT attachment. with certain limitations described in section 2, “Vendor Specific Options” on page 2-1.

1.2 Reference

- Working Draft of Information technology - AT Attachment Interface with Extensions (ATA-2) dated on September-1-93.

1.3 Related Document

- OEM Functional Specifications for DHAA-2270/DHAA-2405/DHAA-2540 2.5 Inch Hard Disk Drive with AT Interface (S66G-8101).

1.4 Terminology

Drive Drive indicates DHAA-2540, DHAA-2405 or DHAA-2270.

Host Host indicates the system that the drive is attached to.

Drive Lock function This is a powerful security feature. With a drive lock password users can prevent unauthorized access to the hard disk drive even if the drive is removed from the computer.

Drive Locked mode In this mode, the drive disables media access commands after power on. Media access commands are enabled by either an unlock command or an erase unit.

Drive Unlocked mode In this mode, the drive enables all commands. If a password is not set this mode is entered after power on, otherwise it is entered by an unlock or an erase unit command.

Drive Frozen mode In this mode, the drive enables all commands except those which can update the drive lock function, set/change password. The drive enters this mode via a Freeze Lock command. It cannot quits this mode until power off.

High level security When the drive lock function is enabled and the user password is forgotten the drive can be unlocked via a master password.

Maximum level security When the drive lock function is enabled and the user password is forgotten then only the master password with an Erase Unit command can unlock the drive. Then user data is erased.

2. Vendor Specific Options

The drive conforms to the referenced specifications, with vendor specific options described below.

Seek Overlap	When a seek command is issued the drive will wait for the seek to complete before resetting the busy bit in the interface status register.
Sleep/standby mode	When entering sleep or standby mode as a result of a command the busy bit in the status register will remain set until the transition to the new state is complete.
Drive Lock Function	This enables the drive to be password protected after power on. Refer to 8.1, “Drive Lock Function” on page 8-1 for the details.

3. Registers

Command Block Registers		
Address	Input Register	Output Register
1F0h	Data	Data
1F1h	Error	Features
1F2h	Sector Count	Sector Count
1F3h	Sector Number	Sector Number
1F4h	Cylinder Low	Cylinder Low
1F5h	Cylinder High	Cylinder High
1F6h	Drive/Head	Drive/Head
1F7h	Status	Command
3F6h	Alternate Status	Device Control
3F7h	Drive Address	Not Used

Control Block Registers		
3F6h	Alternate Status	Device Control
3F7h	Drive Address	Not Used

Figure 3-1. Register Set

The host uses the register interface to communicate to and from the drive. The registers are accessed through the host port addresses shown.

The host should not access Command Block registers except Status Register when the Status Register BSY bit = 1.

3.1 Alternate Status Register

Alternate Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR

Figure 3-2. Alternate Status Register

This register contains the same information as the Status Register. The only difference is that reading this register does not imply interrupt acknowledge or clear a pending interrupt. See 3.13, “Status Register” on page 3-5 for the definition of the bits in this register.

3.2 Command Register

This register contains the command code being sent to the drive. Command execution begins immediately after this register is written. The command set is shown in Figure 6-1 on page 6-1.

All other registers required for the command must be set up before writing the Command Register.

3.3 Cylinder High Register

This register contains the high order bits of the starting cylinder address for any disk access. At the end of the command, this register is updated to reflect the current cylinder number.

In LBA Mode this register contains Bits 16-23. At the end of the command, this register is updated to reflect the current LBA Bits 16-23.

The cylinder number may be from zero to the number of cylinders minus one.

3.4 Cylinder Low Register

This register contains the low order 8 bits of the starting cylinder address for any disk access. At the end of the command, this register is updated to reflect the current cylinder number.

In LBA Mode this register contains Bits 8-15. At the end of the command, this register is updated to reflect the current LBA Bits 8-15.

The cylinder number may be from zero to the number of cylinders minus one.

3.5 Data Register

This register is used to transfer data blocks between the device data buffer and the host. It is also the register through which sector information is transferred on a Format Track command, and configuration information is transferred on an Identify Drive command.

All data transfers are 16 bits wide, except for ECC byte transfers, which are 8 bits wide. Data transfers are PIO only.

The register contains valid data only when DRQ=1 in the Status Register.

3.6 Device Control Register

Device Control Register							
7 –	6 –	5 –	4 –	3 1	2 SRST	1 –IEN	0 0

Figure 3-3. Device Control Register

Bit Definitions

SRST (RST) Software Reset. The drive is held reset when RST=1. Setting RST=0 re-enables the drive.

The host must set RST=1 and wait for at least 5 microseconds before setting RST=0, to ensure that the drive recognizes the reset.

-IEN Interrupt Enable. When IEN=0, and the drive is selected, drive interrupts to the host will be enabled. When IEN=1, or the drive is not selected, drive interrupts to the host will be disabled.

3.7 Drive Address Register

Drive Address Register							
7 HIZ	6 –WTG	5 –H3	4 –H2	3 –H1	2 –H0	1 –DS1	0 –DS0

Figure 3-4. Drive Address Register

This register contains the inverted drive select and head select addresses of the currently selected drive.

Bit Definitions

HIZ High Impedance. This bit is not driven and will always be in a high impedance state.

-WTG -Write Gate. This bit is 0 when writing to the disk drive is in progress.

-H3,-H2,-H1,-H0 -Head Select. These four bits are the one's complement of the binary coded address of the currently selected head. -H0 is the least significant.

-DS1 -Drive Select 1. Drive select bit for drive 1, active low. DS1=0 when drive 1 (slave) is selected and active.

-DS0 -Drive Select 0. Drive select bit for drive 0, active low. DS0=0 when drive 0 (master) is selected and active.

3.8 Drive/Head Register

Drive/Head Register							
7 1	6 L	5 1	4 DRV	3 HS3	2 HS2	1 HS1	0 HS0

Figure 3-5. Drive/Head Register

This register contains the drive and head numbers.

Bit Definitions

L Binary encoded address mode select. When L=0, addressing is by CHS mode. When L=1, addressing is by LBA mode.

DRV Drive. When DRV=0, drive 0 (master) is selected. When DRV=1, drive 1 (slave) is selected.

HS3,HS2,HS1,HS0 Head Select. These four bits indicate binary encoded address of the head . HS0 is the least significant bit. At command completion, these bits are updated to reflect the currently selected head.

The head number may be from zero to the number of heads minus one.

In LBA mode, HS3 through HS0 contain bits 24-27 of the LBA. At command completion, these bits are updated to reflect the current LBA bits 24-27.

3.9 Error Register

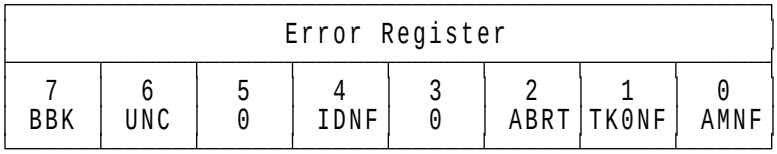


Figure 3-6. Error Register

This register contains status from the last command executed by the drive, or a diagnostic code.

At the completion of any command except Execute Drive Diagnostic, the contents of this register are valid always even if ERR=0 in the Status Register.

Following a power on, a reset, or completion of an Execute Drive Diagnostic command, this register contains a diagnostic code. See Figure 4-3 on page 4-2 for the definition.

Bit Definitions

BBK Bad Block. BBK=1 indicates a bad block mark was detected in the requested sector's ID field.

UNC Uncorrectable Data Error. UNC=1 indicates an uncorrectable data error has been encountered.

IDNF (IDN) ID Not Found. IDN=1 indicates the requested sector's ID field could not be found.

ABRT (ABT) Aborted Command. ABT=1 indicates the requested command has been aborted due to a drive status error or an invalid parameter in an output register.

TK0NF (T0N) Track 0 Not Found. T0N=1 indicates track 0 was not found during a Recalibrate command.

AMNF (AMN) Address Mark Not Found. AMN=1 indicates the data address mark has not been found after finding the correct ID field for the requested sector.

3.10 Features Register

This register is command specific. This is used with the Set Features, Erase Unit command.

3.11 Sector Count Register

This register contains the number of sectors of data requested to be transferred on a read or write operation between the host and the drive. If the value in the register is set to 0, a count of 256 sectors is specified.

If the register is zero at command completion, the command was successful. If not successfully completed, the register contains the number of sectors which need to be transferred in order to complete the request.

The contents of the register are defined otherwise on some commands. These definitions are given in the command descriptions.

3.12 Sector Number Register

This register contains the starting sector number for any disk data access for the subsequent command. The sector number is from one to the maximum number of sectors per track.

In LBA mode, this register contains Bits 0-7. At the end of the command, this register is updated to reflect the current LBA Bits 0-7.

