S84G-8402-00

OEM INTERFACE SPECIFICATIONS

for

DSAA-3xxx (281/365/548(528MB)/730MB)

3.5-Inch Hard Disk Drive with ATA Interface

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S84G-8402-00 (Rev. 1.0) February 23, 1994

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1.0 General

1.1 Introduction

This document describes the interface specifications of the following drives.

- DSAA-3270 (281MB)
- DSAA-3360 (365MB)
- DSAA-3540 (548/528MB)
- DSAA-3720 (730MB)

1.2 Related Document

- OEM Functional Specifications for DSAA-3xxx ((281/365/548(528)/730MB)) 3.5-Inch Hard Disk Drive with ATA Interface (S84G-8403-00).

1.3 Caution

Without the IBM shipping package, avoidance of shock/vibration damage is a user's responsibility. Once, opening ESD protective bug for shipment, avoidance of ESD damage is a user's responsibility.

1.4 References

- ISO/IEC Draft. ANSI X3.221 (Information technology AT Attachment Interface with Extensions ATA-2) Rev 0, Printed on September 01, 1993

2.0 Conformance

The drive conforms to the referenced specifications, with the limitations described below.

Automatic Power Down Sequence A hard reset will disable the automatic power down sequence.

Format Track	A drive will not perform a physical format. Instead it will simply write a data pattern of all zeros to the sectors which have been specified by the Format Track command. LBA mode for format track is not supported.
Format Track Interleave Factor	The drive only supports an interleave factor of 1:1, and may ignore any other specified interleave, without returning an error.
Write long	Write long command should be executed for the same sector after Read long command execution. Otherwise, unexpected ECC correctable error may occur. Because of the limitation of the emulation technique to support 4 byte ECC mode which is implemented in the drive.
Seek Overlap	The drive will wait for the seek to complete before interrupting the host. Therefore, no seek overlap can occur. This will be transparent to the host except that performance may be degraded in certain environments where the host could perform other work while waiting for seek complete, such as multitasking operating systems.
Sleep Mode	During Sleep mode the drive will be activated by any command, including, but not limited to, a soft reset.
Drive/Head Register	Bits 5 and 7 of Drive/Head Register are not written to 0. (These 2 bits are always read as '1' even after host writes to '0'..)
Auto Reallocation Jumper *1	(+)Auto reallocation jumper is checked during the initial power on reset (POR). This jumper position needs to be OPEN, if a user wants to use this function.
Write Cache Jumper *1	(+)Write cache jumper is checked during the initial POR. This jumper position needs to be OPEN, if a user wants to use this function.

Note *1 : Write cache becomes OFF automatically, if the Auto-Reallocation jumper is set for customer data protection.

(+)Auto reallocation jumper position needs to be OPEN when a user system wants to use write cache.

SET FEATURE COMMAND (Write Cache Enable/Disable) can only work with Auto Reallocation Jumper = OPEN (ON) and Write Cache = OPEN (ON).

3.0 Registers

Address	Input Register	Output Register
1F0h	Data	Data
1F1h	Error	Features
1F2h	Sector Count	Sector Count
1F3h	Sector Number *LBA Bits 0–7	Sector Number *LBA Bits 0–7
1F4h	Cylinder Low *LBA Bits 8–15	Cylinder Low *LBA Bits 8–15
1F5h	Cylinder High *LBA Bits 16–23	Cylinder High *LBA Bits 16–23
1F6h	Drive/Head /*LBA Bits 24–27	Drive/Head /*LBA Bits 24–27
1F7h	Status	Command
3F6h	Alternate Status	Device Control
3F7h	Drive Address	Not Used

Figure 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 read or write any registers when the Status Register BSY bit = 1.

Note: * means meaning registers in LBA mode.

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 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 9 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 10 on page 17.

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

3.3 Cylinder High Register

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

3.4 Cylinder Low Register

In CHS mode, 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.

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 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	2	1	0
–	–	–	–	1	SRST	–IEN	0

Figure 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 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 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 5. Drive/Head Register

This register contains the drive and head numbers.