3.13 Status Register

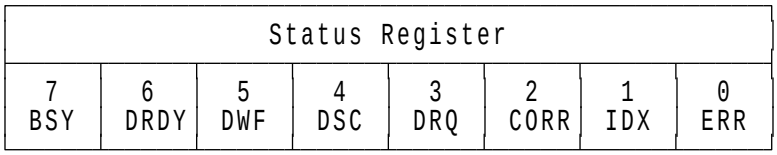


Figure 3-7. Status Register

This register contains the drive status. The contents of this register are updated whenever an error occurs and at the completion of each command.

If the host reads this register when an interrupt is pending, it is considered to be the interrupt acknowledge. Any pending interrupt is cleared whenever this register is read.

If BSY=1, no other bits in the register are valid.

Bit Definitions

BSY Busy. BSY=1 whenever the drive is accessing the registers. The host should not read or write any registers when BSY=1. If the host reads any register when BSY=1, the contents of the Status Register will be returned.

DRDY (RDY) Drive Ready. RDY=1 indicates that the drive is capable of responding to a command. RDY will be set to 0 during power on until the drive is ready to accept a command. If the drive detects an error while processing a command, RDY is set to 0 until the Status Register is read by the host, at which time RDY is set back to 1.

DWF Drive Write Fault. DWF=1 indicates that the drive has detected a write fault condition. DWF is set to 0 after the Status Register is read by the host.

DSC Drive Seek Complete. DSC=1 indicates that a seek has completed and the drive head is settled over a track. DSC is set to 0 by the drive just before a seek begins. When an error occurs, this bit is not changed until the Status Register is read by the host, at which time the bit again indicates the current seek complete status.

DRQ Data Request. DRQ=1 indicates that the drive is ready to transfer a word or byte of data between the host and the drive.

CORR (COR) Corrected Data. COR=1 indicates that a correctable data error was encountered and the data has been corrected using the drive's ECC. The sector buffer contains the corrected data and multi-sector reads continue. The bit is set to 0 when a command is received.

During multi-sector reads, COR=1 only while DRQ=1 for the sector or sectors containing correctable errors.

During a multi-sector read verify operation, COR is set to 1 at the end of the operation if any of the verified sectors contained a correctable error.

IDX Index. IDX=1 once per revolution. Since IDX=1 only for a very short time during each revolution, the host may not see it set to 1 even if the host is reading the Status Register continuously. Therefore the host should not attempt to use IDX for timing purposes.

ERR Error. ERR=1 indicates that an error occurred during execution of the previous command. The Error Register should be read to determine the error type. The drive sets ERR=0 when the next command is received from the host.

4. Reset Response

There are three types of reset in ATA as follows:

Power On Reset (POR)

Soft Reset SRST bit is set in the Drive Control Register.

Hard Reset RESET- signal is negated in ATA Bus.

The actions of each reset is shown in Figure 4-1

	POR	hard reset	soft reset
Aborting Host interface	–	o	o
Aborting Drive operation	–	o	Note.1
Initialization of hardware	o	o	x
Internal diagnostics.	o	o	x
Spinning spindle	o	x	x
Initialization of registers (Note.2)	o	o	o
DASP handshake	o	o	x
PDIAG handshake	o	o	o
Reverting programmed parameters to default – Number of CHS (set by Initialize Drive Parameter) – Multiple mode – Look–ahead	o	o	Note.3
Disable automatic power down	o	o	x
Power mode	Idle	Note.4	Note.4
Reset timeout value to Standby Mode Note. 5	o	o	x

o — execute
x — not execute

Figure 4-1. Reset Response Table

Note 1. Execute after the data in write cache has been written.

Note 2. Default value on POR is shown in Figure 4-2 on page 4-2.

Note 3. According to setting by Set Feature command, If setting of 66h is applied, disable reverting.

Note 4. In the case of sleep mode, the drive go to standby mode. In other case, the drive does not change current mode.

Note 5. After reset the time out value, it is set to 3 hours.

4.1.1 Register Initialization

Register	Default Value
Error	Diagnostic Code
Sector Count	01h
Sector Number	01h
Cylinder Low	00h
Cylinder High	00h
Drive/Head	A0h
Status	00h
Alternate Status	00h

Figure 4-2. Default Register Values

After power on, hard reset, or software reset, the register values are initialized as shown in Figure 4-2.

Code	Description
01h	No error detected
02h	Formatter device error
03h	Sector buffer error
04h	ECC circuitry error
05h	Controller microprocessor error
8xh	Slave drive failed

Figure 4-3. Diagnostic Codes

The meaning of the Error Register diagnostic codes resulting from power on, hard reset or the Execute Drive Diagnostic command are shown in Figure 4-3.

5. Command Protocol

The commands are grouped into different classes according to the protocols followed for command execution. The command classes with their associated protocols are defined below.

For all commands, the host must first check if BSY=1, and should proceed no further unless and until BSY=0. For all commands except Execute Drive Diagnostics and Initialize Drive Parameters the host must also wait for RDY=1 before proceeding.

Interrupts are cleared when the host reads the Status Register, issues a reset, or writes to the Command Register.

Figure 7-1 on page 7-1 shows the drive timeout values.

5.1 Data In Commands

These commands are:

- Identify Drive
- Read Buffer
- Read Long
- Read Multiple
- Read Sectors

Execution includes the transfer of one or more 512 byte (>512 bytes on Read Long) sectors of data from the drive to the host.

1. The host writes any required parameters to the Features, Sector Count, Sector Number, Cylinder, and Drive/Head Registers.
2. The host writes the command code to the Command Register.
3. For each sector (or block) of data to be transferred:
   a. The drive sets BSY=1 and prepares for data transfer.
   b. When a sector (or block) of data is available for transfer to the host, the drive sets BSY=0, sets DRQ=1, and interrupts the host.
   c. In response to the interrupt, the host reads the Status Register.
   d. The drive clears the interrupt in response to the Status Register being read.
   e. The host reads one sector (or block) of data via the Data Register.
   f. The drive sets DRQ=0 after the sector (or block)has been transferred to the host.
4. For the Read Long command:
   a. The drive sets BSY=1 and prepares for data transfer.
   b. When the sector of data is available for transfer to the host, the drive sets BSY=0, sets DRQ=1, and interrupts the host.
   c. In response to the interrupt, the host reads the Status Register.
   d. The drive clears the interrupt in response to the Status Register being read.

e. The host reads the sector of data via the Data Register.

f. The drive sets DRQ=0 after the sector has been transferred to the host.

g. The drive sets DRQ=1 when the ECC bytes are available for transfer to the host.

h. In response to DRQ=1, the host reads the ECC bytes via the Data Register.

i. The drive sets DRQ=0 after the ECC bytes have been transferred to the host.

The Read Multiple command transfers one block of data for each interrupt. The other commands transfer one sector of data for each interrupt.

Note that the status data for a sector of data is available in the Status Register **before** the sector is transferred to the host.

If the drive detects an invalid parameter, then it will abort the command by setting BSY=0, ERR=1, ABT=1, and interrupting the host.

If an uncorrectable error occurs, the drive will set BSY=0, ERR=1, and DRQ=1. The drive will then store the error status in the Error Register, and interrupt the host. The registers will contain the location (CHS) of the sector in error.

If an Uncorrectable Data Error (UNC=1) occurs, the defective data will be transferred from the media to the sector buffer, and will be available to be transferred to the host, at the host's option. In case of Read Multiple command, the host should complete transfer the block which includes error from the sector buffer and terminate whatever kind of type of error occurred.

If an error occurs that is correctable by using the ECC, the data will be corrected and the transfer will continue. The result will appear like a normal transfer except that the drive will set COR=1 in the Status Register.

If an error occurs that is correctable by retries, the data will be corrected and the transfer will continue normally. There will be no indication to the host that any retry occurred.

All data transfers to the host through the Data Register are 16 bits, except for the ECC bytes, which are 8 bits.

5.2 Data Out Commands

These commands are:

- Disable Password
- Erase Unit
- Format Track
- Set Password
- Unlock
- Write Buffer
- Write Long
- Write Multiple
- Write Sectors
- Write Verify

Execution includes the transfer of one or more 512 byte (>512 bytes on Write Long) sectors of data from the host to the drive.

1. The host writes any required parameters to the Features, Sector Count, Sector Number, Cylinder, and Drive/Head Registers.
2. The host writes the command code to the Command Register.
3. The drive sets BSY=1.
4. For each sector (or block) of data to be transferred:
   a. The drive sets BSY=0 and DRQ=1 when it is ready to receive a sector (or block).
   b. The host writes one sector (or block) of data via the Data Register.
   c. The drive sets BSY=1 after it has received the sector (or block).
   d. When the drive has finished processing the sector (or block), it sets BSY=0, and interrupts the host.
   e. In response to the interrupt, the host reads the Status Register.
   f. The drive clears the interrupt in response to the Status Register being read.
5. For the Write Long command:
   a. The drive sets BSY=0 and DRQ=1 when it is ready to receive a sector.
   b. The host writes one sector of data via the Data Register.
   c. The drive sets BSY=1 after it has received the sector.
   d. When the drive has finished processing the sector, it sets BSY=0 and DRQ=1.
   e. In response to DRQ=1, the host writes the ECC bytes via the Data Register.
   f. After receiving the ECC bytes, the drive sets BSY=1.
   g. After processing the ECC bytes, the drive sets BSY=0 and interrupts the host.
   h. In response to the interrupt, the host reads the Status Register.
   i. The drive clears the interrupt in response to the Status Register being read.

The Write Multiple command transfers one block of data for each interrupt. The other commands transfer one sector of data for each interrupt.

If the drive detects an invalid parameter, then it will abort the command by setting BSY=0, ERR=1, ABT=1, and interrupting the host.

If an uncorrectable error occurs, the drive will set BSY=0 and ERR=1, store the error status in the Error Register, and interrupt the host. The registers will contain the location (CHS) of the sector in error.

All data transfers to the drive through the Data Register are 16 bits, except for the ECC bytes, which are 8 bits.

5.3 Non-Data Commands

These commands are:

- Check Power Mode
- Execute Drive Diagnostics
- Erase Prepare

- Freeze Lock
- Idle
- Initialize Drive Parameters
- Read Verify Sectors
- Recalibrate
- Seek
- Set Features
- Set Multiple
- Sleep
- Standby

Execution of these commands involves no data transfer.

1. The host writes any required parameters to the Features, Sector Count, Sector Number, Cylinder, and Drive/Head Registers.
2. The host writes the command code to the Command Register.
3. The drive sets BSY=1.
4. When the drive has finished processing the command, it sets BSY=0, and interrupts the host.
5. In response to the interrupt, the host reads the Status Register.
6. The drive clears the interrupt in response to the Status Register being read.

5.4 DMA Data Transfer Commands

These commands are:

- Read DMA
- Write DMA

Data transfer using DMA commands differ in two ways from PIO transfers:

- data transfers are performed using the slave-DMA channel
- no intermediate sector interrupts are issued on multi-sector commands

Initiation of the DMA transfer commands is identical to the Read Sector or Write Sector commands except that the host initializes the slave-DMA channel prior to issuing the command.

The interrupt handler for DMA transfers is different in that:

- no intermediate sector interrupts are issued on multi-sector commands
- the host resets the DMA channel prior to reading status from the drive.

The DMA protocol allows high performance multi-tasking operating systems to eliminate processor overhead associated with PIO transfers.

1. Host initializes the slave-DMA channel
2. Host writes any required parameters to the Features, Sector Count, Sector Number, Cylinder and Drive/Head registers.

3. Host writes command code to the Command Register
4. The drive sets DMARQ when it is ready to transfer any part of the data.
5. Host transfers the data using the DMA transfer protocol currently in effect.
6. When all of the data has been transferred, the drive generates an interrupt to the host.
7. Host resets the slave-DMA channel
8. Host reads the Status Register and, optionally, the Error Register

6. Command Descriptions

Command	Hex Code	Binary Code Bit 7 6 5 4 3 2 1 0
Check Power Mode	E5	1 1 1 0 0 1 0 1
Check Power Mode*	98	1 0 0 1 1 0 0 0
Disable Password	F6	1 1 1 1 1 0 1 0
Execute Drive Diagnostics	90	1 0 0 1 0 0 0 0
Erase Prepare	F3	1 1 1 1 0 0 1 1
Erase Unit	F4	1 1 1 1 0 1 0 0
Format Track	50	0 1 0 1 0 0 0 0
Freeze Lock	F5	1 1 1 1 0 1 0 1
Identify Drive	EC	1 1 1 0 1 1 0 0
Idle	E3	1 1 1 0 0 0 1 1
Idle*	97	1 0 0 1 0 1 1 1
Idle Immediate	E1	1 1 1 0 0 0 0 1
Idle Immediate*	95	1 0 0 1 0 1 0 1
Initialize Drive Parameters	91	1 0 0 1 0 0 0 1
Read Buffer	E4	1 1 1 0 0 1 0 0
Read DMA (retry)	C8	1 1 0 0 1 0 0 0
Read DMA (no retry)	C9	1 1 0 0 1 0 0 1
Read Long (retry)	22	0 0 1 0 0 0 1 0
Read Long (no retry)	23	0 0 1 0 0 0 1 1
Read Multiple	C4	1 1 0 0 0 1 0 0
Read Sectors (retry)	20	0 0 1 0 0 0 0 0
Read Sectors (no retry)	21	0 0 1 0 0 0 0 1
Read Verify Sectors (retry)	40	0 1 0 0 0 0 0 0
Read Verify Sectors (no retry)	41	0 1 0 0 0 0 0 1
Recalibrate	1x	0 0 0 1 – – – –
Seek	7x	0 1 1 1 – – – –
Set Features	EF	1 1 1 0 1 1 1 1
Set Multiple	C6	1 1 0 0 0 1 1 0
Set Password	F1	1 1 1 1 0 0 0 1
Sleep	E6	1 1 1 0 0 1 1 0
Sleep*	99	1 0 0 1 1 0 0 1
Standby	E2	1 1 1 0 0 0 1 0
Standby*	96	1 0 0 1 0 1 1 0
Standby Immediate	E0	1 1 1 0 0 0 0 0
Standby Immediate*	94	1 0 0 1 0 1 0 0
Unlock	F2	1 1 1 1 0 0 1 0

Commands marked * are alternate command codes for previous defined commands.

Figure 6-1. Command Set --- Continued ---

Command	Hex Code	Binary Code Bit 7 6 5 4 3 2 1 0
Write Buffer	E8	1 1 1 0 1 0 0 0
Write DMA (retry)	CA	1 1 0 0 1 0 1 0
Write DMA (no retry)	CB	1 1 0 0 1 0 1 1
Write Long (retry)	32	0 0 1 1 0 0 1 0
Write Long (no retry)	33	0 0 1 1 0 0 1 1
Write Multiple	C5	1 1 0 0 0 1 0 1
Write Sectors (retry)	30	0 0 1 1 0 0 0 0
Write Sectors (no retry)	31	0 0 1 1 0 0 0 1
Write Verify	3C	0 0 1 1 1 1 0 0

Figure 6-2. Command Set

Figure 6-1 on page 6-1 and Figure 6-2 shows the commands that are supported by the drive. The following symbols are used in the command descriptions:

Output Registers

0 Indicates that the bit must be set to 0.

1 Indicates that the bit must be set to 1.

D The drive number bit. Indicates that the drive number bit of the Drive/Head Register should be specified. Zero selects the master drive and one selects the slave drive.

H Head number. Indicates that the head number part of the Drive/Head Register is an output parameter and should be specified.

L LBA mode. Indicates the addressing mode. Zero specifies CHS mode and one does LBA addressing mode.

R Retry. Indicates that the Retry bit of the Command Register should be specified.

V Valid. Indicates that the bit is part of an output parameter and should be specified.

x Indicates that the hex character is not used.

- Indicates that the bit is not used.

Input Registers

0 Indicates that the bit is always set to 0.

1 Indicates that the bit is always set to 1.

H Head number. Indicates that the head number part of the Drive/Head Register is an input parameter and will be set by the drive.

V Valid. Indicates that the bit is part of an input parameter and will be set to 0 or 1 by the drive.

- Indicates that the bit is not part of an input parameter.

The command descriptions show the contents of the Status and Error Registers after the drive has completed processing the command and has interrupted the host.

6.1 Check Power Mode

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 1 0 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	0	0	–	–	0	–	V

Figure 6-3. Check Power Mode Command (E5h)

The Check Power Mode command will report whether the drive is spun up and the media is available for immediate access.

Input Parameters From The Drive

Sector Count The power mode code. The command returns FFh in the Sector Count Register if the spindle motor is at speed and the drive is not in Standby or Sleep mode. Otherwise, the Sector Count Register will be set to 0.

6.2 Disable Password

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 1 0 1 1 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-4. Disable Password Command (F6h)

The Disable Password command requests a transfer of a single sector of data from the host including information specified in Figure 6-5. Then the drive checks the transferred password. If the User Password or Master Password match the drive disables the lock function. This command does not change the Master Password which may be re-activated later by setting User Password.

Word	Description
00	Control word bit 0 : Identifier; 1– Master, 0– User bit 1–15 : Reserved
01–16	Password (32 bytes)
17–255	Reserved

Figure 6-5. Password Information for Password disable command

The drive will compare the password sent from this host with that specified in the control word.

Identifier Zero indicates that the drive should check the supplied password against the user password stored internally. One indicates that the drive should check the given password against the master password stored internally.

6.3 Execute Drive Diagnostics

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 – – – – –
Command	1 0 0 1 0 0 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7	6	5	4	3	2	1	0
V	V	V	V	V	V	V	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	0	0	–	–	0	–	0

Figure 6-6. Execute Drive Diagnostics Command (90h)

The Execute Drive Diagnostics command performs the internal diagnostic tests implemented by the drive. The results of the test are stored in the Error Register.