Bit Definitions

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

HS3,HS2,HS1,HS0 If L=0, Head Select. These four bits select the head number. HS0 is the least significant. If L=1, HS0 through HS3 contain bit 24-27 of the LBA. At command completion, these bits are updated to reflect the current LBA bits 24-27.

L LBA mode. This bit selects the mode of operation. When L=0, addressing is by 'CHS' mode. When L=1, addressing is by 'LBA' mode.

3.9 Error Register

Error Register							
7 BBK	6 UNC	5 0	4 IDNF	3 0	2 ABRT	1 TK0NF	0 AMNF

Figure 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.

Following a power on, a reset, or completion of an Execute Drive Diagnostic command, this register contains a diagnostic code. See Figure 9 on page 12 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 used with the Set Features command to set the feature. See Set Features command description for parameters.

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 may be from one to the maximum number of sectors per track.

See the command descriptions for contents of the register at command completion (whether successful or unsuccessful).

3.13 Status Register

Status Register							
7 BSY	6 DRDY	5 DWF	4 DSC	3 DRQ	2 CORR	1 IDX	0 ERR

Figure 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.

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. 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 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.

4.0 Reset

4.1 Power On Reset

After power on, the drive performs hardware initialization and executes its internal diagnostics. During this time the spindle is spun up to its operating speed.

The registers are initialized as shown in Figure 8 on page 12.

4.2 Hard Reset

A hard reset will cause any task currently in progress to be aborted. The drive will then re-initialize its internal variables and execute its internal diagnostics.

A hard reset occurs when the host asserts the bus RESET signal.

The registers are initialized as shown in Figure 8 on page 12.

4.3 Software Reset

A software reset will cause any task currently in progress to be aborted. The drive will then re-initialize its internal variables and execute its internal diagnostics.

The registers are initialized as shown in Figure 8 on page 12.

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

4.4 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 8. Default Register Values

After power on, hard reset, or software reset, the register values are initialized as shown in Figure 8.

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 9. 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 9.

5.0 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 38 on page 53 shows the drive timeout values.

5.1 PIO 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 and ECC bytes are 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 and ECC bytes via the Data Register.

f. 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 data 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 PIO Data Out Commands

These commands are:

- Format
- Write Buffer
- Write Long
- Write Multiple
- Write Sectors

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 and ECC bytes via the Data Register.

c. The drive sets BSY=1 after it has received the sector and ECC bytes.

d. When the drive has finished processing the sector and ECC bytes, 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.

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 after the data transfer 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
- 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

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

1. Command Phase
   a. Host initialize the Slave-DMA channel
   b. Host updates the Command Block Registers
   c. Host writes command code to the Command Register
   d. The drive sets DRQ=0 after the sector (or block) has been transferred
2. Data Phase
   a. The Slave-DMA channel qualifies data transfers to and from drive with DMARQ
   b. The Drive acknowledges a request with DMACK
   c. Register contents are not valid during this phase
3. Status Phase
   a. Drive generates an interrupt to the host (HIRQ=1)
   b. Host resets the Slave-DMA Channel
   c. Host reads the Status and Error Registers

6.0 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
Execute Drive Diagnostics	90	1 0 0 1 0 0 0 0
Format Track	50	0 1 0 1 0 0 0 0
Identify Drive	EC	1 1 1 0 1 1 0 0
Idle	E3	1 1 1 0 0 0 1 1
Idle Immediate	E1	1 1 1 0 0 0 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
Sleep	E6	1 1 1 0 0 1 1 0
Standby	E2	1 1 1 0 0 0 1 0
Standby Immediate	E0	1 1 1 0 0 0 0 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

Figure 10. Command Set

Figure 10 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.

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.

L This bit selects the mode of operation. When L=0, addressing is by 'CHS' mode. When L=1, addressing is by 'LBA' mode.

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 11. 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 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 12. 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 9 on page 12 for the definition.