The normal Error Register bit definitions do not apply to this command. Instead, the register contains a diagnostic code. See Figure 4-3 on page 4-2 for the definition.

6.4 Erase Prepare

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 1 0 0 1 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-7. Erase Prepare Command (F3h)

The Erase Prepare Command must be issued immediately before the Erase Unit Command to enable drive erasing and unlocking. This command is to prevent accidental erasure of the drive.

This command does not request to data transfer.

6.5 Erase Unit

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	V V V V V V V V
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 1 0 1 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7	6	5	4	3	2	1	0
BBK	UNC	0	IDN	0	ABT	T0N	AMN
0	0	0	0	0	V	V	V

Status Register							
7	6	5	4	3	2	1	0
BSY	RDY	DWF	DSC	DRQ	COR	IDX	ERR
0	V	0	V	–	0	–	V

Figure 6-8. Erase Unit Command (F4h)

This command requests to transfer a single sector data from the host including information specified in Figure 6-9.

If the password does not match then the drive rejects the command with an Aborted error.

Word	Description
00	Control word bit 0 : Identifier; 1– Master, 0– User bit 1–15 : Reserved
01–16	Password (32 bytes)
17–255	Reserved

Figure 6-9. Erase Unit information

Identifier Zero indicates that the drive should check the supplied password against the user password stored internally. One indicates that the drive should check the given password against the master password stored internally.

The Erase Unit command erase all user data. The erase prepare command should be completed immediately prior to the Erase Unit command. If the drive receives an Erase Unit command without a prior Erase Prepare command the drive aborts the erase unit command.

This command disables the drive lock function, however the master password is still stored internally within the drive and may be re-activated later when a new user password is set.

Feature When Feature register is DDH, the drive adapts the skew by itself. Otherwise, current skew parameters are retained.

6.6 Format Track

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 1 0 1 0 0 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7	6	5	4	3	2	1	0
BBK	UNC	0	IDN	0	ABT	T0N	AMN
0	0	0	V	0	V	0	0

Status Register							
7	6	5	4	3	2	1	0
BSY	RDY	DWF	DSC	DRQ	COR	IDX	ERR
0	V	V	V	–	0	–	V

Figure 6-10. Format Track Command (50h)

The Format Track command formats a single track on the drive. Each good sector of data on the track will be initialized to zero. Any data previously stored on the track will be lost.

The host writes a sector containing a format table to the drive. The format table should contain two bytes for each sector on the track to be formatted. The first byte should contain a descriptor value and the second byte should contain the sector number. The descriptor value should be 0 for a good sector, and any other descriptor values will be ignored. The remaining bytes of the sector following the format table are ignored.

Since drive performance is optimal at 1:1 interleave, and the drive uses relative block addressing internally, the drive will always format a track in the same way no matter what sector numbering is specified in the format table.

Output Parameters To The Drive

Sector Number In LBA mode, this register specifies LBA address bits 0 - 7 to be formatted. (L=1)

Cylinder High/Low The cylinder number of the track to be formatted. (L=0)

In LBA mode, this register specifies LBA address bits 8 - 15 (Low), 16 - 23 (High) to be formatted. (L=1)

H The head number of the track to be formatted. (L=0)

In LBA mode, this register specifies LBA address bits 24 - 27 to be formatted. (L=1)

Input Parameters From The Drive

Sector Number	In LBA mode, this register specifies current LBA address bits 0-7. (L=1)
Cylinder High/Low	In LBA mode, this register specifies current LBA address bits 8 - 15 (Low), 16 - 23 (High)
H	In LBA mode, this register specifies current LBA address bits 24 - 27. (L=1)
Error	The Error Register. An Abort error (ABT=1) will be returned under the following conditions: • The sector count does not match the number of sectors per track.

6.7 Freeze Lock

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 1 0 1 0 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	0	–	0	–	V

Figure 6-11. Freeze Lock Command (F5h)

The Freeze Lock Command sets the drive to frozen mode. After this command is completed any other commands which update the drive lock function are rejected. Frozen mode is quit by Power off.

- Set Password
- Unlock
- Freeze Lock
- Disable Password
- Erase Unit

6.8 Identify Drive

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 1 1 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	–	–	0	–	V

Figure 6-12. Identify Drive Command (ECh)

The Identify Drive command requests the drive to transfer configuration information to the host. The drive will transfer a sector to the host containing the information in Figure 6-13 on page 6-13. The Identify Drive information is not affected by the Initialize Drive Parameters command.

Word	Content	Description
00	045AH	Drive classification, bit assignments: 15(=0): 1=not magnetic disk drive 14(=0): 1=format speed tolerance gap required 13(=0): 1=track offset option available 12(=0): 1=data strobe offset option available 11(=0): 1=rotational speed tolerance > 0.5% 10(=1): 1=disk transfer rate > 10 Mbps 9(=0): 1=disk transfer rate > 5 Mbps but = 10 Mbps 8(=0): 1=disk transfer rate <= 5 Mbps 7(=0): 1=removable cartridge drive 6(=1): 1=fixed drive 5(=0): 1=spindle motor control option implemented 4(=1): 1=head switch time > 15 us 3(=1): 1=not MFM encoded 2(=0): 1=soft sectored 1(=1): 1=hard sectored 0(=0): reserved
01	Note.1	Number of cylinders in default translate mode
02	0	Number of removable cylinders
03	Note.2	Number of heads in default translate mode
04	0	Reserved
05	0	Reserved
06	Note.3	Number of sectors per track in default translate mode
07	0000H	Number of bytes of sector gap
08	0000H	Number of bytes in sync field
09	0000H	Reserved
10–19	XXXX	Serial number in ASCII (0 = not specified)
20	0003H	Controller type: 0003: dual ported, multiple sector buffer with look–ahead read
21	0040H	Buffer size in 512–byte increments
22	00xxH	Number of ECC bytes as currently selected via the set features command
23–26	XXXX	Microcode version in ASCII
27–46	Note.4	Model number in ASCII
47	0010H	Number of sectors that can be transferred per interrupt on Read and Write Multiple commands
48	0000H	Capable of double word I/O, '0000'= cannot perform
49	0F00H	Capabilities, bit assignments: 15–12(=0) Reserved 11(=1) IORDY Supported 10(=1) IORDY can be disabled 9(=1) 1=LBA Supported 8(=1) 1=DMA Supported 7– 0(=0) Reserved
50	0000H	Reserved
51	0200H	PIO data transfer cycle timing mode

Figure 6-13. Identify drive information --- Continued ---

Word	Content	Description
52	0000H	DMA data transfer cycle timing mode Refer Word 62 and 63
53	0003H	Validity flag of the word 15– 2(=0) Reserved 1 1= Word 64–70 are Valid 0 1= Word 54–58 are Valid
54	XXXXH	Number of current cylinders
55	XXXXH	Number of current heads
56	XXXXH	Number of current sectors per track
57–58	XXXXH	Current capacity in sectors Word 57 specifies the low word of the capacity
59	0XXXH	Current Multiple setting. bit assignments 15– 9(=0) Reserved 8 1= Multiple Sector Setting is Valid 7– 0 xxh = Current setting for number of sectors
60–61	Note.5	Total Number of User Addressable Sectors Word 60 specifies the low word of the number
62	xx07H	Single Word DMA Transfer Capability 15– 8 Single word DMA transfer mode active 7– 0(=7) Single word DMA transfer modes supported
63	xx03H	Multiword DMA Transfer Capability 15– 8 Multi word DMA transfer mode active 7– 0(=3) Multi word DMA transfer modes supported
64	0001H	Flow Control PIO Transfer Modes Supported 15– 8(=0) Reserved 7– 0(=1) Advanced PIO Transfer Modes Supported '01' = PIO Mode 3 Supported
65	00F0H	Minimum Multiword DMA Transfer Cycle Time Per Word 15– 0(=F0) Cycle time in nanoseconds
66	00F0H	Manufacturer's Recommended Multiword DMA Transfer Cycle Time 15– 0(=F0) Cycle time in nanoseconds
67	00F0H	Minimum PIO Transfer Cycle Time Without Flow Control 15– 0(=14E) Cycle time in nanoseconds. See Note 6.
68	00B4H	Minimum PIO Transfer Cycle Time With IORDY Flow Control 15– 0(=14E) Cycle time in nanoseconds. See Note 6.
69–127	0000H	Reserved
128	XXXXH	Drive Lock Function. Bit assignments 0 Capability 1= Support 1 Enable/Disable 1= Enabled 2 Lock 1= Locked 3 Freeze 1= Frozen 4 Expire 1= Expired 8 Security Level 1= Maximum,0= High 9–15 Reserved
129	XXXXH	Current Set Feature Option. Bit assignments 0 Write Cache 1= Enabled 1 Read Look–ahead 1= Enabled 2 Reverting by Software Reset 1= Enabled 3 Auto reassign 1= Enabled 4–15 Reserved
130–255	0000H	Reserved

Figure 6-14. Identify drive information.

Note 1. The number of cylinders is shown in Figure 6-15 on page 6-15.

Note 2. The number of heads is shown in Figure 6-15 on page 6-15.

Note 3. The number of sectors per track is shown in Figure 6-15 on page 6-15.

Note 4. The model number in ASCII is 'DHAA-2540', 'DHAA-2405' or 'DHAA-2270'.

Note 5. Total Number of User Addressable Sectors is shown in Figure 6-15 on page 6-15.

Note 6. In case '014E'h is indicated in both or one of the word 67 and 68, the minimum PIO cycle time should be limited to 334nsec only for Read Multiple and Write Multiple commands regardless of flow control.

The following list shows the summary of the Note 1 through 5.

Model Number and Capacity	Number of Cylinder	Number of Head	Number of Sectors /Track	Number of User Addressable Sectors
DHAA–2540 (540MB)	0417h= 1047	10h= 16	03Fh= 63	101A90h=1055376
DHAA–2540 (528MB)	0400h= 1024	10h= 16	03Fh= 63	FC000h=1032192
DHAA–2405 (405MB)	0311h= 785	10h= 16	03Fh= 63	C12F0h= 791280
DHAA–2405 (344MB)	0393h= 915	0Fh= 15	031h= 49	A430Dh= 672525
DHAA–2270 (270MB)	020Ch= 524	10h= 16	03Fh= 63	80F40h= 528192

Figure 6-15. Logical Number of Cylinder, Head, Sectors/Track, and User Addressable Sectors

6.9 Idle

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 0 1 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-16. Idle Command (E3h)

The Idle command causes the drive to enter Idle mode. The drive is spun up to operating speed. If the drive is already spinning, the spin up sequence is not executed. The timeout parameter may be used to enable the automatic power down sequence.

During Idle mode the drive is spun up and ready to respond to host commands, but execution may take slightly longer because some drive circuitry must be reactivated.

Output Parameters To The Drive

Sector Count Timeout Parameter. If zero, then the timeout interval is set for 3 hours. If other than zero, the timeout interval is set for (Timeout Parameter × 5) seconds.

When the automatic power down sequence is enabled, the drive will enter Standby mode automatically if the timeout interval expires with no drive access from the host. The timeout interval will be reinitialized if there is a drive access before the timeout interval expires.

6.10 Idle Immediate

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 0 0 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-17. Idle Immediate Command (E1h)

The Idle Immediate command causes the drive to enter Idle mode. The drive is spun up to operating speed. If the drive is already spinning, the spin up sequence is not executed.

During Idle mode the drive is spun up and ready to respond to host commands, but execution may take slightly longer because some drive circuitry must be reactivated.

The Idle Immediate command is not affect to auto power down timeout parameter.

6.11 Initialize Drive Parameters

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D H H H H
Command	1 0 0 1 0 0 0 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	0	0	–	–	0	–	V

Figure 6-18. Initialize Drive Parameters Command (91h)

The Initialize Drive Parameters command enables the host to set the number of sectors per track and the number of heads minus 1, per cylinder. Words 54-58 in Identify Drive Information reflects these parameters.

The parameters remain in effect until following events:

- Another Initialize Drive Parameters command is received.
- The drive is powered off.
- Hard reset is occurred.
- Soft reset is occurred and the Set Feature option of CCh is set instead of 66h.

Output Parameters To The Drive

Sector Count The number of sectors per track. 0 does not mean there are 256 sectors per track, but there is no sector per track.

H The number of heads minus 1 per cylinder. The minimum is 0 and the maximum is 15. However inline with CAM any other value will be accepted but drive operation is then not guaranteed.

6.12 Read Buffer

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 1 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	–	–	0	–	V

Figure 6-19. Read Buffer Command (E4h)

The Read Buffer command transfers a sector from the sector buffer to the host. The sector is transferred through the Data Register 16 bits at a time.

The sector transferred will be from the same part of the buffer written to by the last Write Buffer command. The contents of the sector may be different if any reads or writes have occurred since the Write Buffer command was issued.

6.13 Read DMA

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	1 1 0 0 1 0 0 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-20. Read DMA Command (C8h/C9h)

The Read DMA command transfers one or more sectors from the drive to the host. The sectors are transferred through the Data Register 16 bits at a time.

The host initializes a slave-DMA channel prior to issuing the command The data transfers are qualified by DMARQ and are performed by the slave-DMA channel. The drive issues only one interrupt per command to indicate that data transfer has terminated and status is available.

If an uncorrectable error occurs, the read will be terminated at the failing sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register specifies LBA address bits 0 - 7 to be transferred. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register specifies LBA address bits 8 - 15 (Low) 16 - 23 (High) to be transferred. (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register specifies LBA bits 24-27 to be transferred. (L=1)

R The retry bit. If set to one, then retries are disabled.

Input Parameters From The Drive

Sector Count The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.

Sector Number The sector number of the last transferred sector. (L=0)

In LBA mode, this register contains current LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the last transferred sector. (L=0)

In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the sector to be transferred. (L=0)

In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.14 Read Long

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	0 0 0 0 0 0 0 1
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 0 1 0 0 0 1 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-21. Read Long Command (22h/23h)

The Read Long command transfers the data and ECC bytes of the designated sector from the drive to the host.

After 512 bytes of data have been transferred, the drive will set DRQ=1 to indicate that the drive is ready to transfer the ECC bytes to the host. The data is transferred 16 bits at a time, and the ECC bytes are transferred 8 bits at a time. The number of ECC bytes are 4 or 18 according to setting of Set Feature option. The default setting is 4 bytes of ECC data.

The command makes a single attempt to read the data and does not check the data using ECC, whatever is read is returned to the host.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. The Sector Count must be set to one.

Sector Number The sector number of the sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H	The head number of the sector to be transferred. (L=0)
	In LBA mode, this register contains LBA bits 24-27. (L=1)
R	The retry bit. If set to one, then retries are disabled.

Input Parameters From The Drive

Sector Count	The number of requested sectors not transferred.
Sector Number	The sector number of the transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24-27. (L=1)

It should be noted that the drive internally uses 18 bytes of ECC data on all data written or read from the disk. The 4 byte mode of operation is provided via an emulation. It is recommended that for testing the effectiveness and integrity of the drives ECC functions that the 18 byte ECC mode should be used.

6.15 Read Multiple

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	1 1 0 0 0 1 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	V	0	V	0	V	0	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	V	–	V

Figure 6-22. Read Multiple Command (C4h)

The Read Multiple command transfers one or more sectors from the drive to the host. The sectors are transferred through the Data Register 16 bits at a time. Command execution is identical to the Read Sectors command except that an interrupt is generated for each block (as defined by the Set Multiple command) instead of for each sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

Input Parameters From The Drive

Sector Count The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.

Sector Number	The sector number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.16 Read Sectors

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 0 1 0 0 0 0 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	V	0	V	0	V	0	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	V	–	V

Figure 6-23. Read Sectors Command (20h/21h)

The Read Sectors command transfers one or more sectors from the drive to the host. The sectors are transferred through the Data Register 16 bits at a time.

If an uncorrectable error occurs, the read will be terminated at the failing sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

R The retry bit. If set to one, then retries are disabled.

Input Parameters From The Drive

Sector Count The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.

Sector Number	The sector number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.17 Read Verify

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 0 1 0 0 0 0 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	V	0	V	0	V	0	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	V	–	V

Figure 6-24. Read Verify Sectors Command (40h/41h)

The Read Verify Sectors verifies one or more sectors on the drive. No data is transferred to the host.

If an uncorrectable error occurs, the read verify will be terminated at the failing sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be verified. If zero is specified, then 256 sectors will be verified.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

R The retry bit. If set to one, then retries are disabled.

Input Parameters From The Drive

Sector Count The number of requested sectors not verified. This will be zero, unless an unrecoverable error occurs.

Sector Number	The sector number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.18 Recalibrate

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	0 0 0 1 – – – –

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	V	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-25. Recalibrate Command (1xh)

The Recalibrate command moves the read/write heads from anywhere on the disk to cylinder 0. If the drive cannot reach cylinder 0, T0N (Track 0 Not Found) will be set in the Error Register.

6.19 Seek

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 1 1 1 – – – –

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	V	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-26. Seek Command (7xh)

The Seek command initiates a seek to the designated track and selects the designated head. The drive need not be formatted for a seek to execute properly. The drive will wait for the seek to complete before setting BSY=0, DSC=1, and issuing the interrupt.

Output Parameters To The Drive

Sector Number In LBA mode, this register specifies LBA address bits 0 - 7 for seek. (L=1)

Cylinder High/Low The cylinder number of the seek.

In LBA mode, this register specifies LBA address bits 8 - 15 (Low), 16 - 23 (High) for seek. (L=1)

H The head number of the seek.