6.3 Format Track

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
Cylinder Low	V V V V V V V V
Cylinder High	V V V V V V V V
Drive/Head	1 0 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	– – – – – – – –
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	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 13. Format Track Command (50h)

The Format Track command formats a single track on the drive. Each 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 80h for a bad sector. The descriptor value of 20h is to unassign the alternate location for this sector. And the descriptor value of 40h is for assign this sector to an alternate location. The remaining bytes of the sector following the format table are ignored.

Output Parameters To The Drive

Cylinder High/Low The cylinder number of the track to be formatted.

H The head number of the track to be formatted.

Input Parameters From The Drive

Error The Error Register. An Abort error (ABT=1) will be returned under the following conditions:

- The cylinder number is not valid.
- The head number is not valid.

6.4 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 14. 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 15. The Identify Drive information is not affected by the Initialize Drive Parameters command.

Figure 15 (Page 1 of 3). Identify Drive Information

Word	Content	Description
00	045CH	• Drive classification, bit assignments: – 15(=0): reserved for non-magnetic drives – 14(=0): format speed tolerance gap not required – 13(=0): track offset option not available – 12(=0): data strobe offset option not available – 11(=0): rotational speed tolerance < = 0.5% – 10(=1): disk transfer rate > 10 Mbps – 9(=0): disk transfer rate not (> 5 Mbps but < = 10 Mbps) – 8(=0): disk transfer rate not (< = 5 Mbps) – 7(=0): not removable cartridge drive – 6(=1): fixed drive – 5(=0): spindle motor control option not implemented – 4(=1): head switch time > 15 us – 3(=1): not MFM encoded – 2(=1): soft sectored – 1(=0): not hard sectored – 0(=0): reserved
01	954	Number of Cylinders. DSAA-3270
	929	Number of Cylinders. DSAA-3360
	1024	Number of Cylinders. DSAA-3540 (528MB)
	1062	Number of Cylinders. DSAA-3540 (548MB)
	1416	Number of Cylinders. DSAA-3720
02	0	reserved
03	16	Number of heads. DSAA-3270
	16	Number of heads. DSAA-3360
	16	Number of heads. DSAA-3540 (528MB/548MB)
	16	Number of heads. DSAA-3720
04	59400	Number of unformatted bytes per track.
05	550	Number of unformatted bytes per sector
06	36	Number of sectors per track DSAA-3270
	48	Number of sectors per track DSAA-3360
	63	Number of sectors per track DSAA-3540(528MB/548MB)
	63	Number of sectors per track DSAA-3720
07-09	0	Vendor Unique
10-19	XXXX	Serial number in ASCII
20	0003H	A dual ported, multi-sector buffer capable of simultaneous transfers with a read caching.
21	00C0H	Buffer size in 512-byte increments

Figure 15 (Page 2 of 3). Identify Drive Information		
Word	**Content**	**Description**
22	0010H	Number of ECC bytes
23-26	XXXX	Microcode revision (ASCII)
27-46	DSAA-3270	Model number in ASCII
	DSAA-3360	Model number in ASCII
	DSAA-3540	Model number in ASCII
	DSAA-3720	Model number in ASCII
47	0020H	Number of sectors that can be transferred per interrupt on Read and Write Multiple commands
48	0000H	cannot perform doubleword I/O
49	0B00H	IORDY, LBA and DMA are supported
50	0000H	Reserved
51	0200H	PIO data transfer cycle timing mode 2 is supported
52	0200H	DMA data transfer cycle timing mode 2 is supported
53	0003H	Words 54-58 are valid.
54		Number of current cylinders
55		Number of current heads
56		Number of current sectors per track
57-58		Current capacity in sectors
59	01xxH	Multiple Sector Setting is Valid. xx = current setting for multiple commands.
	0000H	Multiple Sector Setting is no valid.
60-61	00086280H	Number of LBAs for DSAA-3270
	000AE300H	Number of LBAs for DSAA-3360
	000FC000H	Number of LBAs for DSAA-3540 (528MB)
	001055A0H	Number of LBAs for DSAA-3540 (548MB)
	0015C780H	Number of LBAs for DSAA-3720
62	0x07H	Single word DMA Mode 2 is supported. The high order byte contains a single bit set to indicate which mode is active.
63	0x03H	Multiword DMA Mode 1 is supported. The high order byte contains a single bit set to indicate which mode is active.

Figure 15 (Page 3 of 3). Identify Drive Information		
Word	**Content**	**Description**
64	0001H	PIO Mode 3 is Not Supported.
65	00F0H	Minimum multiword DMA cycle time is 240ns.
66	00F0H	Recommended multiword DMA cycle time is 240ns.
67	00F0H	Minimum PIO Transfer Cycle Time without flow control, 240ns.
68	00B4H	Minimum PIO Transfer Cycle Time with IORDY flow control, 240ns.
69-255	0000H	reserved

Logical Drive Format (Reference)

The customer usable data capacity is as shown below.

Descriptions	**&Model15.**	DSAA-3360	DSAA-3540 **(CLIPPED)**	DSAA-3720
Logical Head Number	16	16	16	16
Logical Sectors/Track	36	48	63	63
Logical Cylinder Number	954	929	1062 (1024)	1416
Logical Sector Size	512	512	512	512
Total Customer Usable Data Sectors	549,504	713,472	1,070,496 (1032192)	1,427,328
Total Customer Usable Data Bytes	281 MB	365 MB	548 (528)MB	730 MB

6.5 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 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 automatic power down sequence is disabled. If non-zero, then the automatic power down sequence is enabled, and the timeout interval is set to the Timeout Parameter times 5, in seconds, for the value range from 12 to 255. If the value is 1 to 11, the Timeout Parameter is 60 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.

6.6 Idle Immediate Parameters

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	– – – – – – – –
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 17. Idle Immediate Command (E1h)

The Idle Immediate command causes the drive to set BSY, enter the Idle Mode, clear BSY, and generate an interrupt. When the Idle Immediate command is received during the Standby mode, the drive will spin up to become ready to execute drive access command without delay.

6.7 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 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.

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.

6.8 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 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.

6.9 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	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 20. Read DMA Command (C8h/C9h)

This command executes in a similar manner to the Read Sectors command except for the following:

- The host initialize 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.

Any unrecoverable error encountered during execution of a Read DAM command results in the termination of data transfer. The Drive issues an interrupt to indicate that data transfer has terminated and Status is available in the Error register. The error posting is the same as that for the write sectors command.

Output Parameters To The Drive

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

Sector Number The sector number of the first sector to be transferred.

Cylinder High/Low The cylinder number of the first sector to be transferred.

H The head number of the first sector to be transferred.

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 sector transferred.
Cylinder High/Low	The cylinder number of the last sector transferred.
H	The head number of the last sector transferred.

6.10 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 21. Read Long Command (22h/23h)

The Read Long command requests the file to transfer 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.

Output Parameters To The Drive

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

Sector Number The sector number of the sector to be transferred.

Cylinder High/Low The cylinder number of the sector to be transferred.

H The head number of the sector to be transferred.

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 transferred.

Cylinder High/Low The cylinder number of the sector transferred.

H	The head number of the sector transferred.

6.11 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 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.

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

Output Parameters To The Drive

Sector Count The number of contiguous 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.

Cylinder High/Low The cylinder number of the first sector to be transferred.

H The head number of the first sector to be transferred.

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 sector transferred.

Cylinder High/Low The cylinder number of the last sector transferred.

H The head number of the last sector transferred.

6.12 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 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 contiguous 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.

Cylinder High/Low The cylinder number of the first sector to be transferred.

H The head number of the first sector to be transferred.

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 sector transferred.

Cylinder High/Low The cylinder number of the last sector transferred.

H The head number of the last sector transferred.

6.13 Read Verify 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 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 contiguous 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 verified.

Cylinder High/Low The cylinder number of the first sector to be verified.

H The head number of the first sector to be verified.

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 sector verified.

Cylinder High/Low The cylinder number of the last sector verified.

H The head number of the last sector verified.