In LBA mode, this register specifies LBA address bits 24 - 27 for seek. (L=1)

Input Parameters From The Drive

Sector Number In LBA mode, this register contains current LBA bits 0 - 7. (L=1)

Cylinder High/Low In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.20 Set Features

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	V V V V V V V V
Sector Count	Note.1
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 1 1 1 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	–	–	0	–	V

Figure 6-27. Set Features Command (EFh)

The Set Feature command is to establish the following parameters which affect the execution of certain features as shown in below table.

ABT will be set to 1 in the Error Register if the Feature register contains any undefined values.

Output Parameters To The Drive

Feature Destination code for this command.

02H Enable write cache (Power on default) - See Warning in the next page.

03H Set transfer mode based on value in sector count register

44H 18 bytes of ECC apply on Read Long/Write Long commands

55H Disable read look-ahead feature

66H Disable reverting to power on defaults (Power on default)

82H Disable write cache

AAH Enable read look-ahead feature (Power on default)

BBH 4 bytes of ECC apply on Read Long/Write Long commands (Power on default)

CCH Enable reverting to power on defaults

Warning:
When write cache is enabled, Hard Reset or Power Off must not be done while -DASP signal is asserted in order to prevent data loss.

Note: 1.
When Set Feature register is 03h (=Set Transfer mode), the Sector Count Register specifies the transfer mechanism. The upper 5 bits define the type of transfer and the low order 3 bits encode the mode value.

PIO Default Transfer Mode	00000 000
PIO Default Transfer Mode,Disable IORDY	00000 001
PIO Flow Control Transfer Mode x	00001 nnn (nnn=000,001,010,011)
Single word DMA mode x	00010 nnn (nnn=000,001,010)
Multiword DMA mode x	00100 nnn (nnn=000,001)

6.21 Set Multiple

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 0 0 0 1 1 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	–	–	0	–	V

Figure 6-28. Set Multiple Command (C6h)

The Set Multiple command enables the drive to perform Read and Write Multiple commands and establishes the block size for these commands. The block size is the number of sectors to be transferred for each interrupt.

The default block size after power up, soft reset, or hard reset is 0, and Read Multiple and Write Multiple commands are disabled.

If an invalid block size is specified, an Abort error will be returned to the host, and Read Multiple and Write Multiple commands will be disabled.

Output Parameters To The Drive

Sector Count. The block size to be used for Read Multiple and Write Multiple commands. Valid block sizes can be selected from 0, 1, 2, 4, 8 or 16. If 0 is specified, then Read Multiple and Write Multiple commands are disabled.

6.22 Set Password

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 1 0 0 0 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7	6	5	4	3	2	1	0
BBK	UNC	0	IDN	0	ABT	T0N	AMN
0	0	0	0	0	V	0	0

Status Register							
7	6	5	4	3	2	1	0
BSY	RDY	DWF	DSC	DRQ	COR	IDX	ERR
0	V	0	–	–	0	–	V

Figure 6-29. Set Password Command (F1h)

This command requests a transfer of a single sector of data from the host including the information specified in Figure 6-30.

The data transferred controls the function of this command.

Word	Description
00	Control word bit 0 : Identifier: 1– Master, 0– User bit 1–7 : Reserved bit 8 : Security level; 1– Maximum, 0– High bit 9–15 : Reserved
01–16	Password (32 byte)
17–255	Reserved

Figure 6-30. Set Password Information

Identifier Zero indicates that drive regards Password as User Password. One indicates that drive regards Password as Master Password.

Security Level Zero indicates High level, one indicates Maximum level. If the host sets High level and the password is forgotten, then the Master Password can be used to unlock the drive. If the host sets Maximum level and the user password is forgotten, only an Erase Prepare/Unit command can unlock the drive and all data will be lost.

Password The text of the password - all 32 bytes are always significant.

The setting of the Identifier and Security level bits interact as follows.

Identifier=User / Security level = High The password supplied with the command will be saved as the new user password. The lock function will be enabled from the next power on. The drive may then be unlocked by either the user password or the previously set master password.

Identifier=Master / Security level = High This combination will set a master password but will NOT enable the lock function.

Identifier=User / Security level = Maximum The password supplied with the command will be saved as the new user password. The lock function will be enabled from the next power on. The drive may then be unlocked by only the user password. The master password previously set is still stored in the drive but may NOT be used to unlock the drive.

Identifier=Master / Security level = Maximum This combination will set a master password but will NOT enable the lock function.

6.23 Sleep

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 1 1 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-31. Sleep Command (E6h)

The Sleep command causes the drive to enter Sleep mode, which is exactly the same mode as Standby mode.

6.24 Standby

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 0 1 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-32. Standby Command (E2h)

The Standby command causes the drive to enter the Standby Mode.

When the Standby mode is entered, the drive is spun down but the interface remains active. If the drive is already spun down, the spin down sequence is not executed.

During the Standby mode the drive will respond to commands, but there may be a delay while waiting for the spindle to reach operating speed.

The automatic power down sequence is enabled and the timer starts counting down when the drive returns to Idle mode.

Output Parameters To The Drive

Sector Count Timeout Parameter. If zero, then the timeout interval is set for 3 hours. If other than zero, the timeout interval is set for (Timeout Parameter × 5) seconds.

When the automatic power down sequence is enabled, the drive will enter Standby mode automatically if the timeout interval expires with no drive access from the host. The timeout interval will be reinitialized if there is a drive access before the timeout interval expires.

6.25 Standby Immediate

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 0 0 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	V	–	0	–	V

Figure 6-33. Standby Immediate Command (E0h)

The Standby Immediate command causes the drive to enter Standby mode immediately. The drive is spun down but the interface remains active. If the drive is already spun down, the spin down sequence is not executed.

During the Standby mode, the drive will respond to commands, but there may be a delay while waiting for the spindle to reach operating speed.

The Standby Immediate command is not affect to auto power down timeout parameter.

6.26 Unlock

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 1 0 0 1 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	V	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	–	–	0	–	V

Figure 6-34. Unlock Command (F2h)

The Unlock command requests to transfer a single sector of data from the host including information specified in Figure 6-35 on page 6-41.

If the Identifier bit is set to master and the drive is in high security mode then the password supplied will be compared with the stored master password. If the drive is in maximum security mode then the unlock will be rejected.

If the Identifier bit is set to user then the drive compares the supplied password with the stored user password.

If the password compare fails then the drive returns an abort error to the host and decrements the unlock attempt counter. This counter is initially set to 5 and is decremented for each password mismatch, this includes password mismatches for all security commands. When this counter reaches zero then all password protected commands are rejected until a hard reset.

Word	Description
00	Control word bit 0 : Identifier; 1– Master, 0– User bit 1–15 : Reserved
01–16	Password (32 bytes)
17–255	Reserved

Figure 6-35. Unlock Information

Identifier Zero indicates that drive regards Password as User Password. One indicates that drive regards Password as Master Password.

The user can detect if the attempt to unlock the drive has failed due to a mismatched password as this is the only reason that an abort error will be returned by the drive AFTER the password information has been sent to the drive. If an abort error is returned by the drive BEFORE the password data has been sent to the drive then another problem exists.

6.27 Write Buffer

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	1 0 1 D – – – –
Command	1 1 1 0 1 0 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	– – – – – – – –
Cylinder High	– – – – – – – –
Drive/Head	– – – – – – – –
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
0	0	0	0	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	0	–	–	0	–	V

Figure 6-36. Write Buffer Command (E8h)

The Write Buffer command transfers a sector of data from the host to the sector buffer. The sectors are transferred through the Data Register 16 bits at a time.

The Read Buffer and Write Buffer commands are synchronized such that sequential Write Buffer and Read Buffer commands access the same 512 byte within buffer.

6.28 Write DMA

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	1 1 0 0 1 0 1 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	V	V	–	0	–	V

Figure 6-37. Write DMA Command (CAh/CBh)

The Write DMA command transfers one or more sectors from the host to the drive. The sectors are transferred through the Data Register 16 bits at a time.

The host initializes a slave-DMA channel prior to issuing the command. Data transfers are qualified by DMARQ and are performed by the slave-DMA channel. The drive issues only one interrupt per command to indicate that data transfer has terminated and status is available.

If an uncorrectable error occurs, the write will be terminated at the failing sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

R The retry bit. If set to one, then retries are disabled. But ignored, when write cache is enabled. (Ignoring the retry bit is in violation of CAM.)

Input Parameters From The Drive

Sector Count The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.

Sector Number The sector number of the last transferred sector. (L=0)

In LBA mode, this register contains current LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the last transferred sector. (L=0)

In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the last transferred sector. (L=0)

In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.29 Write Sectors

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	1 1 0 0 1 0 1 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	V	V	–	0	–	V

Figure 6-38. Write Sectors Command (CAh/CBh)

The Write Sectors command transfers one or more sectors from the host to the drive. The sectors are transferred through the Data Register 16 bits at a time.

If an uncorrectable error occurs, the write will be terminated at the failing sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

R The retry bit. If set to one, then retries are disabled. But ignored, when write cache is enabled. (Ignoring the retry bit is in violation of CAM.)

Input Parameters From The Drive

Sector Count	The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.
Sector Number	The sector number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.30 Write Long

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	0 0 0 0 0 0 0 1
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 0 1 1 0 0 1 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	– – – – – – – V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	V	V	–	0	–	V

Figure 6-39. Write Long Command (32h/33h)

The Write Long command transfers the data and ECC bytes of the designated sector from the host to the drive.

After 512 bytes of data have been transferred, the drive will set DRQ=1 to indicate that the drive is ready to receive the ECC bytes from the host. The data is transferred 16 bits at a time, and the ECC bytes are transferred 8 bits at a time. The number of ECC bytes are 4 or 18 according to setting of Set Feature option. The default number after power on is 4 bytes.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. The Sector Count must be set to one.

Sector Number The sector number of the sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

R The retry bit. If set to one, then retries are disabled.

Input Parameters From The Drive

Sector Count	The number of requested sectors not transferred.
Sector Number	The sector number of the sector to be transferred. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the sector to be transferred. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the sector to be transferred. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

The drive internally uses 18 bytes of ECC on all data read or writes. The 4 byte mode of operation is provided via an emulation technique. As a consequence of this emulation it is recommended that 18 byte ECC mode is used for all tests to confirm the operation of the drive ECC hardware. Unexpected results may occur if such testing is performed using 4 byte mode.

6.31 Write Multiple

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	1 1 0 0 0 1 0 1

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	V	V	–	0	–	V

Figure 6-40. Write Multiple Command (C5h)

The Write Multiple command transfers one or more sectors from the host to the drive. Command execution is identical to the Write Sectors command except that an interrupt is generated for each block (as defined by the Set Multiple command) instead of for each sector. The sectors are transferred through the Data Register 16 bits at a time.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

Input Parameters From The Drive

Sector Count The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.

Sector Number	The sector number of the last transferred sector. (L=0) In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0) In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0) In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.32 Write Sectors

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 0 1 1 0 0 0 R

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	0	0	V	0	V	0	0

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	V	V	–	0	–	V

Figure 6-41. Write Sectors Command (30h/31h)

The Write Sectors command transfers one or more sectors from the host to the drive. The sectors are transferred through the Data Register 16 bits at a time.

If an uncorrectable error occurs, the write will be terminated at the failing sector.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

R The retry bit. If set to one, then retries are disabled. But ignored, when write cache is enabled. (Ignoring the retry bit is in violation of CAM.)

Input Parameters From The Drive

Sector Count	The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.
Sector Number	The sector number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

6.33 Write Verify

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 L 1 D H H H H
Command	0 0 1 1 1 1 0 0

Command Block Input Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Error	...See Below...
Sector Count	V V V V V V V V
Sector Number	V V V V V V V V
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	– – – – H H H H
Status	...See Below...

Error Register							
7 BBK	6 UNC	5 0	4 IDN	3 0	2 ABT	1 T0N	0 AMN
V	V	0	V	0	V	0	V

Status Register							
7 BSY	6 RDY	5 DWF	4 DSC	3 DRQ	2 COR	1 IDX	0 ERR
0	V	V	V	–	V	–	V

Figure 6-42. Write Verify Command (3Ch)

The Write Verify command transfers one or more sectors from the host to the drive. The sectors are transferred through the Data Register 16 bits at a time. After the sectors are transferred to the drive, a verify operation is performed for each sector.

If an uncorrectable error occurs, the write will be terminated at the failing sector. Any errors encountered during the verify operation will be returned at the final interrupt.

Output Parameters To The Drive

Sector Count The number of continuous sectors to be transferred. If zero is specified, then 256 sectors will be transferred.

Sector Number The sector number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 0 - 7. (L=1)

Cylinder High/Low The cylinder number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)

H The head number of the first sector to be transferred. (L=0)

In LBA mode, this register contains LBA bits 24 - 27. (L=1)

Input Parameters From The Drive

Sector Count	The number of requested sectors not transferred. This will be zero, unless an unrecoverable error occurs.
Sector Number	The sector number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 0 - 7. (L=1)
Cylinder High/Low	The cylinder number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 8 - 15 (Low), 16 - 23 (High). (L=1)
H	The head number of the last transferred sector. (L=0)
	In LBA mode, this register contains current LBA bits 24 - 27. (L=1)

7. Timings

The timing of BSY and DRQ in Status Register are shown in Figure 7-1

The other timings are described in OEM Functional Specifications for DHAA-2270/DHAA-2405/DHAA-2540 2.5-Inch Hard Disk Drive with ATA Interface (Document number : S66G-8101).

FUNCTION	INTERVAL	START	STOP	TIMEOUT
Power On	Drive Busy After Power On	Power On	Status Register BSY=1	400 ns
	Drive Ready After Power On	Power On	Status Register BSY=0 and RDY=1	31 sec
Software Reset	Drive Busy After Software Reset	Device Control Register RST=1	Status Register BSY=1	400 ns
	Drive Ready After Software Reset	Device Control Register RST=1	Status Register BSY=0 and RDY=1	6 sec
Hard Reset	Drive Busy After Hard Reset	Bus RESET Signal Asserted	Status Register BSY=1	400 ns
	Drive Ready After Hard Reset	Bus RESET Signal Asserted	Status Register BSY=0 and RDY=1	31 sec
Data In Command	Drive Busy After Command Code Out	OUT to Command Register	Status Register BSY=1	400 ns
	Interrupt, DRQ For Data Transfer In	Status Register BSY=1	Status Register BSY=0 and DRQ=1, Interrupt	10 sec
	Drive Busy After Data Transfer In	256th Read From Data Register	Status Register BSY=1	10 us
Data Out Command	Drive Busy After Command Code Out	OUT to Command Register	Status Register BSY=1	400 ns
	Data Request For Data Transfer Out	Status Register BSY=1	Status Register BSY=0 and DRQ=1	20 ms
	Drive Busy After Data Transfer Out	256th Write From Data Register	Status Register BSY=1	5 us
	Interrupt For Data Transfer Out	Status Register BSY=1	Interrupt	10 sec
Non–Data Command	Drive Busy After Command Code Out	OUT to Command Register	Status Register BSY=1	400 ns
	Interrupt For Command Complete	Status Register BSY=1	Interrupt	6 sec

Figure 7-1. Timeout Values

FUNCTION	INTERVAL	START	STOP	TIMEOUT
DMA Data Transfer Command	Drive Busy after Command Code Out	Out to Command Register	Status Register BSY=1	400 ns

Figure 7-2. Timeout Values --- Continued ---

Command category is referred to 5, “Command Protocol” on page 5-1.

The abbreviations "ns", "us", "ms" and "sec" mean nanoseconds, microseconds, milliseconds and seconds, respectively.

8. Vendor Unique Functions

8.1 Drive Lock Function

Drive Lock is powerful security feature. With a drive lock password, user can prevent unauthorized access to hard disk drive even if the drive is removed from the computer.

New commands are supported for this feature as below.

- Set Password ('F1'h)
- Unlock ('F2'h)
- Erase Prepare ('F3'h)
- Erase Unit ('F4'h)
- Freeze Lock ('F5'h)
- Disable Password ('F6'h)

8.1.1 Operation example

8.1.1.1 Default setting

The Master Password is set to all ASCII blanks (20H) during manufacturing and the lock function is disabled.

The system manufacturer/dealer can set a new Master Password using the Set Password command, without enabling the lock function.

8.1.1.2 Initial Setting user password by System user

When a user password is set, the drive will automatically enter lock mode the next time the drive is powered on.