6.14 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 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.

6.15 Seek

Command Block Output Registers	
Register	7 6 5 4 3 2 1 0
Data	– – – – – – – –
Feature	– – – – – – – –
Sector Count	– – – – – – – –
Sector Number	– – – – – – – –
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	– – – – – – – –
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	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 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

Cylinder High/Low The cylinder number of the seek.

H The head number of the seek.

6.16 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	– – – – – – – –
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 27. Set Features Command (EFh)

The Set Features command is used by the host to establish the following parameters which affect the execution of certain drive features as shown in Figure 28. If the value in the register is other than one defined in the table, the drive posts an Aborted Command Error.

Figure 28. Set Feature Parameters

	Description
02h	Enable Write Cache
03h	Set Transfer Mode based on value in Sector Counter Register
44h	Vendor unique length of ECC on Read Long/Write Long command
55h	Disable read look-ahead feature
66h	Disable reverting to power on defaults
82h	Disable Write Cache
AAh	Enable read look-ahead feature
BBh	4 bytes of ECC apply on Read Long/Write Long commands
CCh	Enable reverting to power on defaults

At power on, or after a hardware reset, the default mode is 02h,66h,0AAh and 0BBh. A setting of 66h allows settings which may have been modified since power on to remain at the same setting after a soft reset.

A host can choose the transfer mechanism by Set Transfer Mode and specifying a value in the Sector Count Register. The upper 5 bits define the type of transfer and the low order 3 bits encode the mode value:

```
PIO default mode          00000 000
Single word DMA mode x    00010 0nn   (nn=00, 01, or 10)
Multiword DMA mode x      00100 0nn   (nn=00, 01)

where 'nn' is a valid mode number in binary bit for the associated
transfer type.
```

6.17 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 29. 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.

At power on, or after a hardware reset, the default mode is Read and Write Multiple disabled. If Disable Default has been set in the Features Register then the mode remains the same as that last established prior to a soft reset, otherwise it reverts to the default of 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 are 0, 2, 4, 8, 16, and 32. If 0 is specified, then Read Multiple and Write Multiple commands are disabled.

6.18 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 30. Sleep Command (E6h)

The Sleep command causes the drive to enter Standby mode, which is its minimal power mode. If the drive is not already spun down, the spin down sequence is executed. After the drive has stopped, BSY is set to 0, and the host is interrupted.

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

6.19 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 31. 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.

If the Sector Count Register is non-zero then the automatic power down sequence shall be enabled and the timer will begin counting down when the drive returns to Idle mode. If the Sector Count Register is zero then the automatic power down sequence shall be disabled.

Output Parameters To The Drive

Sector Count Timeout Parameter. If zero, then the automatic power down sequence is disabled. If non-zero, then the automatic power down sequence is enabled, and the timeout interval is set to the Timeout Parameter times 5, in seconds, for the value range from 12 to 255. If the value is 1 to 11, the Timeout Parameter is 60 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.

6.20 Standby Immediate Parameters

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	– – – – – – – –
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 32. Standby Immediate Command (E0h)

The Standby Immediate command causes the drive to set BSY, enter the Standby Mode, clear BSY, and generate an interrupt. The spindle will be stopped to reduce the power usage. The Host interface is always ready to receive a command from the host. Any media access command will cancel the Standby mode. The host is required to resend the Standby Immediate command to spin down the drive.

6.21 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 33. 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.

6.22 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 34. Write DMA Command (CAh/CBh)

This command executes in a similar manner to the Write Sectors command except for the following:

- The host initialize 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.

Any unrecoverable error encountered during execution of a Write DAM command results in the termination of data transfer. The Drive issues an interrupt to indicate that data transfer has terminated and Status is available in the Error register. The error posting is the same as that for the write sectors command.

Output Parameters To The Drive

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

Sector Number The sector number of the first sector to be transferred.

Cylinder High/Low The cylinder number of the first sector to be transferred.

H The head number of the first sector to be transferred.

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 sector transferred.
Cylinder High/Low	The cylinder number of the last sector transferred.
H	The head number of the last sector transferred.