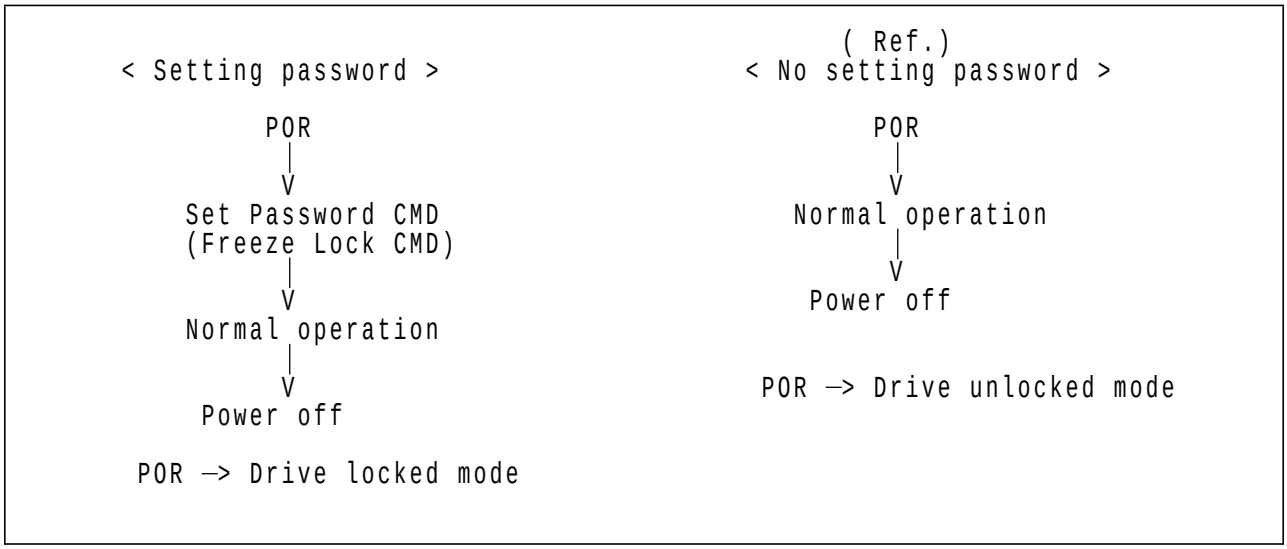
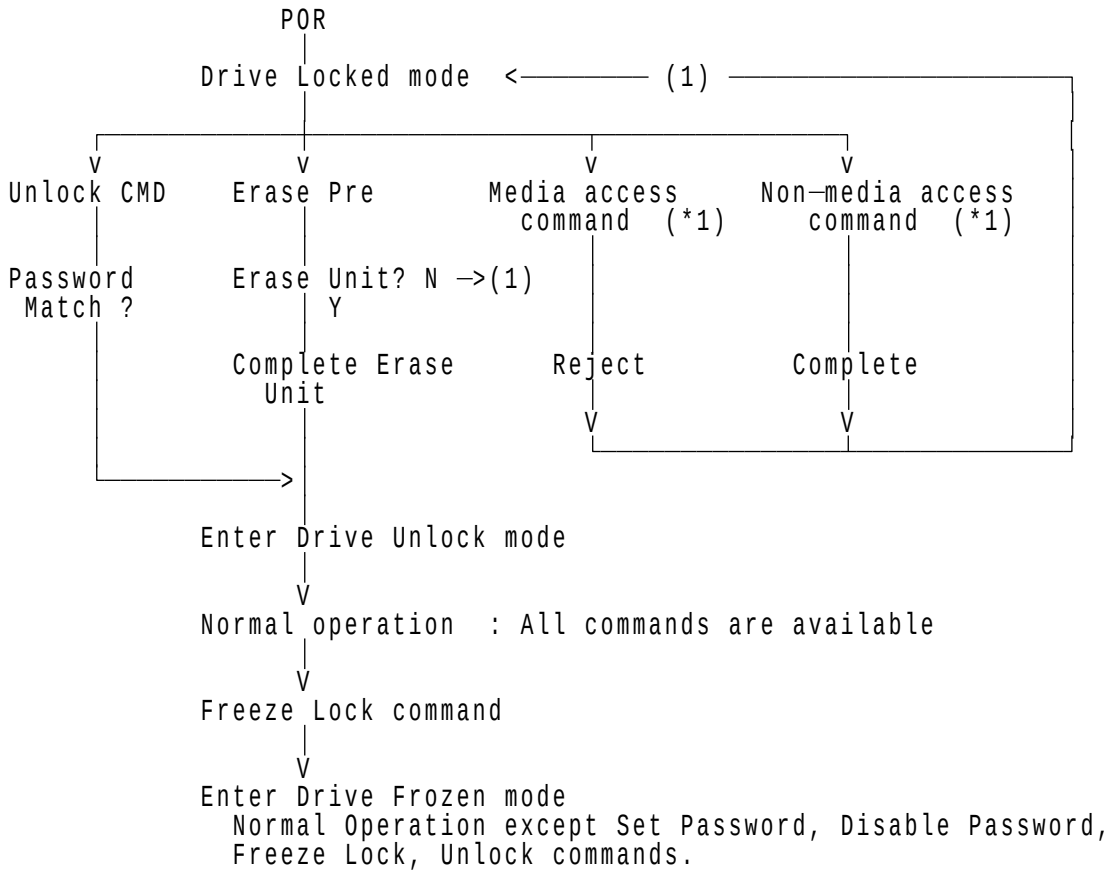


Figure 8-1. Initial Setting

8.1.1.3 Operation from POR after User Password is set

When drive lock is enabled, the drive rejects media access command until an Unlock command is successfully completed.



(*1) refer to command table in Figure 8-4 on page 8-5

Figure 8-2. Usually Operation

8.1.1.4 Password Lost

If the user password is forgotten and High level security is set, the user can't access any data. However the drive can be unlocked using the master password.

If a user forgets the user password and Maximum security level is set, data access is impossible. However the drive can be unlocked using the Erase Unit command to unlock the drive and erase all user data.

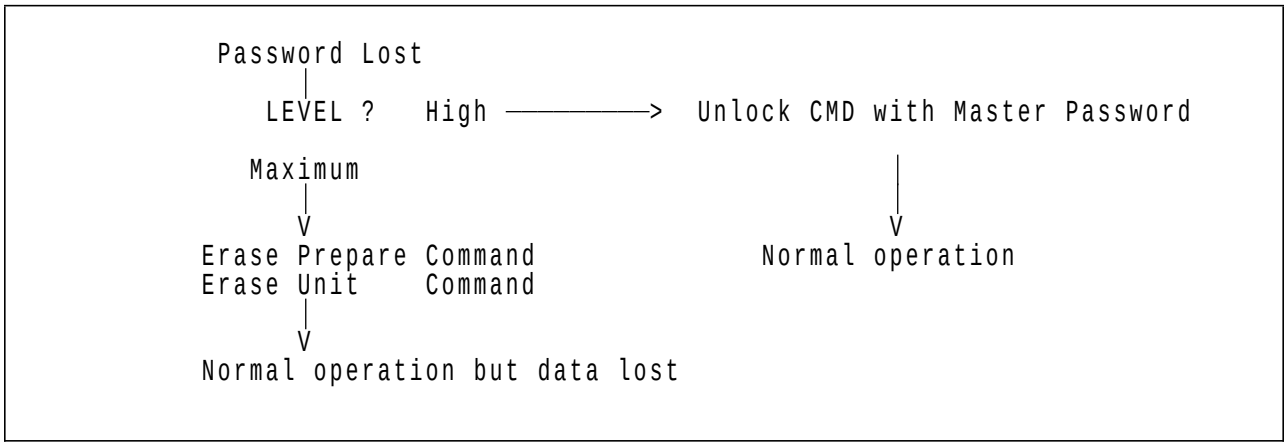


Figure 8-3. Password Lost

8.1.2 Command Table

This table shows the drive's response to commands when the Drive lock function is enabled.

Command	Drive Locked Mode	Drive Unlock Mode	Drive Frozen Mode
Check Power Mode	o	o	o
Disable Password	x	o	x
Execute Drive Diagnostic	o	o	o
Erase Prepare	o	o	o
Erase Unit	o	o	o
Format Track	x	o	o
Freeze Lock	x	o	x
Identify Drive	o	o	o
Idle	o	o	o
Idle Immediate	o	o	o
Initialize Drive Parameters	o	o	o
Read Buffer	o	o	o
Read DMA (w/o retry)	x	o	o
Read DMA (w/retry)	x	o	o
Read Long (w/o retry)	x	o	o
Read Long (w/retry)	x	o	o
Read Multiple	x	o	o
Read Sector(s) (w/o retry)	x	o	o
Read Sector(s) (w/retry)	x	o	o
Read Verify Sector(s) (w/o retry)	x	o	o
Read Verify Sector(s) (w/retry)	x	o	o
Recalibrate	o	o	o
Seek	o	o	o
Set Features	o	o	o
Set Multiple Mode	o	o	o
Set Password	x	o	x
Set Sleep Mode	o	o	o
Standby	o	o	o
Standby Immediate	o	o	o
Unlock	o	o	x
Write Buffer	o	o	o
Write DMA (w/o retry)	x	o	o
Write DMA (w/retry)	x	o	o
Write Long (w/o retry)	x	o	o
Write Long (w/retry)	x	o	o
Write Multiple	x	o	o
Write Sector(s) (w/o retry)	x	o	o
Write Sector(s) (w/retry)	x	o	o
Write Verify	x	o	o

o —— Drive executes command normally
x —— Drive terminates command with error register of Aborted Command.

Figure 8-4. Command table for drive lock operation

8.2 Write Cache Function

Write cache is a performance enhancement whereby the drive reports as completing the write command (Write Sectors and Write Multiple) to the host as soon as the drive has received all of the data into its buffer. And the drive assumes responsibility to write the data subsequently onto the disk.

8.2.1 Attention

- While writing data after completed acknowledgment of a write command, soft reset does not affect its operation. But hard reset or power off terminates writing operation immediately and unwritten data are to be lost. So hard reset or power off must not be done in 5 seconds after the completion of a write command.
- The retry bit of Write Sectors is ignored when write cache is enabled. This is in violation of CAM.

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