6.23 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 35. Write Long Command (32h/33h)

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

The data is transferred 16 bits at a time, and the ECC bytes are transferred 8 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 contiguous sectors to be transferred. The Sector Count must be set to one.

Sector Number The sector number of the sector to be transferred.

Cylinder High/Low The cylinder number of the sector to be transferred.

H The head number of the sector to be transferred.

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 transferred.

Cylinder High/Low The cylinder number of the sector transferred.

H The head number of the sector transferred.

6.24 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 36. 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.

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

Output Parameters To The Drive

Sector Count The number of contiguous 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.

Cylinder High/Low The cylinder number of the first sector to be transferred.

H The head number of the first sector to be transferred.

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 sector transferred.

Cylinder High/Low The cylinder number of the last sector transferred.

H The head number of the last sector transferred.

6.25 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 37. 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.

When write cache is disable, the write will be terminated at the failing sector if an uncorrectable error occurs.

When write cache is enable, automatic reallocation will be invoked at the failing sector if an uncorrectable error occurs and the write will be completed normally.

Output Parameters To The Drive

Sector Count The number of contiguous 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.

Cylinder High/Low The cylinder number of the first sector to be transferred.

H The head number of the first sector to be transferred.

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 sector transferred.

Cylinder High/Low	The cylinder number of the last sector transferred.
H	The head number of the last sector transferred.

7.0 Timings

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	1 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	700 us
	Interrupt For Command Complete	Status Register BSY=1	Interrupt	6 sec

Figure 38. Timeout Values

The host must always give the drive sufficient time to perform each command or command phase. Figure 38 shows the commands and command phases, and the minimum timeout intervals that the host should wait before reporting an error. The abbreviations "ns", "us", "ms" and "sec" mean nanoseconds, microseconds, milliseconds and seconds, respectively.

The timeout values shown do not relate to normal drive performance. They are based on worst case conditions, with an added safety margin. Since timeout conditions will be very rare events, host performance will not be affected by the added safety margin.

It is recommended that the host use processor-independent timing loops, so that the timeout intervals will still be valid when faster processors are implemented.

When issuing a software reset, the host must set Device Control register bit RST=1 and wait for at least 5 microseconds before setting RST=0, to ensure that the drive recognizes the reset.

Appendix A. Cache

A.1 Read Look-Ahead

The drive keeps the buffers segmented into 32 Kbytes as read/write cache.

- Least Frequent Used buffer is discarded to save the newly requested data.

A.2 Write Cache

When the write cache is enabled, write cache uses a dedicated 32 Kbytes buffer. (The write cache is enabled by checking jumper setting at power-on-reset period. And if the jumper setting is for enabling write cache, this can be enabled or disabled by sending set features commands.)

- If the previous command is WRITE, and the block requested is consecutive to the previous, the drive will return "COMPLETE" after all data is received in the drive buffer.
- Soft reset is recommended to check the actual data writing to media, i.e., soft reset is processed after the previous write command (with cache) completes the actual writing to media.
- Certain power down during Write Cache operation may result in Non-recoverable error later. Write to the broken sector will recover this sector.
- Automatic reallocation will be invoked at the failing sector if a non-recoverable error occurs and the write will be completed normally.
- If the drive runs out of spares for reallocation, write cache and reallocation will be turned off.
- If the drive is unable to complete a cached write and/or reallocation after good status has been returned,the drive will not process any commands including a soft reset. This condition will be cleared at power on,or a hardware reset.
- It is possible to check if the data in the write cache have been written onto the disk by successful completion of Soft Reset or the following commands.

  Check Power Mode, Execute Drive Diagnostics, Format Track, Identify Drive, Idle, Idle Immediate, Initialize Drive Parameters, Read Buffer, Read Long with Retry, Read Long without Retry, Recalibrate, Seek, Set Features, Set Multiple, Sleep, Standby, Standby Immediate, Write Buffer, Write Long with retry, Write Long without Retry.

Appendix B. Index

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